Revised September 26, 2024

TRAFFIC TECHNICAL SPECIFICATIONS
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CIP 23-188C – Traffic Signal Improvements
97th Avenue & Thornton Parkway

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 a minimum of two (2) working days 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 limited to: 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 a 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 or United Power 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 at https://permits.thorntonco.gov/. Links to permit applications for capital improvement projects are in the CIP Permit section.

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 **lates 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 Grade SX, (PG 64-22). All aggregate base coarse 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 pole foundation, traffic cabinet, pull box or conduit installations will not be paid for separately but included in the unit price for the item being installed. Removal, replacement and modify items that will be measured and paid for separately are as follows:

Payment shall be made as follows:

Landscape Restoration = Lump Sum
Potholing = Lump Sum
Remove Sign (R1-1, S1-1, W16-9p, etc.) = Each
Install R10-27a Sign = Each

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 HDPE) 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 Rigid Conduit (PVC or HDPE)

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 or HDPE conduit and the various PVC or HDPE 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 or HDPE 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 or HDPE 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. If 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 roadway and/or 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, ADA ramps, or native growth areas created by installation of conduit and/or potholes will not be paid for separately, but included in the unit price for conduit. Concrete replacement shall consist of replacing entire concrete panels. ADA ramps replacements shall include a minimum of six feet of truncated domes.

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.

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.

Payment shall be made as follows:

Conduit (2”) = Linear Foot
Conduit (3”) = Linear Foot
Conduit (4”) = Linear Foot

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.

Payment shall be made as follows:

Pull Box 12” x 18” x 12” = Each
Pull Box 20” x 33” x 15” = Each
Pull Box 24” x 36” x 24” = Each
Pull Box 30” x 48” x 24” = Each

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 greater than 70-feet 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 Scope

Specification sections 4.4.2 through 4.4.11 are for the signal pole with mast arms being provided by the contractor and for the contractor's information when the signal pole with mast arms is Owner supplied. The specification is designed for the use of Valmont triglycidyl isocyanurate (TGIC) or super durable polyester powder (part number 250257 for mocha brown or 349235 for beige) or approved equivalent in conjunction with Valmont dark gray high build epoxy powder (part number 347380) or approved equivalent for the protection and finish of the tapered and non-tapered colored steel poles. Interior surfaces shall be prime painted by dip or spray.

4.5.2 General

To be acceptable, poles and component parts furnished on the project by the Contractor shall be in accordance with the terms and requirements set forth herein. Other comparable coating systems that comply with these specifications may be acceptable, subject to approval by the Owner. The Contractor shall be required to furnish the City with a notarized certificate of compliance from the pole manufacturer that guarantees that the coating system used is in conformance with these specifications and is free of defective workmanship.

4.5.3 Surface Preparation for Exterior Protective Coating Systems

Exterior surfaces of shaft and arm(s), