THE CITY OF THORNTON
Infrastructure Engineering
9500 CIVIC CENTER DRIVE
THORNTON, CO 80229-4326

Volume - 2
Project Manual
For
Construction of

112th Ave Intersection Improvements
Birch Drive - Traffic Signal

PROJECT NO. 21-93

December 2022

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TECHNICAL SPECIFICATIONS

CITY OF THORNTON
112th Avenue Intersection Improvements – Birch Drive Traffic Signal
Project No. 21-093

The latest editions of the 2021 CDOT Standard Specifications for Road and Bridge Construction and Thornton Engineering Construction Standards and Specifications control 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

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REVISION OF DIVISION 100
GENERAL PROVISIONS

Unless otherwise noted, all Division 100 General Provisions are deleted and replaced with the City of Thornton's Contract Documents included in Volume 1.

Any references to Division 100 in Divisions 200 through 700 are removed. The City of Thornton General and Special Provisions shall apply for any removed provisions.

Section 105.7 Conformity to Roadway Smoothness Criteria of HMA shall be included in this contract.

Section 106 as revised herein shall be included in the Contract.

Other General Provisions:

1. **The City's standard details are referenced on the drawings and utilized for this project. Some of the details have been modified for the specific needs of this project. The Contractor shall not obtain City standard detail from the City's website or other sources and shall only use the standard City details presented on the drawings.**

1

REVISION OF SECTION 106
CONTROL OF MATERIAL

Section 106 of the Standard Specifications is hereby replaced with the following:

106.01 Quality Control Testing. The Contractor shall be responsible for Quality Control Testing for this project. The following minimum testing shall be included:

1. Concrete Tests for Concrete Work (traffic signal caissons, curb & gutters, etc.):
    - One (1) test series shall be taken per 50 cubic yards (or fraction thereof) of the concrete placed per day, or as directed by the Owner.
    - Field cured test series: four (4) cylinders, one (1) to be broken at seven (7) days or as directed by the Owner.
    - Lab cured test series: four (4) cylinders one (1) to be broken at seven (7) days; two (2) to be broken at 28 days. One (1) to be held for 56 day break should the 28 day breaks fail. Approval based on lab tests verified by field samples if necessary.

- Determine slump of the concrete sample of each strength test whenever consistency of concrete appears to vary, or when directed by the Infrastructure Engineering Manager, in accordance with AASHTO Tll9.

- Determine air content of the concrete sample for each strength test

2. Compaction Testing - Subgrade:
   - Field moisture-density tests shall be required at random locations at the rate of one (1) for each 250 linear feet of paving for each travel lane.

3. Compaction Testing – Aggregate Base Course:
   - At least one (1) sample of aggregate base course for each 500 tons of material placed shall be tested to determine gradation and Atterberg limits.
   - During placement and compaction, Compaction Curves shall be required for each material used.
   - Field moisture-density tests shall be taken of each lift of material at random locations, at approximate intervals of 250 feet in each travel lane and 100-foot intervals in the parking lot. At least 20% of the tests shall be taken within one (1) foot of manholes, valves and curbs.

4. Compaction Testing - Fill:
   - In-place moisture-density / percent relative compaction: 1 per 500 cu yds. or fraction thereof with one additional test required per change in material type being placed with minimum 1 test per lift.

3
REVISION OF SECTION 106
CONTROL OF MATERIAL

106.02 Measurement and Payment

The cost of sampling, testing, and corrective action by the Contractor will not be paid for separately but shall be included in the work.

The Pay Item price for Quality Control shall also include any "startup" or incidental costs necessary to provide quality control, including but not limited to any necessary Construction Equipment, offices, buildings, Materials or Equipment, or personnel.

Payments for Quality Control shall be made on a monthly basis in accordance with the following formula:

Contract Amount Completed		Quality Control Amount Paid
25%	=	25%
50%	=	50%
75%	=	75%
100%	=	100%

Payment will be made under:

Pay Item	Pay Unit
Quality Control	Lump Sum

END OF SECTION

1
REVISION OF SECTION 107
PERFORMANCE OF CRITICAL WORK

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

107.061 Performance of Safety Critical Work. The following work elements are considered safety critical work for this project:

(1) Removal of bridge

The Contractor shall submit, for review, an initial, detailed construction plan that addresses safe construction methods for each of the safety critical elements applicable to this project. The Engineer will submit the plans to City of Thornton for a concurrent review. The Engineer's review will be for general conformance with the plans, specifications, best management practices regarding safety of the operation and industry standards. 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 be reviewed for acceptance by the Engineer.

2
REVISION OF SECTION 107
PERFORMANCE OF CRITICAL WORK

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 work required: falsework, bracing, shoring, etc.

(5) Underground, above grade, and overhead utilities identification and protective steps taken.

(6) Communication plan as necessary with stakeholders, media, and the public.

(7) Additional actions that will be taken to ensure that the work will be performed safely.

(8) 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

(9) 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

(10) The construction plan shall address how the Contractor will handle contingencies such as:
   A. Unplanned events (storms, traffic accidents, work 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. Unexpected absence of critical management team
   F. Equipment failure
   G. Other potential difficulties inherent in the type of work being performed

(11) 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.

(12) 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.

3
REVISION OF SECTION 107
PERFORMANCE OF CRITICAL WORK

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. Communications staff (Contractor or CDOT) shall also attend in order to address any public/media needs.

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 Work. 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, or an authorized representative, is on the project site. The Contractor's Engineer shall be onsite 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 onsite 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 which 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 108.06.

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.

The Contractor shall not be relieved from ultimate liability for unsafe or negligent acts or receive a waiver of the Colorado Governmental Immunity Act on behalf of the Department.

1

REVISION OF SECTION 201
CLEARING AND GRUBBING

Section 201 of the Standard Specifications is hereby revised for this project as follows:

Subsection 201.01 shall include the following:

All trees and shrubs adjacent to and within the project limits shall be protected with the exception of those specified within the Plans to be removed.

Removal of small brush and trees with trunk diameter (caliper) less than 6-inches will not be measured and paid for separately but shall be included in the work.

Temporary easement areas shall not be cleared and grubbed unless absolutely necessary for construction purposes. Limits of clearing and grubbing shall be field verified by the Owner after field staking has been completed and prior to clearing and grubbing.

Subsection 201.02 shall include the following:

The Contractor shall make necessary arrangements for obtaining suitable disposal locations. If disposal will be at other than established dump sites, the City may require the Contractor to furnish written permission from the property owner on whose property the materials and debris will be placed.

In subsection 201.02 delete the 3rd, 4th, and 5th paragraphs and replace them with the following:

Surface objects and trees, stumps, roots, and other protruding obstructions not designated to remain shall be cleared and/or grubbed as required, to ensure complete removal; however, nonperishable, non-toxic objects which shall be a minimum of two (2) feet below subgrade may remain when such objects will not impede other subsurface operations.

Except in areas to be excavated, stump holes, and other holes from which obstructions are removed shall be backfilled with suitable material and compacted in accordance with subsection 203.06. Materials and debris shall be disposed of in a manner acceptable to the City.

Burning of any materials shall not be permitted without prior written approval of the City, the County Health Department, and Fire Department. If permitted, perishable material shall be burned under the constant care of the Contractor, at times and in a manner that will not endanger the surrounding vegetation, adjacent property, or objects designated to remain. Burning shall be done in accordance with applicable laws and ordinances.

2
REVISION OF SECTION 201
CLEARING AND GRUBBING

Subsection 201.04 shall include the following:

Payment will be made under:

Pay Item	**Pay Unit**
Clearing and Grubbing	Lump Sum

END OF SECTION

1

REVISION OF SECTION 202
REMOVAL OF STRUCTURES AND OBSTRUCTIONS

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

In Subsection 202.02 delete the 1st paragraph and replace it with the following:

The Contractor shall raze, remove, and dispose of foundations, signs, structures, fences, pavements, utilities, traffic signal materials, and other obstructions, which are designated for demolition within the project limits, except for utilities and for materials which are to be preserved or salvaged.

Subsection 202.02 shall include the following:

Where portions of structures are to be removed, the remaining portions shall be prepared to fit new construction. The work shall be done in accordance with plan details and in such a manner that materials to be left in place shall be protected from damage. Damage to portions of structures which are to remain in place shall be repaired at the expense of the Responsible Party. Reinforcing steel, projecting from the remaining structure, shall be cleaned and aligned to provide bond with new extension. Dowels shall be securely grouted with City-approved grout. Remaining structures are to be delineated in the as-built drawings.

Storm sewers, culverts, waterlines, and other conduits that are to be removed shall be saw-cut, completely removed, and disposed of off-site. Storm sewers, culverts, waterlines, and other conduits that are to be abandoned in place shall be saw-cut, and completely filled with flash or flow fill. All of the Contractor's costs, for removing and disposing of conduits or abandoning conduit pipes in place shall be included in the bid price for the particular item that requires removal and/or abandonment of structures and obstructions.

Removal of existing signs shall include the removal and disposal of all types and classes of traffic signs designated to be removed on the drawings. Pedestals and bases from sign posts and similar structures shall be removed to one (1) foot below the proposed subgrade.

2
REVISION OF SECTION 202
REMOVAL OF STRUCTURES AND OBSTRUCTIONS

Fire hydrant, valves, and waterlines:

All salvable material shown on the Plans or as directed shall be removed, without unnecessary damage, in sections or pieces that may be readily transported, and delivered by the Contractor to the location noted above, or as directed by the Engineer. The Contractor shall be held responsible for the safekeeping of all salvable materials during the period of the Contract until they are delivered to the City of Thornton location. The Contractor shall make good or replace at his own expense any such materials damaged, stolen or otherwise lost prior to receipt by City of Thornton. All salvable materials, as designated on the Plans or as directed, shall remain the property of City of Thornton.

There are existing boulders within the project area that are prescribed on the Plans to be removed. The Contractor shall coordinate with the City of Thornton on where to deliver the boulders. Should the City not want the boulders, they shall be become the property of the contractor.

Subsection 202.11 shall include the following:

When specifically noted on the drawings, the Removal of Full Depth Asphalt Pavement shall include the removal of all aggregate base course material below the asphalt to native soil. The Removal of aggregate base course under existing asphalt shall be considered incidental to Removal of Full Depth Asphalt Pavement. The assumed depth of existing asphalt, along 112th Avenue is 5 to 8 inches thick.

There will be no measurement and payment for saw cutting required for the removal of asphalt and concrete. Saw cutting shall be considered incidental to bid items which require saw cutting.

The Removal of Pavement Markings for traffic control will not be measured and paid for separately but shall be considered incidental to Removal of Asphalt Mat or Removal of Full Depth Asphalt. Variable milling as shown on the Construction Plans will not be measured and paid for separately, but shall be considered incidental to Removal of Asphalt Mat.

The Removal of Trees shall include tree stumps and roots by pre-approved methods by the City. Remove stumps and roots of removed plants to depths needed for installation of new plants. Fill voids left by stump/root removal with amended topsoil mix as specified in the PLANTING section of these specifications. The Contractor shall visit the site to view all trees that are designated to be removed. Several trees have multiple trunks. Removal of trees with multiple trunks shall be considered removal of one tree.

Removal of concrete flatwork shall include: over excavation; moisture conditioning the over excavated soil; replacing and compacting the over excavated soil, providing suitable material if the over excavated soil is not suitable; disposal of unsuitable material; all in accordance with the soils report to provide a suitable base for fill and/or the pavement section.

3

REVISION OF SECTION 202

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

Subsection 202.12 shall include the following:

Payment includes all labor, equipment, saw cutting, and materials necessary to complete the work. All costs associated with stockpiling, safekeeping, and delivering salvaged materials to the City of Thornton shall be included in the work.

No material or debris shall be disposed of within the project limits without the written permission of the Engineer. The Contractor shall advise the Engineer in writing of the intended disposal site before the disposal site is used; and provide documentation confirming the property owner's acceptance of such materials.

There will be no separate measurement or payment of removal of different types of fencing and gates. All types of fencing and gates shall be measured and paid for under pay item Removal of Fence.

Payment will be made under:

Pay Item	Pay Unit
Removal of Curb and Gutter	Linear Foot
Removal of Asphalt Mat [Full Depth]	Square Yard
Removal of Ground Sign	Each
Removal of Light Standard	Each

END OF SECTION

1
REVISION OF SECTION 208
EROSION CONTROL

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

Subsection 208.01 shall include the following:

The Contractor shall provide routine inspection and maintenance of final erosion control BMPs and temporary BMPs left on-site for one year after final acceptance of the project by the City. This work shall be completed in accordance with the requirements of this section.

After one year, the Contractor shall remove all temporary BMPs. Inspection reports shall be delivered to the City within 48 hours after each inspection. When maintenance is required, the Contractor shall notify the City 48 hours prior to completing maintenance. The Contractor shall anticipate 24 inspections (twice monthly).

Subsection 208.11 shall include the following:

There will be no measurement and payment made for erosion control maintenance before final acceptance of the project.

There will be measurement and payment made for erosion control maintenance after final acceptance of the project under Erosion Control Maintenance (1-Year).

In subsection 208.11 delete the 1st paragraph and replace it with the following:

Erosion Control Management will not be measured and paid for separately but shall be considered incidental to the project regardless of the number of ECIs required. Erosion Control Management shall include, but is not limited to, erosion control inspections, documentation, meeting participation, SWMP Administration, and the preparation of the SWMP notebook.

There will be no separate measurement or payment for maintenance of individual BMPs while under the Erosion Control Maintenance (1-year) pay item. Erosion Control Maintenance includes, but is not limited to, removal of sediment, and adjustment of erosion logs and/or silt fence.

In subsection 208.12 delete the 5th paragraph after the list of pay items.

2
REVISION OF SECTION 208
EROSION CONTROL

Section 208.12 shall include the following:

Erosion Control Management, Removal and Disposal of Sediment (Equipment), Removal and Disposal of Sediment (Labor), Sweeping and Trash Removal, Stabilized Staging Area, Stockpile Management, Dust Control, Good Housekeeping Practices, and Sediment Trap are required as part of the project SWMP and ESCP but will not be measured and paid for separately but shall be considered incidental to the project.

Payment will be made under:

Pay Item	Pay Unit
Erosion Log (Type 1) (12 inch)	Linear Foot
Silt Fence	Linear Foot
Storm Drain Inlet Protection (Type 1)	Linear Foot
Concrete Washout Structure	Lump Sum

END OF SECTION

1
REVISION OF SECTION 211
DEWATERING

For all traffic signal caissons excavation, the Contractor shall provide suitable equipment materials and labor to remove surface and ground water, lower and control groundwater table levels and hydrostatic pressures to permit the required construction to be performed in accordance with the plans and specifications. Control of surface water shall be considered part of this work.

Contractor shall submit a dewatering plan to the Engineer for review prior implementing any dewatering efforts.

Disposal of water shall be completed in a manner such that it complies with the required permits for disposal, it will not endanger portions of work under construction or completed, it will not cause flooding to streets or adjacent properties, runoff is controlled, and is not a menace to public health or convenience.

The Contractor shall obtain from the Colorado Department of Public Health and Environment (CDPHE) a permit to discharge water removed from excavations and operations. The Contractor shall assume full responsibility for compliance with the terms and conditions of the permit and shall pay all associated permit fees.

Dewatering will not be measured but will be paid by lump sum. The lump sum shall include all work necessary to dewater sections of the Work if groundwater and wet subsurface soil conditions are encountered. Groundwater may be encountered at various depths during excavation for this project. The project work will require adequate dewatering measures to enable construction to proceed in relatively dry conditions. Water control measures shall include, but are not limited to diversions, sumps with pumps or other means necessary to maintain the level of groundwater below subgrade elevation and to divert surface water away from the work area. The Contractor is responsible for investigating and familiarizing himself with respect to all site conditions that may affect the work, including surface water, level of groundwater and time of year the work is to be done.

Payment will be based on the percentage of completed and accepted Work. One third of the lump sum price for this item will be paid after twenty-five percent (25%) of the original Contract amount has been earned, the second third after fifty percent (50%) of the original Contract amount has been earned, and the final third will be paid upon final acceptance of the Project.

The Engineer shall be notified when dewatering operations are required. Dewatering requires approval from the Engineer in order to be paid.

Payment will be made under:

Pay Item	Pay Unit
Dewatering – Caissons	Lump Sum

END OF SECTION

1

REVISION OF SECTION 304
AGGREGATE BASE COURSE

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

Delete Subsection 304.02 and replace it with the following:

Aggregate base course materials shall be from a source approved by the City. The Contract shall provide a submittal including all material properties for review and approval prior to construction.

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

The Aggregate Base Course (Class 6) shall meet the gradation requirements and have a resistance value of at least 78 when tested by the Hveem Stabilometer method.

Acceptance will be based on random samples taken from each lift.

Subsection 304.04 shall include the following:

Materials shall be placed on an approved subgrade which has been proof-rolled within the past 24 hours and found to be stable and non-yielding. Should weather conditions change, such as freezing, precipitation, etc., aggregate base materials shall not be placed until the subgrade is reapproved.

Delete Subsection 304.07 and replace it with the following:

Measurement shall be based on tons taken from the weight tickets provided to the City at time of delivery to the site.

Delete Subsection 304.08 and replace it with the following:

The accepted quantities of aggregate base course, of the class specified, 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 (Class 6)	Ton
Aggregate Base Course (Class 6) (Subgrade, Under HMA)	Ton

Water will not be measured and paid for separately but shall be included in the work.

Commercial mineral fillers, when used, shall be considered incidental to the bid item for Aggregate Base Course

END OF SECTION

1

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(75)	S(75)	SX(50)	S(50)		Patching
Air Voids, percent at: N (design)	CPL 5115		3.5 – 4.5				3.5 – 4.5
Lab Compaction (Revolutions): N (design)	CPL 5115		75				75
Stability, minimum	CPL 5106		30				30
Aggregate Retained on the 4.75 mm (No. 4) Sieve for S, SX and SG, and on the 2.36mm (No. 8) Sieve for ST and SF with at least 2 Mechanically Induced fractured faces, % minimum*	CP 45		60				60
Accelerated Moisture Susceptibility Tensile Strength Ratio (Lottman), minimum	CPL 5109 Method B		80				80
Minimum Dry Split Tensile Strength, kPa (psi)	CPL 5109 Method B		205 (30)				205 (30)
Grade of Asphalt Cement, Top Layer							PG 76-28
Grade of Asphalt Cement, Layers below Top			PG 64-22				PG 64-22
Voids in the Mineral Aggregate (VMA) % minimum	CP 48		See Table 403-2				See Table 403-2
Voids Filled with Asphalt (VFA), %	AI MS-2		65-75				65-75
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

Note: AI MS-2 = Asphalt Institute Manual Series 2

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 3/4" to 3/8" are considered a coarse gradation if they pass below the maximum density line at the #8 screen.
Gradations for mixes with a nominal maximum aggregate size of #4 or smaller are considered a coarse gradation if they pass below the maximum density line at the #16 screen.

*Fractured face requirements for SF may be waived by RME depending on project conditions.

2
REVISION OF SECTION 403
HOT MIX ASPHALT

Hot mix asphalt may contain up to 20% of recycled asphalt pavement. Recycled asphalt pavement shall meet requirements of Section 504.2 of the City of Thornton's Standards and Specifications.

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. CDOT will establish the production asphalt cement and volumetric targets based on the Contractor's mix design and the relationships shown between the hot mix asphalt mixture volumetric properties and asphalt cement contents on the Form 429. CDOT may select a different AC content other than the one shown at optimum on the Contractor's mix design in order to establish the production targets as contained on the Form 43. Historically, Air Voids adjustments typically result in asphalt cement increases from 0.1 to 0.5 percent. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

Table 403-2

	Minimum Voids in the Mineral Aggregate (VMA)			
Nominal Maximum Size*, mm (inches)	***Design Air Voids **			
	3.5%	**4.0%**	**4.5%**	**5.0%**
37.5 (1½)	11.6	11.7	11.8	N/A
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	
4.75 (No. 4)	16.6	16.7	16.8	16.9
	* 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.

Hot mix asphalt for patching shall conform to the gradation requirements for Hot Mix Asphalt Grading SX for the top lift and Grading S for the bottom lifts.

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

Acceptance samples shall be taken at the location specified in Method A of CP 41.

3
REVISION OF SECTION 403
HOT MIX ASPHALT

Subsection 403.03 shall include the following:

The Contractor shall construct the work such that all roadway pavement placed prior to the time paving operations end for the year, shall be completed to the full thickness required by the Plans. The Contractor's Progress Schedule shall show the methods to be used to comply with this requirement.

At locations where new Hot Mix Asphalt is to abut existing asphalt, saw cut the existing pavement a minimum of 1 foot back from the existing edge with a neat line and remove pavement. A tack coat shall be applied along the vertical abutting face of the existing asphalt.

A tack coat shall be applied to all milled surfaces prior to applying an asphalt pavement overlay. A tack coat shall be applied along the vertical face of all curb and gutter prior to asphalt paving.

At patches, compaction shall initially be completed along the outside edges of the patch, and then proceed from the low side to the high side of the patch. The new asphalt patch shall have a minimum compacted thickness equal to the existing pavement thickness and be level and well matched to the existing pavement.

The Contractor shall commence placing hot mix asphalt within 3 working days after the street has been milled, and within 1 working day after the subgrade has been proof rolled, weather permitting.

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 by the City is shown on each ticket.

The scale tickets shall be available on site for City 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.

4
REVISION OF SECTION 403
HOT MIX ASPHALT

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.

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.

Payment will be made under:

Pay Item	**Pay Unit**
Hot Mix Asphalt (Grading S) (75) (PG 64-22)	Ton

Aggregate, asphalt recycling agent, asphalt cement, additives, hydrated lime, and all other work and materials 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, any change to the submitted mix design optimum asphalt cement content to establish production targets on the Form 43 will not be measured and paid for separately, but shall be included in the work. No additional compensation will be considered or paid for any additional asphalt cement, plant modifications and additional personnel required to produce the HMA as a result in a change to the mix design asphalt cement content.

Historically, typical asphalt cement increases reflected on the Form 43 are from 0.1 to 0.5 percent. However, the Contractor should anticipate the AC increases typical of his mixes. Contractors bidding the project should anticipate this change and factor it into their unit price bid.

Asphalt cement used will not be measured and paid for separately, but shall be included in the work.

5
REVISION OF SECTION 403
HOT MIX ASPHALT

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

Tack Coat will not be paid for separately but shall be considered incidental to the project.

Temporary asphalt installation and removal required for sanitary sewer, waterline, and storm sewer patches will not be paid for separately but shall be considered incidental to the project.

Additional Hot Mix Asphalt required to bring the final surface to the noted finished grade elevations as a result of the variable milling as shown on the Construction Plans will not be measured and paid for separately, but shall be considered incidental to Hot Mix Asphalt (Grading S)(75)(PG 64-22)

END OF SECTION

1

REVISION OF SECTION 407
PRIME COAT, TACK COAT, AND REJUVENATING AGENT

Section 407 of the Standard Specifications is hereby revised for this project as follows:

Delete Subsection 407.09 and replace with the following:

Prime Coat, Tack Coat, and Rejuvenating Agents will not be measured and paid for separately. The cost for these items shall be considered incidental to all bid items requiring Prime Coat, Tack Coat, and Rejuvenating Agents.

END OF SECTION

1
REVISION OF SECTION 503
DRILLED SHAFTS

Section 503 of the Standard Specifications is hereby revised for this project as follows:

Subsection 503.22 shall include the following:

Drilled shafts will be measured by the linear foot from the elevation shown on the plans to the bottom of the hole as drilled.

Each approved splice of the reinforcing cage for additional length of shaft will be measured as ½ linear foot of additional length of drilled shaft.

Subsection 503.23 shall include the following:

The unit price of drilled shafts shall be full compensation for making all excavations; hauling and disposal of excavated material; provision and disposal of slurry, performing all necessary pumping; furnishing and placing required concrete and reinforcement steel, including the reinforcement projecting above the tops of the drilled shafts necessary for splicing and any intermediate reinforcement splices; furnishing and placing of CSL tubes; all backfilling; furnishing, placing, and removing temporary casings; furnishing permanent casing if required to complete the work; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the work. Costs associated with repairing defects found in the drilled shaft shall be included in the cost of the drilled shaft.

Obstruction encounter and removal will not be measured and paid for separately but shall be included in the work.

Payment will be made under:

Drilled Caisson (18 Inch)	Linear Foot
Drilled Caisson (36 Inch)	Linear Foot

END OF SECTION

1

REVISION OF SECTION 608
SIDEWALKS AND BIKEWAYS

Section 608 of the Standard Specifications is hereby revised for this project as follows:

Delete subsection 608.01 and replace it with the following:

This work consists of the construction of bituminous or concrete sidewalks, bikeways, curb ramps, colored and patterned concrete pavements, and concrete sidewalk curb walls in accordance with these specifications and in conformity with the lines and grades shown on the Plans or established.

Delete subsection 608.02 and replace it with the following:

Materials shall meet the requirements specified in the following subsections:

Joint Fillers	705.01
Aggregate for Bases	703.03
Bed Course Materials	703.07

Concrete for sidewalks and curb ramps shall be CDOT class D and conform to the following minimum requirements:

Required Field Compressive Strength	4500 psi at 28 days
Nominal Sized Course Aggregate	3/4 –inches
Maximum Slump	4-inches
Air Content Range	5% to 8%
Water Cement Ratio	0.45

Concrete shall be mixed with Fibermesh reinforcing strands (or approved equal), at the rate of 1.5 pounds per cubic yard. Mixing, placing and finishing shall be performed according to manufacturer's recommendations.

Sidewalk ramp detectable warning field shall be cast-in-place red East Jordan Iron Works or approved equal.

Subsection 608.03(c) shall include the following:

Prior to placing concrete for sidewalks, curb ramps, and colored patterned concrete, a minimum of 4 inches of class VI aggregate base course shall be placed in accordance with Section 304 of the Project Specifications.

Subsection 608.03(d) shall include the following:

Where identified on the Plans, concrete shall be color stained and have a patterned surface texture. The surface finish or pattern and coloring shall be as shown on the Plans.

2
REVISION OF SECTION 608
SIDEWALKS AND BIKEWAYS

Subsection 608.03(f) shall include the following:

Concrete shall not be left exposed for more than 2 hours between the time finishing is completed and commencement of curing treatment unless approved by the Owner.

It shall be the Contractor's responsibility to protect the concrete from the elements, vandalism, and physical damage. Any concrete showing any signs of exposure to precipitation, flowing water or freezing, or showing any signs of physical damage shall be removed and replaced by the Contractor at his expense.

Sections of concrete sidewalks, and curb and gutters which develop random cracking shall be removed and replaced, or repaired in a satisfactory manner approved by the Owner, at the Contractor’s expense.

Subsection 608.05 shall include the following:

Colored and patterned concrete shall be measured by the square yard of finished surface. Coloring material and fibrous reinforcement shall be not be measured and paid for separately but shall be included in the work.

Detectable warnings will be included in curb ramps and not measured separately. Materials and work for detectable warnings will not be measured and paid for separately but shall be included in the work.

3
REVISION OF SECTION 608
SIDEWALKS AND BIKEWAYS

Subsection 608.06 shall include the following:

Payment will be made under:

Pay Item	Pay Unit
Concrete Sidewalk (6-Inch Thick)	Square Yard
Concrete Curb Ramp (6-Inch Thick)	Square Yard
Cover Material (6-Inch Colored Concrete)	Square Foot

Joints of all types will not be measured and paid for separately but shall be included in the work.

Aggregate base course will be measured and paid for in accordance with Section 304.

Fibrous concrete reinforcement material will not be measured and paid for separately but shall be included in the work.

Detectable warnings shall be included in the curb ramp pay item and not measured separately. All materials, equipment, work for detectable warnings will not be measured and paid for separately but shall be included in the work.

The colored concrete shall be desert tan and shall be approved by the city prior to placement.

END OF SECTION

1
REVISION OF SECTION 609
CURB AND GUTTER

Section 609 of the Standard Specifications is hereby revised as follows:

Subsection 609.01 shall include the following:

The work under this section shall also include construction of the proposed Curb Opening/Sediment Pad as shown on the Project Construction Plans.

Delete subsection 609.02 and replace it with the following:

Except as provided below the materials used shall meet the requirements of the following subsections:

Bed Course Material	703.07
Joint Filler	705.01
Reinforcing Steel	709.01

Concrete for curb and gutter shall conform to the following minimum requirements:

Required Field Compressive Strength	4500 psi at 28 days
Nominal Sized Course Aggregate	3/4 –inches
Maximum Slump	4-inches
Air Content Range	5% to 8%
Water Cement Ratio	0.45

Concrete shall be mixed with Fibermesh reinforcing strands (or approved equal), at the rate of 1.5 pounds per cubic yard. Mixing, placing and finishing shall be performed according to manufacturer's recommendations.

Subsection 609.03 is revised to include the following:

Materials required for construction of the proposed Curb Opening/Sediment Pads shall be controlled based on specifications herein. Dimensions, layout and details for construction of the proposed Curb Opening/Sediment Pads shall be in accordance with the Project Construction Plans.

Subsection 609.03(f) is revised to include the following:

Concrete shall not be left exposed for more than 2 hours between the time finishing is completed and commencement of curing treatment unless approved by the Owner.

It shall be the CONTRACTOR's responsibility to protect the concrete from the elements, vandalism, and physical damage. Any concrete showing any signs of exposure to precipitation, flowing water or freezing, or showing any signs of physical damage, shall be removed and replaced by the CONTRACTOR at his expense.

2
REVISION OF SECTION 609
CURB AND GUTTER

Subsection 609.06 is revised to include the following:

Materials and work required to construct the proposed Curb Opening/Sediment Pads will not be measured separately, but shall be included in the work.

Measurement for Type 2 gutter, Type 2 curb and gutter, and concrete pavement at intersections shall be measured in accordance with CDOT Standard Plan No. M-609-1.

Subsection 609.07 shall include the following:

Materials, equipment and labor required to construct the proposed Curb Opening/Sediment Pads will not be paid for separately, but shall be included in the work.

Payment will be made under:

Pay Item	Pay Unit
Curb Type 2 (Section B)	Linear Foot
Curb and Gutter, Type 2 (Section II-B)	Linear Foot
Curb and Gutter, Type 2 (Section II-M)	Linear Foot

END OF SECTION

1
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:

The City of Thornton's Standard specification, "SECTION 700 – TRAFFIC TECHNICAL SPECIFICATIONS", shall control the work required for the installation of lighting. The specifications are included in Appendix C at the end of these project special provisions.

All work shall be done in accordance with these specifications, the National Electrical Code, and in conformity with the details shown on the Construction Plans.

The Contractor shall coordinate with the City to establish the final location of proposed street lights.

Subsection 613.02 shall include the following:

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

The warranty shall cover all failures including:

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

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

Technical Support. During the warranty period, technical support shall be available from the manufacturer via telephone within 24 hours of the time the call is made from the Contractor, and this support shall be made available from factory certified personnel or factory certified installers at no additional charge to the Department.

Subsection 613.11 shall include the following:

Street lights will be measured by the number of completed street lights, and accepted. Material, equipment, potholing, and labor required to construct the proposed street lights, approved and complete in place, will not be measured separately, but shall be included in the work.

2
REVISION OF SECTION 613
LIGHTING

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

Meter pedestals will be measured by the number of pedestals installed.

Conduit will be measured by the linear foot in place.

All wiring necessary for the complete installation of traffic signals and street lights will be measured as a single lump sum.

Subsection 613.12 shall include the following:

Materials, equipment, potholing, and labor required to construct the proposed Roadway Light Fixtures, approved and complete in place, will not be paid for separately, but shall be included in the work.

Material, equipment, potholing, and labor required to construct the Electrical Distribution (Copper), approved and complete in place, will not be paid separately, but shall be included in the work.

Material, equipment, potholing, and labor required to construct the Meter Pedestal, approved and complete in place, will not be paid separately, but shall be included in the work.

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

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

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

3
REVISION OF SECTION 613
LIGHTING

The lump sum price bid for wiring will be full compensation for all electrical circuitry necessary to complete the lighting and traffic signal installation as shown on the plans. All conductors in conduit, regardless of type, are part of the wiring item and will not be measured and paid for separately. Connect to power will be included in the cost of the Traffic Signal Meter Pedestal.

Included in the cost of Pull Boxes will be a layer of gravel beneath the Pull Box.

Payment will be made under:

Pay Item	**Pay Unit**
2 Inch Electrical Conduit (Bored)	Linear Foot
2 Inch Electrical Conduit	Linear Foot
Traffic Signal Meter Pedestal and Connect to Power	Each
Pull Box (11x18x12) (Type One)	Each
Traffic Signal Wiring	Lump Sum
3 Inch Electrical Conduit (Bored)	Linear Foot
4 Inch Electrical Conduit	Linear Foot
Pull Box (20”x33”x15”) (Type Three)	Each
Pull Box (30”x48”x24”) (Type Five)	Each
Luminaire (LED) (Install Only)	Each
3 Inch Electrical Conduit	Linear Foot
Illuminated Sign (Install Only)	Each

END OF SECTION

1
REVISION OF SECTION 614
TRAFFIC CONTROL DEVICES

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

Subsection 614.01 shall include the following:

The City of Thornton's Standard specification, "SECTION 700 – TRAFFIC TECHNICAL SPECIFICATIONS", shall control the work required for the installation of traffic control devices. These specifications are include in Appendix C at the end of these project special provisions.

In subsection 614.13 delete the 4th Paragraph and replace it with the following:

Ground signs will be measured by the number of signs installed and accepted by the City. Concrete footing, sign posts, hardware, mounting and backing angles, will not be measured separately. Sign Panel will be measured by the square foot installed and accepted by the City.

Subsection 614.14 shall include the following:

Payment for Sign Panel and Ground Sign shall include, but not be limited to, all labor, materials, and equipment required to complete the work.

Payment will be made under:

Pay Item	Pay Unit
Sign Panel (Class I)	Square Foot
Pedestrian Signal Face (16) (Countdown)	Each
Traffic Signal Face (12-12-12)	Each
Traffic Signal Face (12-12-12-12)	Each
Traffic Signal Controller Cabinet (Install Only)	Each
Accessible Pedestrian Push Button	Each
Fire Preemption Unit & Timer	Each
Vehicle Detection System (Single Camera)	Each
Traffic Signal-Light Pole Steel (Install Only)	Each

END OF SECTION

1

REVISION OF SECTION 625
CONSTRUCTION SURVEYING

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

Subsection 625.11 shall include the following:

All survey records generated shall be the property of the City of Thornton.

Subsection 625.13 shall include the following:

Before granting Initial Acceptance, the following items shall be completed, reviewed and approved by the Engineer:

1. Verification that all Monuments and Stakes have been reset in accordance with sub-section 625.08
2. All Survey Records in accordance with sub-section 625.11

Payment will be made under:

Pay Item	Pay Unit
Construction Surveying	Lump Sum

END OF SECTION

1

REVISION OF SECTION 627
PAVEMENT MARKINGS

Section 627 is hereby revised for this project as follows:

DESCRIPTION

This Work consists of furnishing and applying pavement marking in accordance with these specifications, the Manual of Uniform Traffic Control Devices for Streets and Highways (MUTCD), the Colorado supplement, thereto, and in conformity to the lines, dimensions, patterns, locations, and details shown on the Plans or established.

The City of Thornton's Standard specification, "SECTION 700 – TRAFFIC TECHNICAL SPECIFICATIONS", shall control the work required for the installation of pavement markings. The specifications are included in Appendix C at the end of these project special provisions.

MATERIALS

In general, paint will not be used unless approved by the Owner. On existing pavement, Preformed Thermoplastic Pavement Markings shall be used. On new pavement, Preformed Thermoplastic Pavement Markings shall be used.

2

REVISION OF SECTION 627
PAVEMENT MARKINGS

1. Marking Paint

   Marking paint generally will not be approved for permanent markings. The use of pure acrylic high solids for hot application and quick dry to paint centerlines and edge lines on roads, crosswalks, stop zones, parking lots, storage zones, aisles, etc. as approved by the City of Thornton Project Manager shall contain no lead and comply with the EPA's voluntary 30/50 program, and meet the performance standards of federal specifications TT-P-1952. Prior to application, surfaces must be thoroughly dry and free from dirt, loose paint, oil, grease, and other contaminants. Paint may be thinned if necessary up to two (2)%, thin per manufacturer's recommendation. The paint shall be applied at air, surface, and product temperature above 50° F or per manufacturer's specifications.

% solids by weight	77.5 +/- 3%
Viscosity	80 - 90 K.U.
Sheen	Flat
Wet film per coat	14 – 16 mils
Dry film per coat	8.4 – 9.6 mils
Application rate	1 gal / 100 sf
Unit weight	14 lbs. / gal

2. Thermoplastic Marking

   A. Shall be in conformance with CDOT SSRBC Section 713.12.

3. Reflectorized Glass Beads

   A. A blended material consisting of spheres containing refractive indices of 1.50 and 1.65 and conforming to the following specifications:

      1. Manufactured from high grade optical crown glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.

      2. Colorless, clean and transparent.

   B. Material
      The reflectorizing glass beads shall conform to the following:
      1. Refracture Index - When testing by the liquid immersion method at 77° F, 70% of the spheres shall have an average index of not less than 1.50, and 30% shall have an average index of not less than 1.65.

3

REVISION OF SECTION 627
PAVEMENT MARKINGS

1.50 Index Glass Beads

U.S. Standard Sieve Number	% Passing by Weight
20	95 – 100
30	75 - 95
50	9 - 32
80	0 - 15

1.65 Index Glass Beads

U.S. Standard Sieve Number	% Passing by Weight
50	100
80	90 – 100
100	75 - 90
200	0 - 5

CONSTRUCTION REQUIREMENTS

The contractor shall field layout pavement markings for installation, via chalk or paint lines, for approval of owner prior to installation of material. Permanent pavement markings shall have an epoxy binder applied and be tape unless another material is approved in writing by the Traffic Engineer.

Pavement markings shall be so applied as to assure continuous uniformity in the dimensions of the stripe.

Laydown tolerances for each pavement marking shall be one (1) inch longitudinally and one quarter (1/4)-inch transversely.

Permanent pavement markings installed on new asphalt shall be installed within four (4) hours of placement of the final lift of asphalt pavement. Pavement markings on existing and new concrete pavement shall be recessed in a one fourth (¼) inch groove not to exceed one half (½) inch wider nor two (2) inches longer than the marking being laid. Permanent pavement markings on existing asphalt shall be Performed Thermoplastic.

The pavement marking shall be applied to the pavement either to the right or left of the application unit, dependent upon roadway lane being used. The unit shall not occupy more than one lane of roadway while operating.

4

REVISION OF SECTION 627
PAVEMENT MARKINGS

The finished lines shall have well defined edges and be free of waviness. Tolerance shall be one (1) inch longitudinally and one fourth (¼) inch transversely. The minimum thickness of thermoplastic line shall be three thirty-seconds (3/32) inch at the edges, not less than one eighth (1/8) inch at the center. Measurements shall be taken as an average throughout any 10-foot section of the line. The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall bond itself to the old line in such a manner that no splitting or separation takes place. All of the equipment necessary to the preheating and application of the material shall be so designed that the temperature of the material can be controlled within the limits necessary to its pourability for good application.

The marking material as specified shall be installed at the manufacturer's recommended temperature.

At the time of installation of thermoplastic materials, the pavement shall be clean, dry, and free of laitance, oil, dirt, grease, paint, or other foreign contaminants. Pavement and ambient temperatures shall be at least 50° F.

An epoxy resin primer shall be applied to concrete surfaces prior to the application of the thermoplastic pavement marking. The epoxy resin primer shall be installed per the thermoplastic manufacturer recommendations.

The marking material shall not be applied until the epoxy resin primer reaches the tacky stage. An infrared heating device may be employed to shorten the curing time of the epoxy.

If the City of Thornton Project Manager determines that a new asphalt surface has become soiled, prior to placement of the pavement markings, a pavement primer will be required and preformed plastic pavement markings shall be applied as approved.

The epoxy resin primer material may be accepted at the job site on the basis of a manufacturer's certification, or a sample may be sent to the laboratory for testing, in which case three (3) weeks shall be allowed between sampling and intended use.

5

REVISION OF SECTION 627
PAVEMENT MARKINGS

BASIS OF PAYMENT

Payment shall be made under:

Pay Item	Pay Unit
Removal of Pavement Marking	Square Foot
Preformed Thermoplastic Pavement Marking – White (Type 1)	Square Foot
Preformed Thermoplastic Pavement Marking (Word-Symbol) (Type 1)	Square Foot
Preformed Thermoplastic Pavement Marking (Xwalk-Stop Line) (Type 1)	Square Foot
Performed Thermoplastic Pavement Marking – Yellow (Type 1)	Square Foot
Temporary Pavement Marking	Gallon

Temporary pavement markings required for traffic control shall be considered incidental to the Lump Sum price for Traffic Control.

END OF SECTION

1

REVISION OF SECTION 630
CONSTRUCTION ZONE TRAFFIC CONTROL

Section 630 is hereby revised for this project as follows:

Section 630.17 is deleted and replaced with the following

Traffic control devices, flagging, traffic control inspection and traffic control management will not be measured. A suggested phasing plan and tabulation of traffic control devices are included on the drawings. The phasing plan is only a suggestion and the tabulations are for information only. It shall be the Contractors responsibility to prepare construction phasing plans and traffic control plans for the project.

Section 630.18 is deleted and replaced with the following

Construction traffic control will be paid for on a lump sum basis. Payment for traffic control necessary to complete the work shall be full compensation for furnishing, erecting, cleaning, maintaining, resetting, repairing, replacing, moving, removing, and disposing of the construction traffic control devices. The lump sum payment will also include flagging, traffic control inspection and traffic control management.

The lump sum bid price shall be based on the Contractor's construction phasing plans and traffic control plans.

All construction traffic control devices that are not permanently incorporated into the project will remain the property of the Contractor.

Construction traffic control as determined by the approved project Traffic Control Plan (TCP), will be paid for as follows:

Contract Amount Completed		Traffic Control Paid
Upon First Utilization	=	25%
25%	=	50%
75%	=	90%
100%	=	100%

The percent of original contract amount earned will be determined by comparing the amount earned for bid items, other than traffic control devices and mobilization, with the original contract amount minus the amounts bid for traffic control devices and mobilization.

Payment shall be made under:

Pay Item	Pay Unit
Traffic Control	Lump Sum

Temporary pavement markings required for traffic control shall be considered incidental to the work required for "Traffic Control".

Removal of temporary pavement markings, when required, shall be considered incidental to the work required for Traffic Control.

2

REVISION OF SECTION 630
CONSTRUCTION ZONE TRAFFIC CONTROL

Temporary asphalt required for Traffic Control will not be paid for separately but shall be considered incidental to the project.

END OF SECTION

1
TRAFFIC CONTROL PLAN – GENERAL

The key elements of the Contractor's method of handling traffic (MHT) are outlined in subsection 630.10(a). The components of the TCP for this project are included in the following:

(1) Subsection 104.04 and Section 630 of the Standard 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 (provided for information only).

(4) Signing Plans

(5) Construction Phasing Plans and Details (provided for information only).

The Contractor shall provide, erect and maintain proper traffic control devices until the site is open to traffic. The Contractor shall submit a traffic control plan to the City of Thornton for approval prior to construction. Traffic control shall also include safety and control of pedestrians and bicyclists on the sidewalks and trails in and around the project site.

Unless otherwise approved by the Engineer, the Contractor’s equipment shall follow normal and legal traffic movements. The Contractor’s ingress and egress of the work area shall be accomplished with as little disruption to traffic as possible. Traffic control devices shall be removed by picking up the devices in a reverse sequence to that used for installation. This may require moving backwards through the work zone. When located behind barrier or at other locations shown on approved traffic control plans, equipment may operate in a direction opposite to adjacent traffic.

The responsibility under the Contract for all traffic control resides with the Contractor and any participation by law enforcement personnel in Contractor traffic control activities will be referenced in either the Special Provisions or General Notes of the Plans. Nothing in this Contract is intended to create an entitlement, on the part of the Contractor, to the services or participation of the law enforcement organization.

The flow of vehicular, pedestrian, and bicycle traffic on public streets and roadways shall be maintained at all times during construction in accordance with the rules, regulations, and conditions as set forth in the traffic control permit issued by the City of Thornton Project Manager. Signs, barricades, lights, and warning devices shall be constructed and used in accordance with the MUTCD and the Colorado supplement. The ATSSA Guide shall be strictly followed by the Responsible Party during the progress of the work.

The Responsible Party shall be responsible for the provision of a safe travel way on all streets, roadways sidewalks, and trails on and adjacent to the job site. The Responsible Party shall erect or cause erection of proper traffic control warning devices around all excavations, embankments, and obstructions and shall be responsible for the proper maintenance of said erected devices, in accordance with the traffic control permit and the MUTCD.

2
TRAFFIC CONTROL PLAN – GENERAL

The Responsible Party shall cause suitable warning lights to be provided and kept lighted at night or other times when visibility is limited. The Responsible Party shall provide flaggers and/or off-duty police protection as may be determined by the City of Thornton Project Manager for the protection of the public, as well as workers on the job site.

The Responsible Party shall coordinate with the Traffic Engineer so that arrangements may be made by the Responsible Party for detours, parking, and access to property adjacent to work, etc., 48 hours prior to their need. A minimum notification of one (1) week is required when detouring a street.

The Responsible Party shall not work within any portion of a street without receiving a Traffic Control Permit from the Traffic Engineer prior to such work. Full roadway closures will be reviewed on a case by case basis. The City reserves the right to refuse to allow full road closures. Requirements for such closures will be determined at the time of issuance of permit. The responsible party will be responsible for all public notices, public meetings, and requirements as outlined in the Traffic Control Permit.

Work allowed at signalized intersections or on arterial roadways is from 8:30 am to 3:30 pm, except during emergencies or with prior approval of the Traffic Engineer. Failure to complete work within the traffic control permit may result in a “stop work” order.

The Responsible Party shall be responsible for all damages to the work due to failure to place barricades, signs, lights, flaggers, and other workers to protect it. Whenever evidence of such damage is found prior to acceptance, the Traffic Engineer may order the damaged portion immediately removed and replaced by the Responsible Party.

During the construction of this project, traffic shall use the present traveled roadway unless otherwise approved by the Traffic Engineer.

The Contractor shall not have construction equipment or materials in the lanes open to traffic at any time, unless approved by the Traffic Engineer.

During the resurfacing work, only one lane may be closed to traffic at any time unless approved by the Engineer. Traffic shall not be delayed for more than 5 minutes or as directed by the Traffic Engineer.

Except in cases of emergency, maintenance, or protection of work already completed, no work shall be allowed between the hours of 3:30 p.m. and 8:30 a.m.; nor on Saturday, Sunday, or legal holidays unless approved by Infrastructure Engineering in each case. When any inspector is required to work outside the hours of 8:30 a.m. to 3:30 p.m. on regular City business days, overtime shall be charged to the Responsible Party. However, such Inspectors shall remain employees of the City for all purposes. Requests for overtime shall be made to Infrastructure Engineering at least 48 hours in advance. Payment for such overtime work shall be made to the City prior to final acceptance.

3
TRAFFIC CONTROL PLAN – GENERAL

Due to lane closure and working time restrictions, the Contractor may utilize steel plates during utility relocation work and during storm sewer, sanitary sewer, and waterline system installations. Steel plates shall be temporarily placed over the open trench prior to opening the work area to traffic. The Contractor is responsible for designing the steel plates, including thickness, width, and secure connection to the existing pavement. The design must meet Load and Resistance Factor Design (LRFD) specifications and shall include a PE stamp on the design.

When steel plates are used, the pavement area to be overlapped by the plate shall be planed to the depth of the plate to eliminate a vertical edge for traffic. The use of steel plates and detour pavement requires a Methods Statement, including an emergency action plan in the case of any material failures. In the case of failures, any lane closures taken outside of the Traffic Control Plan – General specification shall be treated as a working time violation.

All work associated with the usage of steel plates will not be measured and paid for separately but shall be included in the work.

All costs incidental to the foregoing requirements shall be included in the original contract price for Traffic control.

Unless otherwise authorized by the Engineer, one lane in each direction must be maintained on all affected roadways. No turn movement restrictions will be permitted.

END OF SECTION

1
UTILITIES

Known utilities within the limits of this project are:

UTILITY / ADDRESS	CONTACT / EMAIL	PHONE
Xcel Energy – Gas 1123 W. 3rd Avenue Denver, CO 80223	Branda Sloan Branda.L.Sloan@xcelenergy.com	(303) 628-2276 (720) 354-2000 cell
Century Link 5325 Zuni Street Denver, CO 80221	Justin Metzler	(303) 525-7086
Comcast 8490 Umatilla Street Federal Heights, CO 80260		(303) 646-7628
Adams County Fiber Optic – 12 Five Star Schools	Perry Movick Perry.Movick@adams12.org	(720) 933-9982
City of Thornton Traffic Operations 12450 Washington Street Thornton, CO 80241	Kenneth Jatho Kenneth.Jatho@thorntonCO.gov	(720) 977-6484
City of Thornton Infrastructure Engineering 12450 Washington Street Thornton, CO 80241	Dan Schiltz daniel.schiltz@thorntonCO.gov	(720)-977-6226

The work described in these Plans and Specifications requires coordination between the Contractor and the utility companies in accordance with the City's General Conditions in conducting their respective operations as necessary to complete the utility work with minimum delay to the project.

The Contractor shall keep each utility company advised of any work being done to its facility or near its facility, so that the utility company can coordinate its inspections for final acceptance of the work with the Engineer.

The Contractor shall contact Xcel Energy Builder's Call Line at (1-800-628-2121) 30 days in advance of requiring connection to power sources to allow Xcel Energy adequate time for administration and processing of the new street lighting and billing. The Contractor shall be responsible for coordination of power source work to be performed by Xcel Energy. The Contractor shall contact the Xcel Energy Builder's Call Line to coordinate the power sources for both street lighting and the traffic signal as shown on the Plans.

The Contractor shall anticipate abandoned gas and electric lines within the project site. The Contractor shall coordinate with Xcel Energy to locate abandoned lines. Some of the abandoned lines may not be able to be located by Xcel Energy. The Contractor shall coordinate the work so as to avoid delays caused by any abandoned utility lines. No additional payment will be made for coordinating, locating, working around, or removing abandoned utility lines. All work associated with abandoned utility lines shall be considered incidental to the project.

2
UTILITIES

The Contractor shall at times be required to work in close proximity to dry utilities such as electric lines, gas lines, telephone lines, cable television lines, and miscellaneous fiber optic lines. This work may include locating the utilities, potholing utilities, careful excavation around utilities to create slack in the lines for minor vertical adjustments and forming walls around utilities including PVC sleeves through the wall. This work shall be coordinated with the utility companies and shall be considered incidental to the work requiring the utility adjustments.

The work listed below will be performed by the utility owners or their agents. The cost of the work listed below shall be the responsibility of the utility owner except for supplying power to the streetlights and traffic control boxes.

3
UTILITIES

GENERAL:

The Contractor shall comply with Article 1.5 of Title 9, CRS ("Excavation Requirements") when excavation 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 day of notification, prior to commencing such operations. The Contractor shall contact the Utility Notification Center of Colorado (UNCC) at (8-1-1) or 1-800-922-1987 to have locations of UNCC registered lines marked by member companies. All other underground facilities shall be located by contacting the respective company.

Utility service laterals shall also be located prior to beginning excavating or grading.

The location of utility facilities as shown on the plan and profile sheets, and utility plans, and herein described, were obtained from the best available information.

Unless otherwise noted. All costs incidental to the foregoing requirements will not be paid for separately but shall be included in the work.

Refer to the Construction Plans for more information regarding utility work and coordination.

END OF SECTION

APPENDICES

APPENDIX "C"

SECTION 700 – CITY OF THORNTON TRAFFIC TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

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

TRAFFIC TECHNICAL SPECIFICATIONS

SECTION 1

TRAFFIC SIGNAL SPECIFICATIONS

1.0 General Requirements

These specifications for traffic signals shall govern the materials used for and the installation of traffic signals.

Construction of traffic signal systems shall be done in accordance with these specifications, the latest revision of the Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways, published by the FHWA, the latest revision of the Colorado Supplement, thereto, and in conformity with the details as shown on the plans.

The Contractor shall have an IMSA Certified Traffic Signal Level II Technician on-site during the period of any splicing and/or termination of wiring for head and controller installation and shall provide the Owner with a copy of the individual's certification prior to the start of work.

1.1 Conditions of Materials Furnished

Items furnished shall be new state-of-the-art equipment and materials. The Contractor shall submit for review and approval a list of equipment and materials as indicated in Appendix B – Submittals that are proposed to be installed, prior to the Contractor ordering such materials. Each item shall be identified by the trade name, size, and catalog number.

Traffic control equipment installed in the controller cabinet shall be products from the same manufacturer, or fully compatible if equipment from more than one manufacturer is used. At existing traffic signal installations being rebuilt, all traffic control equipment furnished by the Contractor shall be compatible with the existing equipment that will remain.

The Contractor shall supply and install all necessary materials, equipment, and labor for the complete installation and operation of the traffic signal system whether specifically mentioned or not on the traffic signal plans and in these specifications. The furnishing and installing of such non-listed items shall be considered incidental to the contract.

The Contractor shall supply and furnish all labor, tools, equipment, and incidentals necessary to complete the project in an efficient and workmanlike manner.

1.2 Definitions

General

Whenever in these specifications or in other contract documents special engineering terms and words are used, the intent and meaning shall be as defined in the Traffic Engineering Handbook, Institute of Transportation Engineers, latest edition and the Transportation Planning Handbook, Institute of Transportation Engineers, latest edition.

The following special terms and words shall have meanings as defined below:

AASHTO	-	American Association of State Highways and Transportation Officials
ANSI	-	American National Standards Institute
ASTM	-	American Society for Testing Materials
CDOT	-	Colorado Department of Transportation
FHWA	-	Federal Highway Administration
IMSA	-	International Municipal Signal Association
ITE	-	Institute of Transportation Engineers
NEC	-	National Electrical Code
NEMA	-	National Electrical Manufacturers Association
SSRBC	-	CDOT Standard Specifications for Road and Bridge Construction
UL	-	Underwriters Laboratories, Inc.

1.3 Regulations and Codes

In addition to the requirements of the plans, these specifications, the Special Conditions, and the General Conditions, all items and workmanship shall conform to the requirements of the National Electrical Code (NEC) hereinafter referred to as the Code; Rules for Overhead Electrical Line Construction of the Colorado Public Utilities Commission; standards of ASTM, ANSI, and local ordinances which may apply.

Wherever reference is made to any of the standards mentioned above, the reference shall be construed to mean the Code, order, or standard that is in effect on the date of advertisement for bids.

1.4 Schedule of Work and Working Conditions

The Contractor shall provide constant attention to the work necessary to facilitate the progress thereof, and shall cooperate with the Owner, utility representatives and other contractors in every way possible.

At the end of each working period, all excavations shall be barricaded and/or covered to provide safe pedestrian and vehicular passage.

At points where the Contractor's operations are adjacent to properties of traffic signal interconnect, railway, telegraph, telephone, power companies, cable television or any other utility to which damage might result in considerable expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection, thereof, shall have been made.

The Contractor shall cooperate with owners of all underground and overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner, that duplication or rearrangement work be reduced to a minimum, and that services rendered by those parties not be unnecessarily interrupted.

In the event of interruption of water or utility services as a result of accidental breakage; being exposed or unsupported, the Contractor shall promptly notify the proper authority and shall cooperate with the authority in restoration of service. If water service is interrupted, repair work shall be continuous until the service is restored. Work shall not be undertaken around fire hydrants until approved by the local fire authority.

1.5 Distribution of Keys and Instruction Manuals

When the project is complete, two keys for each controller cabinet and police panel shall be delivered to the Owner. The instruction manual for the controller shall be left inside the controller cabinet.

1.6 Contractor Supplied Documents

Upon completion of the Work, the Contractor shall submit as-built drawings or corrected plans and/or additional data required by the Owner to show in detail all construction changes. This shall include, but not be limited to wiring, cable, location, depth of conduit, and modifications to original cabinet wiring.

The Contractor shall submit two sets of schematic wiring diagrams to the Owner for the traffic signal controller, the signal installation's light circuits and auxiliary equipment, including units and values of each component used in the cabinet. The diagrams shall show in detail circuits and components. Such components shown, thereon, shall be identified by name or number and in such a manner as to be readily interpreted.

All diagrams, plans, and drawings shall be prepared using graphic symbols shown in ANSI Y32.2, *Graphic Symbols for Electrical and Electronic Diagrams*.

One copy of the controller cabinet diagram and the intersection and phase diagram, as approved by the Owner, shall be placed in a heavy-duty plastic envelope with side

opening, and placed inside of each controller cabinet in the plan drawer prior to Initial Acceptance of the project.

1.7 Maintaining Existing Traffic Signal Operations

Existing traffic signals shall be kept in effective operation for the benefit of the traveling public by the Contractor.

At intersections where power to the signals must be turned off, the Contractor shall contact the Owner requesting a Police Officer(s). This request must be made at least two weeks prior to the time the officer is needed.

The above does not apply to intersections which are completely closed to traffic due to construction.

The Contractor shall maintain a minimum of two three-section (red, yellow, green) traffic signal heads for each approach. Lane assignment changes during construction at existing or temporary traffic signals with video detection shall have the detection zones modified to reflect the lane assignments. In the event that temporary signals are necessary to maintain the minimum signal display, the Contractor shall be responsible for furnishing materials, equipment, tools, and labor necessary to install and maintain the temporary signals. Temporary signals must be in the plans or be approved by the Owner prior to installation. The Contractor shall maintain any temporary signal installed. The City shall furnish electrical energy for operation of a temporary signal.

Temporary span-wire traffic signals are not permitted unless shown on the plans or approved in writing by the Owner.

1.8 Field Test of Equipment

Prior to completion of Work, the Contractor shall make the following tests on traffic signal circuits in the presence of the Owner and the controller representative, if a new controller is used (the Contractor shall notify the Owner 48 hours prior to conducting the tests):

1. Each circuit shall be tested for continuity.

2. Each circuit shall be tested for grounds.

3. An insulation resistance test shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than the values specified in the provisions of the NEC code.

4. Initial functional testing of a new traffic signal system shall be completed while the traffic signal heads are bagged. Heads shall be bagged with orange-colored covers.

5. Louvers, hoods, and signal heads shall be directed to provide maximum visibility.

6. Initial activation shall be between 9:00 a.m. and 2:00 p.m., unless otherwise specified or shown on the plans. Prior to activation, the equipment shown on the plans shall be installed and operable. This includes but is not an inclusive list: pedestrian signals;

pedestrian push buttons; vehicle detectors; system communications; and Opticom. Any exceptions to this must be approved by the Owner.

7. Flash and permanent activation shall have the Owner present.

8. The signal shall be run on flash cycle for a minimum of twenty-four hours prior to turn-on. After flash operations a functional test shall be made which demonstrates that every part of the system functions as specified. The functional test for each traffic signal system shall consist of at least five days of continuous satisfactory operation. If unsatisfactory performance of the system develops, the conditions shall be corrected, and the test shall be repeated until five days of continuous, satisfactory operation is obtained.

9. Prior to the functional test, the contractor shall make every effort to have resolved all operating difficulties and problems. Components of the system must be complete and in operational condition to the satisfaction of the Owner prior to the functional tests being performed.

Functional tests shall start on any working day except Friday or the day preceding a legal holiday, or on a legal holiday. The owner reserves the right to require the test on any day of the calendar week.

During the test period, the Owner will provide the electrical energy. Repair costs of any damage caused by public traffic and all other maintenance costs will be the responsibility of the Contractor until Initial Acceptance of the project by the Owner.

1.9 Activation of Traffic Signal Equipment

Activation of new or modified signal systems shall be made only after all traffic signal circuits have been thoroughly tested as specified and the Owner concurs with the activation.

1.10 Intersection Power

The Contractor shall coordinate with Xcel Energy or United Power sufficiently prior to the signal turn-on so that orders may be issued for power connection to the intersection on the specified turn-on date. The Contractor shall also coordinate with Xcel Energy to ensure that each intersection is checked for and meets the appropriate power requirements for the traffic signal and other equipment.

1.11 Permits

The Contractor shall obtain a Traffic Control Permit from the City of Thornton Traffic division and a construction permit from the City of Thornton Engineering Services division. Construction permits can be applied for online free of charge by using the “CIP Projects” link. Contact Pete Brezall at 720-977-6251 for additional information..

1.12 Concrete Work, Asphalt Work, Aggregate Base Course

All concrete work, asphalt work and aggregate base course installation to be performed under this Contract shall conform to the requirements of the **2011 Edition of the**

Colorado Department of Transportation's Standard Specifications for Road and Bridge Construction or as otherwise specified in these specifications and plans. All concrete, except traffic signal pole foundations and sidewalks, shall be Class D. Traffic signal pole foundation concrete shall be Class BZ. Sidewalk concrete shall be Class B with a fiber mesh. All asphalt shall be Grading S (75) (PG 64-22). Aggregate base course shall be Class 6.

1.13 Measurement and Payment

Excavation and backfill will not be paid for separately, but shall be included with the item being installed, as identified by the different payment categories in the schedule of Contract Items and Prices. Concrete and asphalt restoration work that is required due to foundation, controller or conduit installations will not be paid for separately but included in the unit price for the item being installed.

END OF SECTION

SECTION 2

TRAFFIC SIGNAL, LIGHTING, AND COMMUNICATION CONDUIT

2.0 General Requirements

Underground utility information shown on the plans is for information only. The Contractor is responsible for field locating and verifying utility information before starting installation of underground conduit runs and traffic signal pole foundations.

The Contractor shall cooperate with any other Contractor under contract with the Owner and with utility companies providing services to the City of Thornton while installing underground conduit runs.

Electrical conduit shall be installed in accordance with the applicable requirements described in the latest revision of the Colorado Department of Transportation Utility Manual, as amended.

All buried wiring included in this project shall be placed in a conduit. It will be the option of the Contractor, at his own expense, to use larger size conduit if desired. Where larger size conduit is used, it shall be for the entire length of the run from outlet to pull box or from pull box to pull box. No reducing coupling will be permitted in any conduit run. The Owner must approve increased sizes prior to installation.

Conduits shall be installed under existing pavement through use of directional boring operations. Conduits under pavement may be installed through use of open trench operations only where approved by the Owner.

Conduits shall be rigid plastic (PVC) or galvanized rigid steel (GRC) type conforming to the plans and these specifications. Conduit runs shown on the plans are tentative as to routing and may be changed as directed by the Owner to avoid underground obstructions. In the event of any change from the location shown on the plans, accurate records shall be incorporated into the as-built drawings, and all necessary details and as-built drawings submitted to the Owner before final payment is made.

Conduit installation shall include the installation of marking tape laid in the backfilled trench at a depth not more than 8 inches or less than 4 inches below finished grade. Heavy gauge polyethylene film (0.004-inch tape, with legend "Caution Buried Electric Line Below"), shall be used. Where tape length ends and conduit run continues, lapping of not less than 6 inches will be provided. No glue or adhesive will be allowed to join separate tape sections.

2.1 Nonmetallic Conduit (PVC)

Rigid PVC conduit shall be Schedule 80, Type 2 and shall be manufactured of high-impact PVC and shall conform to industry and commercial standards No. CS-207-60. Each length of PVC conduit and the various PVC fittings (coupling, adapter, etc.) shall bear the label of Underwriter's Laboratories, Inc., or be approved by the Owner. The conduit shall be of the size or sizes shown on the plans or as indicated in these specifications.

Rigid PVC conduit ends shall be squared and trimmed after cutting to remove rough edges. All connections shall be made using E-Loc couplings or approved equal.

Rigid PVC conduit shall only be used for underground installations; conduit used above ground shall be galvanized rigid steel.

2.2 Galvanized Rigid Conduit Steel (GRC)

Steel conduit and fittings shall be rigid galvanized steel and shall be uniformly and adequately zinc-coated by the hot-dipped process conforming to ASTM Designation A153. Joints shall be set up tight with squared ends. Fastenings shall be secured and of a type appropriate in design and dimensions for the particular applications. Couplings, connectors, and fittings shall be approved types specifically designed and manufactured for the purpose. Fittings shall be installed to provide a good electrical ground throughout the conduit system. The interior as well as the exterior of a 6-inch sample cut from a center of a standard length of conduit when tested in accordance with the applicable portion of ASTM Designation A239 shall not show a fixed deposit of copper after four one-minute immersions in the standard copper sulfate solution. The interior of the rigid conduit shall have a continuous coating of lacquer or enamel. Each length shall bear the label of Underwriter's Laboratories, Inc., and shall conform to appropriate articles of the Code. The contractor shall provide catalog information for review by the Owner prior to purchase and installation of GRC.

The end of metallic conduit shall be threaded and well-reamed to remove burrs and rough edges. Field cuts shall be made true and square so that the ends will butt or come together for the full circumference, thereof. Slip joints or running thread will not be permitted for coupling conduit. When a standard coupling cannot be used, weatherproofed threaded three-piece union shall be used. All three-piece unions must be threaded; non-threaded couplings shall not be accepted.

The threads on all conduits shall be well painted with a good quality lead or rust-preventive paint before couplings are made up. All couplings shall be tightened until the ends of the conduits are brought together so that a good electrical connection will be made throughout the entire length of the conduit run. Conduit stubs, caps, and exposed threads, as well as any point along the surface of the conduit that has been injured in handling or installation, shall be painted with good quality asphalt bituminous or other paint suitable for the purpose.

2.3 Installation Methods

Conduit sizes and locations shall be as shown on the plans. Conduit shall be stubbed and capped for future uses where shown on the plans or where specified.

Existing empty underground conduit to be incorporated into a new system shall be cleaned with a mandrel or cylindrical wire brush and blown out with compressed air. The Contractor shall search for such conduit in the general vicinity shown on the plans, and shall notify the Owner in advance as to when this operation will take place. The Owner may, at his option, be present to monitor the activity. The cost of such activity shall be incidental to the project. In the event that such conduit has been rendered inoperative prior to the signal installation, the Contractor shall notify the Owner and payment for new conduit shall be made as per the unit costs provided in the bid.

Conduits terminating in poles, cabinets, and pedestal bases shall extend a maximum of 3 inches and a minimum of 2 inches above the foundation vertically and shall be sloped toward hand holes in poles or base opening where transformer bases are used. Conduit entering pull boxes shall terminate a minimum of 2 inches and a maximum of 3 inches above the bottom of the box.

Conduit ends shall be accomplished by a ninety (90) degree elbow with a minimum radius of forty-eight (48) degrees. Where two (2) or more conduits meet, all ninety (90) degree elbows shall be brought together in the center of the pull box or cabinet foundation. Conduit shall only enter through the bottom of a pull box. Galvanized rigid conduit terminations within pull boxes shall be fitted with an end coupling as well as insulating bushings to prevent chafing the wire.

Conduits required to be terminated, stubbed, and plugged shall be as shown on the plans and as directed by the Owner. Conduit ends shall be capped with standard conduit caps. The location of ends of conduit for future electrical circuits under curbs, gutters, sidewalks, or structures shall be marked by a "Y" at least 3 inches high, cut into the face of the curb, gutter, or structure directly above the conduit.

Ends of unused metal type conduit shall be threaded and shall be capped with standard pipe caps until conductors are in place. When caps are removed, the threaded ends shall be provided with conduit bushings. Ends of unused non-metallic type conduit plugged with a removal conduit plug, ends of conduit populated with wire shall be plugged with duct seal putty to prevent water infiltration and rodent infestation of the conduit.

Conduit installed outside of the traveled portion of the roadway and out of future roadway areas shall be laid as follows: maximum depth of 30 inches and a minimum depth of 24 inches. Conduit installed under in the traveled portion of the roadway and under future roadway areas shall be laid at a minimum depth 36 inches.

Concrete replacement within intersection islands created by installation of conduit will not be paid for separately but included in the unit price for conduit. Replacement of roadway, sidewalk, or native growth areas created by installation of conduit will not be paid for separately but included in the unit price for conduit.

All conduits, including conduits from the home run pull box to the controller cabinet, shall include 14-gauge copper stranded tracer wire inside the conduit for future locating of conduits. The sheathing for the tracer wire shall be purple in color. A minimum of two feet of slack tracer wire shall be left in each pull box and in the controller cabinet. At the end of each conduit run, the tracer wire shall be grounded at each traffic signal pole grounding lug.

2.4 Excavation and Backfilling

The excavations required for the installation of conduit shall be performed in such a manner as to avoid unnecessary damage to streets, sidewalks, landscaping, and other improvements. Trenches shall not be excavated wider than necessary for the installation of the electrical appurtenances. Concrete removal limits shall be to the nearest pavement, sidewalk or curb and gutter control joint. Excavation shall not be performed until immediately before installation of conduits. The material from the excavation shall be placed in a position not to cause damage or obstruction to vehicular or pedestrian traffic or interfere with surface drainage.

Trenches outside the traveled portion of the roadway shall be backfilled with granular material as approved by the Owner, in six-inch lifts and each lift compacted. Off-street trenches in native soil areas shall be backfilled with native soil and shall be compacted and shaped to match the surrounding surface. Surface materials in native soil areas disturbed by excavation and backfilling operations shall be replaced in kind equal to or exceeding original conditions. This shall include replacement of sod in lawn areas or reseeding in native soil areas at no additional cost to the project as directed by the Owner.

Trenches within islands, under sidewalks, in parking lots or other trenches in paved areas outside the traveled portion of the roadway shall be backfilled with Class 6 granular aggregate base course material as approved by the Owner. The backfill shall be in 6-inch lifts and each lift compacted up to a point within 3 inches of existing grade.

Trenches within or across the roadway, bike paths, trails and sidewalks shall be backfilled with CDOT-approved structural backfill (flow-fill) within 3 inches of existing grade, except on concrete surfaces which shall be removed to the nearest control joint and replaced in kind to match existing thickness, grade and finish. The top 3 inches of all trenches in asphalt roadways or asphalt off-roadway areas shall be filled to match existing grade and surfacing materials with hot asphalt mix. All roadways shall be repaired within forty-eight hours of cutting the surface.

Excavations in the street or highway shall be performed in such a manner that not more than one traffic lane is restricted in either direction at any time, unless otherwise permitted by the Owner. A minimum of one lane of traffic in each direction shall be kept open for each direction.

Excavations at intersections being reconstructed or improved shall be performed and backfilled before other improvements are completed so as to not require the repair or replacement of newly installed sidewalks, curbs and gutters, pavement, or landscaping.

Prior to backfilling, the Owner shall have the opportunity to inspect the trench, conduit and tape placement.

2.5 Measurement and Payment

Payment of conduit shall be by linear foot of conduit measured horizontally from centerline of pull box to centerline of pull box and/or centerline of pull box to centerline of controller cabinet. Elbow, vertical, and slack quantities shall be incidental to the horizontal dimension. The cost for conduit installations will include costs for all necessary items including but not limited to backfill, saw cutting, patching, jacking, drilling pits, removal of

pavement, sidewalk, gutters and curbs, and their replacement in kind to match existing grade and other incidentals necessary to complete the conduit installation in place for acceptance.

END OF SECTION

SECTION 3

PULL BOXES

3.0 General

Pull box locations shown on the plans are approximate. The Contractor shall locate the exact location in the field and the Contractor shall have the Owner agree to the location prior to installation. Pull boxes for traffic signal conduit runs shall not be spaced more than 150 feet apart from each other unless approved by the Owner. It shall be the option of the Contractor, at his expense, to install additional pull boxes that he may desire to facilitate his work as approved by the Owner.

Pull boxes shall be constructed of an aggregate material consisting of sand and gravel bound together with a polymer and reinforced with continuous woven glass strands. The material shall have the following mechanical properties.

Compressive Strength	-	11,000 psi
Tensile Strength	-	1,700 psi
Flexural Strength	-	7,500 psi

Pull boxes used for loop detectors on sampling stations shall be a minimum of twelve (12) inches wide by sixteen (16) inches long by twelve (12) inches deep. Pull boxes used at junctions of roadway conduit crossing shall be a minimum of twenty (20) inches long by thirty-three (33) inches wide by fifteen (15) inches deep. Pull boxes used for traffic signal communication interconnect shall be a minimum of twenty-four (24) inches long by thirty-six (36) inches wide by twenty-four (24) inches deep. Pull boxes at the controller cabinet shall be a minimum of thirty (30) inches long by forty-eight (48) inches wide by twenty-four (24) inches deep. Use of two (2) pull boxes in place of the larger one shall not be permitted. Other sizes may be approved by the Owner.

Pull box lids shall have a non-skid surface with a minimum coefficient of friction of 0.5. Covers shall hold a minimum vertical test load of 8,000 pounds over a 10-inch x 10-inch surface with no physical damage or excess deflection. Covers shall have the words Traffic Signal embossed on them and be concrete gray color.

Lids for pull boxes sized thirty (30) inches long by forty-eight (48) inches wide by twenty-four (24) inches deep or larger shall consist of two pieces capable of being removed from the pull box independently. The configuration of the two-piece lid shall be such that access to the pull box is unobstructed when both pieces are removed.

3.1 Installation

Pull boxes shown in the vicinity of curbs and gutters shall be placed adjacent to the back of the curb. Pull boxes adjacent to standards shall be placed along the side of foundations as shown on the plans.

The cover of the pull box shall be installed level with the finish grade. The cover of pull boxes located in sidewalks shall be installed level with the sidewalk. The bottom of all

pull boxes shall rest on firm ground with 12 inches of three-quarters (3/4) inch to two (2) inch river run rock below the pull box for drainage. Pull boxes installed in a sidewalk must be tied into the sidewalk to prevent the boxes from being pushed down below the top of the sidewalk.

Pull boxes installed in dirt or landscaped areas shall have a twelve (12) inch wide by six (6) inch thick concrete collar placed around the top, level with the cover of the pull box and finish grade. All concrete collars shall be Portland cement concrete conforming to the applicable requirements for Class B as referenced in the SSRBC.

3.2 Payment

Payment for pull boxes will be for each box installed as outlined below. The payment will include all work necessary for the final installation.

END OF SECTION

SECTION 4

TRAFFIC SIGNAL POLES AND MAST ARMS

4.0 General - Standard Type Poles

Traffic signal poles, mast arms, luminaire arms, and extensions will be furnished by the Owner. Fifteen-foot pedestal poles, ten-foot pedestal poles, and four-foot pedestal poles shall be provided by the contractor in conformance with Owner specifications.

Poles and mast arms are furnished with anchor bolts, nuts, washers, bolt nut covers, pole caps, mitigation devices, and door covers by the Owner. The contractor shall furnish all anchor bolts, nuts, washers, bolt nut covers, pedestal bases, pole caps and door covers for the fifteen-foot, ten-foot, and pedestrian button poles.

Roadway clearance at end of signal mast arm shall be 21 feet from roadway with side slope of two to three percent to the mast arm / pole connection.

Traffic signal poles, mast arms, concrete foundations, and necessary hardware shall conform to the appropriate requirements of Sections 601, 613, 713, and 715 of SSRBC.

4.1 Standard Poles

Poles shall be straight, with a permissive variation not to exceed 1-inch measured at the midpoint of a 30-foot or longer pole, and not to exceed 3/4-inch measured at the midpoint of a pole shorter than 30 feet.

Standard poles with mast arms shall have a hand hole located opposite the mast arm connection.

The circumference of the poles and mast arms shall be circular. Angles along the circumference, or hexagonal, octagonal, square, or rectangular poles or mast arms shall not be permitted.

Ten-foot and fifteen-foot pedestal type signal poles shall be capable of supporting a signal head using a standard pole top mount.

4.2 Signal Mast Arms

Traffic signal mast arms will be furnished with end caps. If, while being installed, an arm needs to be shortened, the Contractor must fabricate and install a new end cap.

4.3 Luminaire Mast Arms

Luminaire mast arms furnished by the Owner will be of the single arching type. Typically, the length will be either 12 feet or 15 feet.

4.4 Pole Foundations

Contractor shall be responsible for all labor and materials required for foundation installation, including rebar cages. Foundations shall be Portland Cement concrete conforming to the applicable requirements of Class BZ, as referenced in the SSRBC.

The bottom of concrete foundations shall rest on firm ground. Foundations shall be poured monolithically. For poles or pedestals, the top 4 inches shall be poured after the pole or pedestal is in proper position. The exposed portions of the foundation shall be formed to present a neat appearance.

Tops of foundations except as noted on the plans, shall be finished to curb or sidewalk grade, or as indicated in the plans. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in proper position and to proper height and shall be held in place by means of a template until the concrete sets.

Both forms and ground, which will be in contact with the concrete, shall be thoroughly moistened before placing concrete.

Where obstructions prevent construction of the planned foundation, the Contractor shall construct an effective foundation as directed by the Owner.

Traffic signal poles with mast arms 70-feet or greater shall use CDOT's 75-foot mast arm caisson specification per S-614-40 Typical Traffic Signal Installation Details for caisson diameter and depth only.

Mast arm poles shall be installed with the proper rake as recommended by the manufacturers of the poles so as to assure a substantially vertical set when the specified signal and lighting equipment is installed.

Anchor bolts for the mast arm poles will be supplied by the Owner to the Contractor. Anchor bolts shall conform to Subsection 715.02 of the SSRBC and shall be provided with two washers and two nuts and covers each. Plumbing the pole shall be accomplished by adjusting the nuts before the foundation is finished to final grade. Shims or other similar devices for plumbing or raking will be permitted only when approved by the Owner.

The excavation required for the installation of pole foundations shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping, utilities, and other improvements. Excavation shall be performed immediately before the installation of the concrete foundation. The material from the excavation shall be placed in a position that will not cause damage or obstruction to vehicular and pedestrian traffic or interfere with surface drainage.

Foundation holes excavated and not filled with concrete immediately shall be covered with a solid non-breaching surface covering and barricaded until concrete is poured. Foundation holes shall not be drilled more than 24 hours prior to placement of concrete without permission of the owner.

4.5 Protective Coatings for Signal Poles with Mast Arms and Pedestal Poles

4.5.1 Handling and Shipment

Poles, Mast Arms, and luminaire extensions and arms shall be handled in a manner that will preserve the overall appearance and prevent damage to the coating. The use of chains or cables for loading, unloading, shipping or installing is prohibited. Only 3/4-inch diameter or larger nonabrasive nylon rope or equivalent nylon belting will be used. Adequate hold-downs and appropriate blocking shall be utilized for shipping to prevent load movement and damage to the outer coating in transit.

4.5.2 Delivery, Installation and Acceptance of Poles

Extra care will be taken not to damage the coating. Upon arrival of the poles at the delivery point, neither chains nor cables will be used for either unloading or installation of poles.

The mast arm shall be pre-wired on the ground prior to completed installation to hasten installation time in this instance.

4.5.3 Procedure for Field Touch-Up

The Contractor will furnish extra paint, both primer and color coat, to satisfy the needs of field touch-up requirements in the event of minor physical damage to the coating from handling or transit. Damaged area must be clean and dry before repair application. Field touch-up will be at the direction of the Owner and the pole manufacturer or his authorized representative.

4.6 Payment

Replacement of roadway, sidewalk, or native growth areas created by installation of poles and foundations will not be paid separately but included in the unit price for pole installation.

For the poles and mast arms supplied by the Owner will include installation of all conduit connections, mitigation devices, replacement of surface materials in kind to match existing grade, and pole foundation with all material in conformance with the Owner for a full operational signal. Backfill material and seeding will not be paid separately but included in the unit price for pole installation. Payment is for installation of each pole and mast arm type.

Payment for all poles shall include pick up for the city, delivery to project location, installation of the pole, foundation, conduit connections, replacement of surface materials in kind to match existing grade, anchor bolts, and pole painting as required and in conformance with the Owner for a fully operational signal.

END OF SECTION

SECTION 5

CONDUCTORS AND CABLES: SIGNAL WIRING

5.0 General

Aerial cable shall be installed where specified on the plans and secured to messenger cable with cable ties or rings. No self-supported cable shall be installed unless that cable is specifically designed for this purpose. Drip loops shall be provided on all conductors where they enter pole weatherheads or signal heads.

Conductors shall be permanently identified as to function. Identification shall be placed on each conductor, or each group of conductors comprising a signal phase, in each pull box and near the end of terminated conductors.

Identification shall be by bands fastened to the conductors in such a manner that they will not move along the conductors.

All cables and conductors not shown on the plans as aerial cable or imbedded loop detector shall be installed in conduit unless installed in poles, pedestals, or mast arms.

5.1 Codes

Grounds and bonding wire, straps, and electrodes shall conform to NEC Article 250.

Wiring and splices shall conform to appropriate article of the Code. Wiring within cabinets, hand holes, junction boxes, etc., shall be neatly arranged and shall be laced.

Conductors shall be stranded, tinned copper wire, rated at 600 volts and individually insulated with heat stabilized polyethylene. Conductors and cable shall conform to IMSA Specification 19-1.

5.2 Bonding and Grounding

Metallic cable sheaths, conduit, metal poles, and pedestals shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be bare copper wire or copper strap of the same cross-sectional area, No. 8 AWG, for all systems. Sheath for detectors shall be grounded in control cabinet only. The other end of the sheath shall be taped and left ungrounded.

Bonding of poles and pedestals shall be by means of connecting to the ground rod a bonding strap attached to an anchor bolt or a 3/16-inch or larger brass or bronze bolt installed in the lower portion of the shaft.

A ground electrode shall be installed at each control box. Each ground electrode shall be one-piece copper-weld rod of 5/8-inch diameter and eight-feet in length, driven to a depth of at least 8 feet below the surface of the ground (top of rod flush with ground or top of cabinet base).

The ground terminal of controller shall be connected to the ground rod with a No. 8 AWG bare copper wire with an approved ground rod clamp.

5.3 Wire Splices

Splices shall be made in the handholes or cabinet. No splices shall be allowed in pull boxes or conduit unless authorized by the Owner. Method of splicing must be approved by Owner.

5.4 Installation

Sufficient signal light conductors shall be provided to perform the functional operation of signal system. Twenty-one (21) conductor cable shall be run to each signal pole. Seven (7) conductor cable shall be run from the handhole of each signal pole to each signal head. A minimum of three (3) spare conductors per through phase shall be provided throughout the signal light circuit. Additional conductors for service, interconnect, etc., shall be provided as noted on the plans.

Signal light conductors shall conform to the red-yellow-green color sequencing with different colored tracers for each phase provided.

All signal light cable conductors shall have individual terminal lugs for connection to terminal strips in cabinet.

Neutral conductors shall be individually landed on the neutral bus in the traffic signal controller cabinet. Grouping or splicing together of neural conductors prior to landing on the neutral bus shall not be permitted.

When conductors and cables are pulled into the conduit, the ends of all these conductors and cable shall be taped to exclude moisture and shall be so kept until the splices are made or terminal appliances attached. Ends of spare conductors shall be taped to exclude moisture.

Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit.

Pull rope - (1/4-inch nylon rope) shall be installed in all new conduit and all existing conduit where a cable is added, or an existing cable is replaced. At least two feet of pull rope shall be doubled back into the conduit at each termination.

Five feet of slack shall be left for each conductor at each support pole and two feet of slack at each pull box containing cable connections.

At least two feet (2') of slack for both power feed and loop wire is to be provided in each pull box so that testing and splicing can be done outside the pull box.

Splicing of cable will not be permitted in the conduit or outside of pull boxes, standards, or at the hand hole location in pedestals unless authorized by the Owner.

Multi-conductor cable shall be spliced and insulated to provide a watertight joint to prevent absorption of moisture by the cable.

Three-pair Belden twisted cable shall be used for pedestrian push buttons. Each pair shall be individually twisted and shielded 18-gauge stranded wire. The cable shall have polyethylene outer insulation and shall conform to IMSA specification 50-2, Belden part # YC47326 or approved equal. The three pairs of conductors shall be colored white/black, red/black, and green/black. The white/black pair shall be used for eastbound and westbound pedestrian movements. The red/black pair shall be used for northbound and southbound pedestrian movements. The green/black pair shall be spare conductors.

The power feed for the traffic signal controller cabinet shall be continuous without splicing from the power source to the meter, from the meter to the circuit breaker, and from the circuit breaker to the traffic signal controller cabinet. A second power feed for the illuminated overhead signage and luminaires shall be continuous without splicing from the meter to the circuit breaker, and from the circuit breaker to the home run pull box. From the home run pull box, the power feed for the illuminated overhead signage and luminaires shall be split through the use of a URD submersible bus type connector, with separate conductors run to the base of each traffic signal pole. Additional URD submersible bus type connectors shall be used in successive pull boxes that serve more than one traffic signal pole. From the base of each traffic signal pole, the power feed shall be split, with separate conductors run to the luminaire and to the illuminated overhead signage. Daisy-chaining of the conductors shall not be permitted.

5.5 Meter

The Contractor shall install a meter housing as required for the project. Meter housing shall be a bare aluminum Myers Power Products Inc. MEUG3A-12 series, Milbank U5949 Cold Sequence Meter Main Pedestal, or approved equal. The anchor bolt and foundation design for the Myers Power Products Inc. MEUG3A-12 Series meter housing shall be per manufacturer's recommendation. Concrete for the foundation shall be Class BZ per Colorado Department of Transportation SSRBC, latest revision. The contractor shall coordinate with the relevant electrical service provider on the source and connection of the power feed, the installation of the meter in the meter housing, and the connection of the power feed to the meter. Within Xcel Energy territory, the contractor shall coordinate with Xcel Energy to obtain the MI rate for traffic signal electrical service. The contractor shall zip tie all doors on the meter housing that can be padlocked. Padlocks shall not be used.

5.6 Payment

This will be intersection wiring for the entire signal intersection including wiring for power from the Xcel Energy or United Power approved location and installation of a meter and shall be paid for in a lump sum basis.

END OF SECTION

SECTION 6

VEHICLE DETECTION

6.0 General

Vehicle detection shall be video, or loop as shown on the plans unless otherwise authorized in writing by Owner's Traffic Engineer.

Traffic signal equipment shall be designed to operate between an ambient temperature of minus thirty degrees Fahrenheit to plus one hundred sixty-five degrees Fahrenheit with a relative humidity up to ninety-five percent.

The video detection system (VDS) shall consist of up to four video cameras, up to two video detection processors (VDP) capable of processing up to two video sources each, one 19" rack mounted Central Control Unit (CCU), video surge suppressors and a pointing device.

The system shall include software that discriminately detects the presence of individual vehicles and bicycles in a single or multiple lanes using only the video image. Detection zones shall be defined using only an embedded software application. A monitor, a keyboard and a pointing device are used to place the zones on a video image. A minimum of 32 detection zones per camera view shall be available. A separate computer shall not be required to program the detection zones. In addition to creating vehicle and bicycle zones, the system shall automatically define a pedestrian crossing area in front of the stop bar zones. The system shall provide a tracking mechanism that counts pedestrian volume moving within this crossing area, and also determine the average, maximum, and minimum speed of pedestrians moving within this crossing zone. The system shall also provide discrete outputs when pedestrians are in the crosswalk during normal crossing phases and when a red phase input has been detected. The system shall also provide a visual indication on the video image that a pedestrian is in the crosswalk.

6.1 Installation

6.1.1 The VDP shall be a single-rack detector card width and provide provision for up to two sensors per VDP. It may be possible for the VDPs to be embedded in the shelf-mount CCU to provide a single cabinet interface.

Each VDP will be supplied with video from the VDS Camera Sensor via Ethernet cables plugged into the front of the Central Control Unit. The interface connectors shall be RJ-45 type.

The CCU shall provide four ports for connection to VDS camera sensors. The connector shall be an RJ-45 type.

An Ethernet communications port shall be provided on the front panel. The Ethernet port shall be compliant with IEEE 802.3 and shall use a RJ-45 type connector mounted on the front panel of the CCU. The Ethernet communications interface shall allow the user to remotely configure the system and/or to extract calculated vehicle/roadway information. The interface protocol shall be documented, or interface software shall be provided. Each

VDS shall have the capability to be IP addressable. The VDP shall support data rates of up to100Mbps.

The CCU shall provide an SDLC connection to the Traffic Controller. The connector shall be a 'D-15' type, in compliance with NEMA TS-2 specifications.

The VDS camera sensor shall utilize a single shielded CAT5E or CAT6 cable for power and video. Cable termination at the camera shall not require crimping or special tools. The cable termination shall only require a standard wire stripper and a screwdriver. No connectors (e.g., BNC) shall be allowed.

The camera imager shall employ wide dynamic range (WDR) technology to compensate for wide dynamic outdoor lighting conditions. The dynamic range shall be greater than 100 dB.

The VDP and CCU shall be Iteris Vantage Next WDR or approved equal.

6.1.2 The video detection system shall be installed by factory certified installers and as recommended by the manufacturer and documented in the installation materials. If to be mounted on the mast arm the bracket shall be a PELCO #AB-0170-74 with stainless steel straps (not cables), or approved equivalent, minimum 74 inches in length.

END OF SECTION

SECTION 7

PUSH BUTTON STATIONS

7.0 General

Pedestrian detection is accomplished by the push button stations.

Pedestrian push buttons shall be of the direct push button contact type and shall be black Polara Bulldog BDL3-B or approved equal. The push buttons shall operate on a voltage not to exceed 18V AC. The assembly shall be of tamper-proof design and equipped with a push button instruction sign. Button frames shall be painted black, and ADA approved.

The assembly shall be weatherproof and constructed so it shall be impossible to receive any electrical shock under any weather conditions.

The pedestrian push button instruction sign shall include informational text as shown in the detail sheets in the plans.

Sign dimensions shall conform to mounting frames as shown in the detail sheets in the plans.

7.1 Measurement and Payment

Payment will be for each push button station installed and will include all material necessary for proper operation.

END OF SECTION

SECTION 8

SIGNAL HEADS

8.0 General

Signal equipment shall be manufactured and be designed to operate from a 115-volt 60 cycle single-phase source.

All traffic signal equipment shall be designed to operate between ambient temperatures of -30 degrees F to +165 degrees F, with relative humidity up to 95 percent.

Twelve (12) inch signal heads shall be polycarbonate and shall come complete with mounting opening plugs, washers, and gaskets for mounting. Heads shall be highway signal black in color (both faces and housings). Visors shall be polycarbonate and shall be highway black for outside and flat black inside. LED arrows shall not be the outline type.

All signal faces installed prior to final activation of the system shall be covered with orange bags to clearly indicate that the signal is not operational. The covering shall be over the entire head and shall be securely fastened. No adhesive used to secure the head covering shall touch any part of the head or mounting assembly. Signal heads and faces shall not be installed sooner than five (5) days prior to activation, unless approved in writing by the Owner.

All signal hardware to be furnished under this contract shall be of standard design and manufacture. No special fittings and/or components shall be used or furnished which are not shelf type items by the manufacturer and/or vendor.

All vehicle signal faces, and pedestrian signal faces shall be of the adjustable, vertical type as shown on the plans. They shall provide light indication in one direction only and shall be adjustable through 360 degrees about a vertical axis.

All mast arm mounted heads shall be mounted at the location determined by the Owner. No holes shall be placed into the mast arms until actual head location has been determined in the field by the Owner.

All mast arm mounted heads shall be installed at a uniform elevation above the roadway surface.

Unless otherwise shown on the plans, traffic signal faces shall be standard 12-inch LED and shall contain three sections arranged vertically; red--top; yellow--center; green--bottom.

All vehicle signal faces shall be focused to allow maximum visibility to approaching motorists. All signal heads installed at any one intersection shall be of the same make and type, unless otherwise stated in the Schedule of Bid Items, or these Technical Specifications, or approved by the Owner.

8.1 General Standards

The signal housing and LED faces shall conform to the Institute of Transportation Engineers most recent standards. LED on-board circuitry must meet FCC Title 47, CFR Subparts B, Section 15.107, 109 regulations concerning emission of electronic noise. Certificate of Compliance with ITE standards shall be provided upon delivery of material.

8.1.1 Physical

The traffic signal housing shall be for direct LED use or be a retrofit LED in a traffic signal housing built to the ITE Vehicle Traffic Control Signal Head (VTCSH) standards without modification to housing or need of special tools. The lens, lamp module, and gasket shall be weather tight and fit securely in the housing and shall be Gelcore, Dialight, or approved equal.

8.1.2 LED Signal Lens Module

The lens may be uniformly tinted to enhance ON/OFF contrasts in a manner not to affect luminous intensity or chromaticity. The lens shall be easily replaceable in the field without the need of any special tools or any adhesives in the event of vandalism or vehicle impact. The lens shall be keyed to the housing to assure proper orientation. The lens material shall be Ultraviolet (UV) stabilized polycarbonate to withstand direct sunlight exposure for a minimum of five years without exhibiting evidence of deterioration.

8.1.3 Lamp Construction

The LED signal shall be a self-contained device not requiring on-site assembly and be capable of withstanding mechanical shock and vibration.

8.2 Mounting Hardware

8.2.1 Mast Arm Mounts

Signal head placement as shown on the plans are representative only. All mast arm signal head mounts shall be a Pelco Astro-Brac Tallon Series AB-0617 (no paint) with ninety-six inch (96” cable) or Sky Bracket type mount. Each head shall be mounted with a separate mount. Horizontal clustering of two arrowed heads next to a three section standard head will be permitted on one Sky Bracket type signal mast arm mount.

8.2.2 Side of Pole and Top of Pole Mounts

One-way side and top mounts shall be aluminum and shall be highway black in color. The upper and lower arm assemblies for one-way side of pole mounts shall use elbows and not “T” fittings. Two-way side of pole mounts for signal and pedestrian signal heads shall be aluminum and shall be highway black in color. Two-way side of pole signal head mounting assemblies shall use a “T” fitting in the center frame pipe. Elbows shall be used on the upper and lower arm assemblies at the signal head mounting locations.

8.3 Backplates

Backplates shall be furnished and installed on all overhead vehicular signal heads on mast arms. No background light shall show between the backplates and the signal face or between sections of the signal head.

Backplates shall be either all one piece or sectional. Sectional backplates shall be riveted together. No screws shall be allowed for putting backplates together. Backplates shall be 5 inches in width unless otherwise approved by the Owner and shall be louvered to allow airflow and yet not permit background light to be visible to the motorist. Backplates shall be aluminum painted Flat Black. Backplates shall be installed to the signal head using the appropriate screws and 1/4-inch zinc plated flat washers.

8.4 Payment

Signal heads will be paid for each unit, totally installed, and operational with backplate at location shown on the plans.

END OF SECTION

SECTION 9

PEDESTRIAN SIGNAL HEADS

9.0 General

All Pedestrian Signal Heads shall be polycarbonate 18-inch clamshell mounting type, (Portland Orange and Lunar White). Units shall be highway black in color. Units shall come complete with a combination cutout and/or honeycombed visors, to prevent sun washout. Units shall be LED with a Hand/Man and Countdown display.

9.1 Measurement and Payment

Payment will be for each head installed and will include all material necessary for proper operation.

END OF SECTION

SECTION 10

EMERGENCY VEHICLE PRE-EMPT DETECTION

10.0 General

Opticom No. 722 (Detector) (Global Traffic Technologies) units or approved equal shall be used for detection purposes, consisting of a single channel, bi-directional assembly.

10.1 Payment

Payment is for each detector head unit installed and made operational and will include all equipment and wiring needed for operation.

END OF SECTION

SECTION 11

CONTROLLER AND CABINET SPECIFICATIONS

11.0 General – Controller Specifications

The contactor shall install owner supplied Econolite Cobalt Rackmount LT controller with touchscreen and ASC3/LX firmware version 32.67.30 or later.

11.1 General – Cabinet Specifications

11.1.1 General

The contractor shall install owner supplied 333SD-ITS Cabinet with uninterrupted power supply at the intersection.

Cabinets shall have the following items included in addition to the items specified for each cabinet.

1. The cabinet shall be natural aluminum with no anti-graffiti coating and no powder coating finish.

2. A means of selecting the active red monitor channel shall be provided on the rear of the monitor panel. Selection shall be accomplished by means of a two-position jumper (shunt) with the center position wired to a red monitor input and select of 115V AC to the right and red load switch output to the left. Moving the jumper to the right will provide continuous red input and override, while moving a jumper to the left will attach the monitor channel to the corresponding load switch output.

3. This jumper assembly shall be accessible while the intersection is in operation. Means shall be provided to prevent shock to personnel operating jumper selection devices.

4. Red monitoring disable control shall be provided within the red monitor cable assembly. Pin six on TB02 shall connect to a 24V DC relay coil. This relay is designated RM control relay. The normally closed contacts shall provide 115V AC to the red monitor select line and pin 17 on the monitor cable. When a logic ground is applied to TB02-6 the RM relay shall energize and open the cable. The relay power will be derived from the cabinet 24 VDC cabinet power supply.

5. Each unit shall comply with the following:

   a. Clamping level 400V peak normal mode and 500V peak common mode. Trace photos and other test-related information will be available upon request.
   b. EMI/EFI noise rejection derived via standardized 50-ohm insertion loss tests shall have amplitude of at least –20db over a minimum spectrum from 50 KHZ with a –40db being the most desirable.

c. Diagnostics indicators shall clearly display the status of the suppression circuit. The indication shall warn of the loss of protection.

d. Transient energy suppression shall be in excess of 250 Joules.

e. Rated voltage is 120V AC with rated output current minimum 10 amperes single phase operation.

f. All of the above components provided on the project, excluding the signal monitor unit, shall be on the Colorado and California Qualified Products listing.

6. The cabinet drawings shall be non-fading prints using xerography method. No blue line drawings shall be acceptable.

7. Serial connections shall use a standard RJ – type quick lock connection.

8. One (1) Set of anchor bolts.

9. The cabinet shall include the following:

QUANTITY	ITEM
	Internal Fans – 2 for the 333SD-ITS
	Internal (front/back) fluorescent lamps - 4 for the 333SD-ITS
4	Model 430” Transfer Relays
2	Model 204 2-Circuit Flasher (cube type, 25 AMP output)
12 maximum	Model 200 Load Switches w/Input & Output LEDs (cube type, 25 AMP)
3 maximum	Model 242 DC Isolators
*	Model 222 Loop Amplifiers or Video Detection Cards
1	Model 2010ECLip Monitor with absence of red monitoring
	New York 330 Pull-out Drawer Assembly – 2 for the 333SD-ITS
1	Transient Voltage Surge Suppression System
2	Split Input files – 333SD-ITS Cabinets only
1	Output File with terminal strips (not Phoenix connectors)
8	Flash Program Blocks

* As required per plans.

11.2 333SD-ITS Cabinet Assembly

The 333SD-ITS Cabinet shall consist of the following in addition to Section 11.1:

The controller cabinet shall be a four door Model 333SD-ITS as specified. The 333SD-ITS cabinet shall include a base extension assembly. The input file shall meet the requirements of the split input file. Unless otherwise specified in the contract, the cabinet shall include the following:

Cabinet dimensions: 54” X 43” X 26” D
All four doors shall have Corbin #2 locks installed.

A minimum of 12 selections are required eight phase selections and four overlap selections shall be provided with jumper selections.

Split input file shall be an SF 170 that will also operate in the 332/336S cabinets.

The Split Input File shall use a split 22 pin connector (2 rows of 22 pins) which provide for 44 unique contacts, rather than the 22 double contacts as provided by the former input file. This design shall interface electrically with the older 2 and 4 channel devices available under the 170 and NEMA TSI specification as well as the newer 2 and 4 channel devices as specified in the TS2 NEMA specification.

The input file shall be divided into two partitions. The first partition shall include the first eight slots from the left; the second partition shall include the next six slots. All 14 slots shall be able to be tied to one common communication drop if desired.

The serial/ITL Transmit and receive pairs shall be wired across the back panel. TXO, DXO, Ground0 serve the first eight slots. TX1, DX1 and Ground1 serve the next six slots. Back plane addressing is automatically assigned in the rear of the input file, such that:

Slot 1 = Address 0
Slot 2 = Address 1 . . . . . Slot 8 = Address 7 (all three line low)

Addressing from the front of any input device shall override the back plane addressing.

The left side of the 333SD-ITS cabinet assembly shall have shelves assembled to the EIA rack assembly to house additional equipment such as, but not limited to, Video Detection, Standby Uninterrupted Power supply and communication equipment.

Surge suppression for the field wiring shall be installed on the back of the output file.

The contractor shall install a beacon on the cabinet to provide visual alert should an uninterrupted power supply become active. The beacon shall be a 24-volt Whelen 2015HP yellow beacon, or approved equal, and shall be located in the top center of the cabinet. The beacon shall be wired to the cabinet and the uninterrupted power supply using 18-gauge wire. An outdoor silicone caulk bead shall be applied between the beacon and the cabinet to prevent water intrusion.

11.4 Measurement and Payment

Measurement and payment will be for controller and cabinet fully installed with all equipment necessary for full operation and in compliance with these specifications.

END OF SECTION

SECTION 12

COMMUNICATION INTERFACE

12.0 General

Communication interface will consist of fiber or radio or a combination of each. This work shall consist of furnishing, installing, and testing all required fiber optic cable and radio equipment. Fiber optic cable shall include backbone cable, lateral cable and patch cords running from the environmental distribution type enclosure to the optical data link and are explained in detail in this specification. The cable shall be an accepted product of the United States Department of Agriculture Rural Electrification Administration (REA) as meeting the requirements of 7CFR1755.900. The cable shall be new, unused, and of current design and manufacture. Contractor shall provide the Thornton Engineer with two copies of the cable manufacturer's installation instructions. All installation shall be in accordance with these practices except as otherwise directed by the Engineer. Additional cable costs due to damage caused by Contractor neglect of recommended procedures shall be Contractor's responsibility. Backbone cable shall be installed in continuous runs except where cable type changes or where maximum pull lengths govern. The manufacturer's recommended limits for cable pull lengths shall not be exceeded. Cable ends shall be spliced and/or stored in pull boxes as indicated in the plans or as directed. Only fibers indicated in the plans need to be spliced or terminated in controller cabinets or pull boxes. All other fibers shall be sealed in a manner recommended by the manufacturer.

No cutting or splicing of the interconnect cable will be allowed unless shown in the plans or otherwise authorized by the Owner.

12.1 Fiber

Fiber shall be the number of strands indicated on the plans.

Backbone cable shall consist of loose tube non-armored outdoor cable containing the required number of 12-fiber single mode ("SM") tubes. Backbone cable for installation in conduit shall meet the applicable portions of IMSA Specification 60-2 or approved equal. Lateral fiber optic cable shall be dielectric, loose tube, non-armored outdoor cable (UV resistant and flame-retardant outer jacket) suitable for duct installation complying with the following specification for fiber optic cable, Siecor FREEDM/LST cable or approved equal. In addition, the cable shall meet the applicable portions of IMSA specification 60-2 or approved equal. Lateral cable shall consist of six (6) single mode fibers or as indicated on the plans. Odd length cables and reel ends are acceptable for lateral cables provided they are of sufficient length to connect backbone and controller cabinet in continuous runs. Hereinafter single mode fiber may be abbreviated as "SM".

1. FIBER CHARACTERISTICS. All fibers in the cable must be usable fibers and meet the required specifications. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this specification. Each optical fiber shall consist of a doped silica core surrounded by a concentric silica cladding.

The SM fiber utilized in the cable specified herein shall conform to the following specifications:

- Typical Core Diameter 8.3 micrometer.
- Cladding Diameter 125 +/- 1.0 micrometer.
- Core to Cladding Offset $\leq$ 0.6 micrometer.
- Cladding Non-Circularity $\leq$ 1.0%. (Defined as [1 - (min. Cladding dia. + max. Cladding dia.)] x 100.
- Coating Diameter 245 +/- 10 micrometer.
- Colored Fiber Diameter nominal 250 micrometer.
- Attenuation Uniformity - No point discontinuity > 0.10 dB at either 1310nm or 1550nm.
- Attenuation at the Water Peak - The attenuation at 1383 +/- 3nm shall not exceed 2.1 dB/km.
- Cutoff Wavelength - The cabled fiber cutoff wavelength shall be $\leq$ 1250 nm.
- Mode-Field Diameter (Petermann II):
  9.30 plus/minus 0.50 micrometer at 1310nm; 10.50 +/- 1.00 micrometer at 1550nm.
- Zero Dispersion Wavelength $\leq$ 1321.5nm and $\geq$ 1301.5nm.
- Zero Dispersion Slope (S_o): $\leq$ 0.092 ps/(nm^2/km).

The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. Coating shall be mechanically strippable without damaging the fiber.

2. FIBER SPECIFICATION PARAMETERS. All fibers in the cable shall meet the requirements of this specification.

When tested in accordance with FOTP-3, “Procedure to Measure Temperature Cycling Effects on Optical Fiber, Optical Cable, and Other Passive Fiber Optic Components,” the average change in attenuation at extreme operational temperatures (-40^{o}C to +70^{o}C) shall not exceed 0.05 dB/km at 1550 nm. The magnitude of maximum attenuation change of each individual fiber shall not be greater than 0.15 dB/km at 1550 nm.

Required fiber grade = Maximum Individual Fiber Attenuation.

The maximum dispersion shall be $\leq$ 3.3 ps/(nm km) for 1285 nm through 1330 nm and $\leq$ 18 ps/(nm km) at 1550 nm.

3. SPECIFICATIONS FOR OUTDOOR CABLES. Optical fibers shall be placed inside a loose buffer tube. The fibers shall not adhere to the inside of the buffer tube. Each fiber shall be distinguishable from the others with distinct and recognizable colors in accordance with EIA/TIA-598, Optical Fiber Cable Color Coding, latest revision.

Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with EIA/TIA-598, Optical Fiber Cable Color Coding, latest revision.

In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other or the gel filling material. Colors 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.

Fillers may be included in the cable core to lend symmetry to the cable cross-section.

The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.

Each buffer tube shall be filled with a non-hygroscopic, non-nutritive to fungus, electrically non-conductive, homogeneous 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 using the reverse oscillation, or “SZ” stranding process.

The cable core interstices shall be filled with a water-blocking compound. The compound shall be a thixotropic gel containing a Super Absorbent Polymer (SAP) material. The gel shall be non-nutritive to fungus, electrically non-conductive and homogeneous. The gel shall be free from dirt and foreign matter and shall be readily removable using nontoxic solvents.

Binders shall be applied with sufficient tension to secure buffer tubes to central member without crushing the buffer tubes. Binders shall be non-hygroscopic, non-wicking (or rendered so by the flooding compound) and dielectric with low shrinkage.

Cable shall contain at least one ripcord under the sheath for easy sheath removal.

Tensile strength shall be provided by high tensile strength aramid yarns and/or fiberglass yarns. The high tensile strength aramid and/or fiberglass yarns shall be helically stranded evenly around the cable core.

All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. The polyethylene shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.

The jacket or sheath shall be free of holes, splits and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness. Cable jackets shall be marked with sequential meter or foot markings, year of manufacture and a telecommunications handset symbol, as required by Section 350G of the National Electric Safety Code. 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 approximately 2.5 mm.

The maximum pulling tension shall be 2,700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.

Shipping, storage and operating temperature range of the cable shall be -40°C to +70°C. The installation temperature range of the cable shall be the same as the shipping, storage and operating temperature.

4. GENERAL CABLE PERFORMANCE SPECIFICATIONS. The un-aged cable shall withstand water penetration when tested with a one-meter static head or equivalent continuous pressure applied at one end of a one-meter length of filled cable for 24 hours. No water shall leak through the open cable end. When a one-meter static head or equivalent continuous pressure is applied at one end of a one-meter length of aged cable for one hour, no water shall leak through the open cable end. Testing shall be done in accordance with FOTP-82, "Fluid Penetration Test for Filled Fiber Optic Cable."

When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable," Method A; the cable shall exhibit no flow, drip or leak of filling or flooding compound at 80°C. If material flow is detected, the weight of any compound that drips from the sample shall be less than 0.05 g.

The cable shall withstand a minimum compressive load of 220 N/cm for non-armored cables applied uniformly over the length of the compression plate. The cable shall be tested in accordance with FOTP-41 "Compressive Loading Resistance of Fiber Optic Cables," except that the load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for 10 minutes.

The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience attenuation greater than 0.1 dB at 1500 nm (single mode). The average increase in attenuation for the fibers shall be $\leq$ 0.20 dB at 1300 nm (multimode). The repeatability of the measurement system is typically 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.

When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles at a rate of 30 plus/minus 1 cycles per minute, with a sheave diameter not greater than 20 times the cable diameter. The magnitude of the attenuation change shall be within the repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers shall not experience an attenuation change greater than 0.1 dB at 1550 nm. The repeatability of the measurement system is typically 0.05 dB or less. The cable jacket shall not exhibit evidence of cracking or splitting when observed under 5x magnification.

When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," cable shall withstand 25 impact cycles. Magnitude of the attenuation change shall be within repeatability of measurement system for 90% of test fibers. The remaining 10% of the fibers shall not experience attenuation change greater than 0.1 dB at 1550 nm. The repeatability of measurement system is typically 0.05 dB or less. The cable jacket shall not exhibit evidence of cracking or splitting at the completion of the test.

When tested in accordance with FOTP-33, “Fiber Optic Cable Tensile Loading and Bending Test,” using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N applied for one hour (using Test Condition II of the procedure). In addition, cable sample, while subjected to a minimum load of 2660 N, shall be able to withstand twist of 360 degrees in a length of less than 3 m. Magnitude of attenuation change shall be within repeatability of the measurement system for 90% of the test fibers. Remaining 10% of the fibers shall not experience an attenuation change > than 0.1 dB at 1550nm. Repeatability of the measurement system is typically 0.05 dB or less. The cable shall not experience a measurable increase in attenuation when subjected to the rated residual tensile load of 890 N.

When tested in accordance with FOTP-85, “Fiber Optic Cable Twist Test,” a length of cable no greater than 2m will withstand 10 cycles of mechanical twisting. Magnitude of attenuation change will be within the limit of repeatability of the measurement system for 90% of the test fibers. The remaining 10% of the fibers will not experience an attenuation change > 0.1 dB at 1550 nm. The repeatability of the measurement system is typically 0.05 dB or less. The cable jacket will exhibit no cracking or splitting when observed under 5x magnification following completion of the test.

When tested in accordance with the proposed FOTP-181, “Lightning Damage Susceptibility Test for Optic Cables with Metallic Components,” the cable shall withstand a simulated lightning strike with a peak value of the current pulse $\geq$ 105 kA. The test current used shall be damped oscillatory with a maximum time-to-peak value of 15 microseconds (which corresponds to a minimum frequency of 16.7 kHz). The time to half-value of the waveform envelope ($t_{1/2}$) shall be 40-70 microseconds. In addition to the analysis criterion set forth on FOTP-181, the integrity of the buffer tubes (or analogous loose tube, i.e., core tube) and strength members must be intact after removal of the cable specimens from the test box.

5. QUALITY ASSURANCE PROVISIONS. All optical fibers shall be proof tested by the fiber manufacture at a minimum load of 100 kpsi. All optical fibers shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.

6. PACKAGING. The completed cable shall be packaged for shipment on non-returnable wooden reels. Top and bottom ends of the cable shall be available for testing. Both ends of the cable shall be sealed to prevent the ingress of moisture. Each reel shall have a weatherproof reel tag attached identifying the reel and cable. Each cable shall be accompanied by a cable data sheet that contains significant information on the cable.

7. MISCELLANEOUS. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification.

Contractor shall terminate all fibers on the contractor-provided patch panel in the controller cabinets indicated on the plans.

Contractor shall terminate backbone fibers on the contractor-provided patch panel as shown on the plans. Number of bulkheads on individual patch panels shall be

as shown in the plans or as otherwise specified herein. The bulkheads shall be metal type and not plastic.

Cable shall be installed using appropriate strain relief in the cabinet (through cable ties) at a minimum of three locations.

Prior to installation, the contractor shall submit a schematic interconnect diagram to the Owner for approval. The diagram shall clearly indicate cable routing, splice points, and fiber connections including identifying the color-coded fibers and buffer tubes. Installation of the cable will not be permitted until the schematic diagram has been approved by the Owner.

The same color-coded pairs of fibers and/or wires shall be used throughout the entire project.

At the terminal points the jackets shall be stripped and the ends taped. Gel filling compound shall be removed using filled cable cleaner.

Cable shall be installed in new conduit or existing conduit as depicted in the plans. Contractor shall be required to leave a minimum of 75 feet coiled and laced slack lateral cable in each traffic signal controller cabinet; 75 feet coiled and laced slack cable in pull boxes where the lateral cable is spliced; 75 feet coiled and laced slack backbone cable in pull boxes where the backbone is broken out; and 75 feet coiled and laced slack backbone cable at all other pull box locations called out in the plans. The fiber optic cable shall be neatly coiled and clearly tagged and labeled at such pull boxes and at all other locations where it is exposed.

For all fiber optic cables, each fiber shall be checked with an OTDR and full traces documenting fiber performance shall be provided to the Engineer within 30 days of test. All optical fibers shall be within the manufacturer's recommended tolerances. In addition, any other acceptance testing recommended by the manufacturer shall be provided. Data shall be supplied to the Engineer prior to completion of the project.

Cable shall be transported to the site using cable reel trailers. Care shall be taken at all times to avoid scraping, denting or otherwise damaging the cable before, during and after installation. Damaged cable shall be replaced by the Contractor without additional compensation.

Sufficient slack shall be pulled to allow cable cutting and connection to communications equipment.

Cable shall be installed in conduit or duct in accordance with the contract drawings. Conduit and duct ends shall have all rough edges smoothed to prevent scraping the cable. A stiff bristle brush shall be pulled through each section of conduit before pulling cable. A manufacturer recommended lubricant shall be applied to the cable to reduce friction between the cable and duct or conduit. Where fiber optic cables are to be installed in inner duct, the Contractor shall secure each section of inner duct to prevent it from being pulled with the cables.

A cable grip shall be attached to the cables so that no direct force is applied to the optical fiber. The cable grip shall have a ball-bearing swivel to prevent the cable from twisting during pulling. Cable rollers and feeders and winch cable blocks shall be used to guide the cable freely into the duct and at maintenance hole locations. The Contractor shall ensure that the tensile load on the cable does not exceed the manufacturer's recommended maximum. Mechanical aids and pulling cables or ropes shall be used as required.

Personnel equipped with two-way radios shall be stationed at each maintenance hole, cabinet, pedestal, communications box, and junction box through which the cable is to be pulled to observe and lubricate the cable.

Where mechanical pulling is required (i.e., all runs greater than 150 feet), a dynamometer shall be used to record installation tension and a tension limiting device shall be used to prevent exceeding the maximum pulling tension as defined by the cable manufacturer. The maximum pulling tension shall be recorded for each run of cable. The cable shall be taken up at intermediate pulling points with an intermediate cable take-up device as approved by the Engineer to prevent over-tension on the cable. Cable pulls shall be continuous and steady between pull points and shall not be interrupted until the entire run of cable has been pulled.

Contractor shall be responsible for ensuring the cable length is sufficient to allow for connection between the communications equipment and the splice enclosures (if applicable) including provision for slack, vertical runs, cable necessary for splicing, wastage and cable to allow for the removal of the splice enclosure for future splicing.

Where backbone or lateral cable runs are left to be "dead ended," a minimum of 100 feet of cable shall be left coiled in the final cabinet, manhole, or pull box, unless otherwise called for in the plans.

8. SPLICES AND SPLICE CLOSURES. Splices are not allowed without the written authorization of the Engineer. If splices are authorized, each such splice shall occur in a new pull box to be installed by the Contractor or an existing manhole or pull box already installed along the route. All splices shall be enclosed within a splice closure, Siecor Catalog SCN-CAN or approved equal.

Following successful splicing, said splice closure shall be placed inside the described pull box or manhole. Contractor shall accomplish the work using splicing tools and hardware recommended by the cable manufacturer. The average splice loss shall not exceed 0.2 dB for any given span.

9. TESTING. Cable reels shall be tested for attenuation prior to installation. Contractor shall measure attenuation of at least 10% of the total fibers randomly selected on each reel. Where the 10% quantity equates to more than one fiber, the fibers tested shall be located in different buffer tubes. Attenuation shall meet or exceed the specified performance requirements. If cable is furnished by the Contractor, Contractor shall ensure that specifications for fiber optic cable have been met prior to installation.

10. BUFFER TUBE FAN-OUT. Contractor shall terminate the loose-tube lateral cable at the controller using a buffer tube fan-out kit, Siecor Catalog FAN-BT or approved equal. Fanned-out cables shall be terminated at the controller telemetry panel or in the contractor-furnished termination enclosure as shown in the plans. The fan-out kit shall be placed inside the cabinet rack-mounted termination enclosure. The number of fibers to be landed and terminated shall be as shown in the plans.

11. TERMINATION ENCLOSURE. Contractor shall furnish and install a cabinet rack-mounted termination enclosure for storage of the fan-out kit and broken-out fibers. This enclosure shall be sized as called out in the plans. Optional guard and dust proofing components shall be included. Contractor shall furnish and install all connectors, adaptors, jumpers and/or pigtails required to establish the final connection to the controller. Contractor shall furnish and install a rack-mounted termination enclosure for storage of the fan-out kit and broken out fibers at the IMC or other City facility as indicated in the plans. This enclosure shall be sized as called out in the plans.

12. FIBER OPTIC PATCH CORD (PIGTAIL) CABLES. Fiber optic patch cord cables shall consist of SM fibers housed individually in protective jackets. Both ends of the cable shall be connected. Fiber optic patch cord cable shall be suitable for operation over a temperature range of -30° to +60° C.

Fiber optic patch cords shall be fiber optic jumper cable, duplex, ceramic ferrule, yellow-jacketed (for SM) 8.3/125nm or orange-jacketed (for multimode) 62.5/125nm, adaptable to LC style connectors.

Fiber optic patch cord cables shall be a minimum of six (6) feet in length and suitably long enough to be connected between the interconnect panel and the communications equipment (i.e., the fiber optic transceivers). Patch cord couplings shall be compatible with termination points.

Appropriate strain relief in the cabinet (through cable ties) shall be installed at a minimum of three locations. Sufficient slack shall be left to allow relocation of the equipment anywhere within the existing cabinet. The attenuation of a fiber optic patch cord cable after installation, not including the connector loss, shall not exceed 0.1dB measured at 1310nm and 1550nm.

13. CONNECTORS. The connector shall have a ceramic ferrule with a nickel-plated nut and body. The connector shall be LC style field mounted connector compatible with communication equipment as identified in the plans and these specifications. The connector shall be compatible with a physical contact (PC) finish.

All connectors shall be polished to a PC finish such that the return loss per mate pair of connectors is less than -25dB.

The return loss when the connector is mated with previously installed connectors shall be less than -18dB. The connector insertion loss shall not be greater than 0.20dB (typical). The connector loss shall not vary more than 0.20dB after 1000

repeated matings. The tensile strength shall withstand an axial load of 20lb with less than 0.20dB change.

Index matching fluids or gels shall not be used. The connectors shall be compatible with the optical fiber surrounding jacket and shall be installed on one end of the optical fiber in accordance with the manufacturer's recommended materials, equipment, and practices. The connector shall be suitable for the intended environment and shall meet the following environmental conditions:

1. Operating Temperature: -40° to +80° C
2. Storage Temperature: -40° to +85° C

The connector loss shall not vary more than 0.20 dB over the operating temperature range. Connectors shall be protected by a suitably installed waterproof protection cap.

12.2 Conductor Cable

Five feet of slack shall be left for each conductor at each support pole and two feet of slack at each pull box containing cable connections.

See Section 5 – Conductors and Cables: Signal Wiring for additional conductor specifications.

12.3 Ethernet Field Switches

Ethernet field switches shall be used to facilitate communication between the ATC controller and an Ethernet system. The field Ethernet switch shall be a KYLAND-USA KY-3170EM4 industrial field switch or approved equal with six (6) copper 10/100/1000 RJ-45 Ethernet ports and four (4) 100/1000 SFP slots. Two SFP slots shall be populated with 1310 nm SM SFP transceivers with transmission speed of one (1) Gigabit, and coverage distance of ten (10) kilometers.

12.4 Ethernet Telemetry

Ethernet Telemetry shall consist of a 5 GHz airMAX ac Radio BaseStation with airPrism Active RF Filtering Technology used to enable the controller to communicate over an Ethernet system. Unless otherwise specified in the plans, antennae wiring shall be CAT5E outdoor rated or approved equal. Software shall be included to allow the Traffic Engineer to configure the radios on an as-needed basis. All data shall be encrypted.

The radios are to be equipped with an external jack allowing the use of a dish antenna or sector antenna.

Sector and dish antennas shall be furnished and installed per the Ubiquiti Networks system manufacturer's recommendations for antenna, make, model, and installation. Sector antenna shall be Ubiquiti AM-5AC22-45 or approved equal, dish antenna shall be Ubiquiti PBE-5AC-ISO-Gen2 or approved equal.

The Contractor shall field test all radios and antenna's and provide compliance testing and approval verification to the Traffic Engineer. The Contractor must provide a fully functional radio communication system for the project.

The Contractor shall test signal reception at all intersections to verify end-to-end communications system performance prior to physical installation. The Contractor shall notify the Traffic Engineer of the intended implementation plan based on the findings of the initial reception test.

12.5 Measurement and Payment

Ethernet Field Switch shall include all labor and materials required to install and make it operational including the following items:

- Ethernet Field Switch
- One straight-through Ethernet cable six feet in length
- Two pair of fiber optic patch cables, each six feet in length
- All other work and materials necessary to complete the item.

Fiber optic cable shall be measured horizontally by the linear foot from centerline of pull box to centerline of pull box and/or centerline of pull box to centerline of controller cabinet. All required coiled and laced slack cable shall be considered incidental to the horizontal dimension. The fiber optic cable measurement shall also include all labor and materials required to install and terminate the interconnect cable (and make it operational) including the following items:

- All required splicing, splice enclosures, splice kits, splicing tools, ancillary hardware and labor to accomplish the splices.
- All required fan-out kits, fan-out kit tools, ancillary hardware, and labor to accomplish the fan-out.
- All required termination enclosures (including specified features), connectors, adaptors, jumpers, pigtails, patch panels (including specified number of bulkheads), ancillary hardware and labor required to accomplish the termination.
- All required testing and documentation activities.
- Identification labels for both backbone and lateral fiber cables in each pull box and cabinet.
- Fiber delineators installed at each pull box location.
- All required rigid conduit risers, weather-heads, attachment hardware, pole guying and bracing (temporary or permanent).
- As-built documentation.
- All other work and material necessary to complete the item.

Ethernet Telemetry shall include all labor and materials required to install and make it operational, including the following items:

- One Sector Antenna
- Access Point Radio
- Two Station Radios w/ Integrated Dish
- All other work and materials necessary to complete the item.

END OF SECTION

SECTION 13

UNINTERRUPTED POWER SUPPLY (CONTINUOUS POWER SYSTEM)

13.0 General

The Uninterrupted Power System (UPS) is a true on-line power conditioner and battery backup, or uninterruptible power system designed for transportation and traffic applications. The UPS shall be capable of operating up to its rated power level in extreme environments with existing equipment on the street today including any and all signal heads (i.e., Incandescent, LED, Neon, etc.) The UPS shall be a complete Clary SP1250LX system or approved equal.

13.1 Battery System

The battery shall be comprised of extreme temperature, deep cycle, Absorbed Glass Material/Valve Regulated Lead Acid (AGM/VRLA) batteries that have been field proven and tested by the U.S. Military.

The battery system shall consist of one or more strings (typically 4 or 6 batteries per string) of extreme temperature, deep cycle AGM/VRLA batteries such as Clary Outpost batteries or equivalent.

Batteries shall be certified to operate at extreme temperatures from -40° C to +74° C.

The batteries shall be provided with appropriate interconnect wiring and corrosion resistant mounting trays and/or brackets appropriate for the cabinet into which they will be installed.

The interconnect cable shall be protected with abrasion resistant nylon sheathing and shall connect to the base module via a quick-release circular connector.

For safety and proper operation purposes, the circular battery connector shall have interlocking pins to prevent turn-on if batteries are not connected and to shut off the UPS should the batteries be disconnected.

Battery construction shall include heavy-duty, inter-cell connections for low impedance between cells, and heavy-duty plates to withstand shock and vibration.

The top cover shall use tongue and groove construction and shall be epoxy glued to the battery case for maximum strength and durability.

An optional lifting handle shall be available on most battery models.

13.2 Measurement and Payment

Payment for Uninterrupted Power Supply shall be per unit installed and shall include all labor and materials in order to have a fully functional system to the satisfaction of the Owner.

END OF SECTION

SECTION 14

ILLUMINATED OVERHEAD SIGNAGE

14.0 General

All internally illuminated street name signs will be provided by the City of Thornton Traffic Engineering.

The internally illuminated signs shall be "Naim-Series-Inter Mark II" signs manufactured by NuArt Lighting, Fullerton, California, or standard (96" L x 19" H x 9.375" D) signs manufactured by Southern Manufacturing, Orlando, Florida, or approved equal. The internally illuminated signs shall be single or double faced as indicated on the plans with logo and guide. Some manufacturers fabricate standard sizes of those signs required on the plans. All signs on any single project shall be from the same manufacturer or fabricator. Signs shall be eight (8) feet in length.

The face of the panel shall be "Lexan" or an approved type of sufficient thickness to permit minimum deflection, as certified by the manufacturer. All faces shall be of the same material.

Colors for the sign faces shall be standard approved colors for highway signs. The colors may include white, green, blue, and red applied on the interior sign face. Green shall be Pantone 3435c Emerald Green (3M 3630-126). The City of Thornton logo shall be Pantone 300 Intense Blue (3M 3630-127). Blue for highway shields shall be Pantone 294 Bristol Blue (3M 3630-097). Red shall be Pantone 485 (3M 3630-33). Color tint shall show as intended and be consistent regardless of whether the sign is lit or unlit.

The sign layout shall include all necessary text and logos on one or both sides of the sign assembly as indicated on the plans.

The illumination source shall be light emitting diode (LED) and shall be from the same manufacturer or fabricator of the internally illuminated sign. The interval illumination shall provide a uniform lighting on the sign message and background. The light produced by the LED's shall not alter the colors or background on the signs faces.

Each sign shall have a plug-in type photocell. Photo-electric controls are required and shall be of the "hail-resistant" type and meet the requirements of Section 15.1.4 Luminaire Photo-electric control.

An appropriately rated in-line fuse shall be installed at the base of the pole where the sign feed connects to the power feed.

The front sign panel of the cage shall be hinged, either by a continuous hinge or extruded interlocking hinge, to provide access to the internal components of the sign. A weather-tight gasket shall be provided all around the sign face to exclude dust and moisture. The latching devices shall be either screw type or latch type to provide a secure attachment of the sign face to the case. All exterior hardware, hinges, etc., shall be painted mocha-brown or beige, in accordance with Section 4.5 Protective Coatings for Signal Poles with Mast Arms and Pedestal Poles.

The sign case shall be securely attached to the support structure. Close coordination is to be maintained between the sign fabricator and support fabricator to assure all attachment devices are properly placed. The sign shall be hung using Pelco SP5559 brackets or approved equal.

A one-half (½) inch cord grip connector shall be installed where the illuminated street name sign wiring enters the signal pole.

One galvanized ½-inch eyebolt with washer and nut shall be installed adjacent to each mounting bracket for installation of safety cable. An outdoor silicone caulk bead shall be applied at the entrance of the eyebolt into the sign to prevent water intrusion.

END OF SECTION

SECTION 15

GLOBAL POSITIONING SYSTEM

15.0 General

North American Datum 83 (NAD83) Colorado State Plane Central Zone coordinate system (grid) units in feet shall be provided for all roadway devices within the project limits. This shall include traffic signal controller cabinets, sign posts, pull boxes, water valve type pull boxes, traffic signal poles, pedestal poles, and street light poles. The elevation datum shall be based upon the North American Vertical Datum 1988 (NAVD 88).

15.1 Data Format

The GPS data collected shall be provided to the City in an AutoCAD drawing format using model space or using the GPS Device Installation form in Appendix C. The use of AutoCAD drawings or the GPS Device Installation Location form in Appendix C shall be at the discretion of the Traffic Engineer. If AutoCAD drawings are required, the drawings shall include a note describing how the coordinates were established along with the primary control points that were used. The AutoCAD information shall also be incorporated into the as-builts for the project.

The horizontal and vertical positional accuracy of the data collected shall be within a tolerance of ± 0.3 feet.

15.2 Payment

GPS information gathering will not be measured or paid for separately but shall be considered subsidiary to the pay item being installed. This work shall include all labor, materials, and equipment required to complete the work.

END OF SECTION

SECTION 16

SPECIAL PROVISIONS
TRAFFIC CONTROL

16.0 General

The following special provisions supplement or modify the Technical Specifications in preceding sections.

16.1 Traffic Control

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

Subsection 630.09. Delete the first, second and third paragraph as well as item #3 of the fourth paragraph and add the following:

The Contractor shall develop an individual Traffic Control Plan (TCP) and supporting Method of Handling Traffic (MHT) for each of the locations included in the Contract to be approved by the Owner prior to starting construction. Individual Traffic Control Permits will be issued for each respective location included in the Contract. The Contractor shall submit all TCP's and MHT's to the Owner for approval within 10 Days after formal Award of the Contract. Failure of the Contractor to submit detailed, comprehensive and clearly legible TCP's and MHT's will constitute grounds for rejection of TCP's and MHT's without extensive elaboration or comment from the Owner. The Owner will return approved or "redlined" TCP's and MHT's to the Contractor within 5 Days from receipt of the submittal. The Contractor shall then present final corrected TCP's and MHT's to the Owner for final approval and issuance of a Traffic Control Permit.

Pedestrian movements shall also be fully addressed in the TCP and MHT submittals. No plan will be approved that unreasonably impedes or restricts pedestrian movements. No devices required for the implementation of the Contract requirements will be permitted to be installed on or above sidewalk surface areas unless otherwise approved by the Owner in the respective MHT.

The Contractor shall also obtain traffic control permits as required by other municipal, county or state agencies when the Work requires traffic control devices to be installed within the limits of their respective jurisdictions. The Contractor shall contact other appropriate municipalities at least seventy-two (72) hours before starting work in any areas that will affect or change traffic flow within other jurisdiction(s). The Contractor shall obtain approval from the respective responsible representative of other jurisdictions for any lane or street closure, or any change or interruption of the flow of traffic within that respective City. If the Contractor desires to revise the approved TCP or MHT as a result of comments received from other jurisdictions, the Contractor shall submit such revisions to the Owner and allow one (1) week for review and comment. The Owner will approve a plan that, in his judgment, provides adequately for the safety and convenience of the public and provides the same or greater service as the previously approved plan.

The Contractor shall work only between the hours of 8:30 a.m. and 3:30 p.m. on Arterial and Collector streets, with the stipulation that only one direction of travel be interrupted at any given time unless working in median areas. Active traffic control devices shall be installed and removed between the hours of 8:30 a.m. and 3:45 p.m. The Contractor must maintain at least one (1) lane of traffic in each direction as well as a median lane for left turn movements on all Collector and Arterial Streets unless otherwise approved by the Owner and incorporated into an approved MHT. Business access closures may only occur on Monday through Thursday for duration not to exceed 2 hours before reopening each access. Businesses must have at least one access point open during construction. Requests for other hours, special conditions or time allowances will be subject to approval by the Owner. Separate turn lanes will be required at all signalized intersections during the course of construction at intersections.

The Contractor shall notify the project construction coordinator at least two weeks in advance of the need for a uniformed police officer for traffic control during paving or excavation at any signalized intersection when his operations require either his equipment or the public to operate contrary to the signals. The contract coordinator shall notify the Thornton Police Department of the need for a uniformed police office for traffic control. The Contractor shall coordinate the electrical “shut-down” of the respective signal operation by the Owner. Contractor’s personnel shall NOT direct traffic through a signalized intersection. All Contractor personnel on site, including superintendents and principals, are required to wear a visible safety vest in conformance with the MUTCD.

Drums shall be placed at a maximum spacing of thirty (30) feet. Each barricade shall be furnished with two steady-burn beacons. Other construction traffic control devices shall be used where applicable.

The Contractor will not be permitted to have construction equipment, personal vehicles, or materials in the lanes open to traffic unless permitted by the Owner. The Contractor is cautioned that all personal vehicle and construction equipment parking will be prohibited where it conflicts with safety, access, or flow of traffic at any time. Personal vehicle and construction equipment parking will be prohibited on all private lots without the respective property owner’s permission.

Traffic lanes through construction areas shall be maintained as shown on the approved traffic control plans or with a clear width of at least eleven (11) feet per lane. When directed by the Owner, the Contractor shall provide and maintain an acceptable temporary asphalt surface for temporary roads or driveways. Temporary surfacing shall conform to the applicable portions of Section 400 of the SSRBC.

In the event there is a violation of the working hours limitations or any other Traffic Control requirement, the Contractor will automatically be subject to a “Stop Work Order” immediately. Work shall not resume until the Contractor assures the Owner, in writing, that there will not be a reoccurrence of the violation. In the event more violations take place, there will be an Incident Credit issued to the Owner for each incident.

“No Parking” signs shall be placed not less than forty-eight (48) hours in advance of any temporary on-street parking restrictions and shall conform to the requirements listed under the section titles Legal Relations and Responsibilities to the Public. During non-construction periods (evenings, weekends, holidays, etc.), all Work shall be adequately protected to ensure the safety of vehicular and pedestrian traffic. Open trenches during

non-construction periods are not permitted. The Contractor must periodically check on the condition of traffic control devices that may be utilized during the course of the Project on weekends or holidays as may be warranted to ensure that devices that are damaged or moved during non-work hours are restored in an expedient fashion.

Three days prior to mobilization the Contractor shall erect at Project end points automated variable message signs for Arterial streets or orange reflective sign panels of adequate size utilizing black 4" lettering for Collector streets. The signs will advertise the anticipated start date, Project duration and description. The signs will be required to be updated should information expressed be changed during the course of the project. These signs will not be paid for separately but be included in the cost for Traffic Control. An automated variable message sign will be considered as an acceptable substitution for the aforementioned described signage for Collector streets.

Subsection 630.14 shall be deleted and replaced with the following:

All construction Traffic Control shall be measured on a lump sum basis.

Subsection 630.15 shall be deleted and replaced with the following:

Traffic Control shall be paid for by one lump sum as listed on the respective Bid Proposal Form. Payment for all other traffic control devices, personnel, equipment, material and any other related expense for traffic control shall be included in the lump sum Bid unit price for Traffic Control.

END OF SECTION

APPENDIX C-1

GLOBAL POSITIONING SYSTEM (GPS) DEVICE INSTALLATION LOCATION

Date of GPS Locate:

_____

Item Being Located – "Device", "Pull Box", etc:

_____

Location of Item – "Street", "Direction of Travel", "Side of Street", etc.:

_____

North American Datum:

Northing_____
(based on NAD83 Colorado State Plane Central Zone Coordinate System)

Easting_____
(based on NAD83 Colorado State Plane Central Zone Coordinate System)

Vertical_____
(based on NAVD 88)

Remarks (primary control points used and how coordinates were established):

_____

_____

_____

_____

_____

APPENDIX C-2

SUBMITTALS

The Contractor shall submit for review and approval the following list of equipment and materials as required by the plans, prior to the Contractor ordering such materials. Submittals shall consist of product cut sheets and necessary supporting material and each item shall be identified by the trade name, size, and catalog number. Additional documentation may be requested at the discretion of the Traffic Engineer.

Antennas (Dish & Sector)
Antenna Base Station
Conduit
Conduit Coupler
Conduit Plug
Pull Boxes
Pedestrian Push Button and Station (including instruction sign)
Signal Head (including mounting hardware)
Backplate
Signal Indications
Pedestrian Signal Head (including mounting hardware)
Pedestrian Signal Face
Emergency Vehicle Preemption
Ethernet Telemetry
Ethernet Field Switch
URD Mold
In-line Fuse
Concrete Mix Design (Class BZ)
Concrete Mix Design (Class D)
Wire (traffic signal conductors, pedestrian pushbutton. etc.)
Meter Housing
Signs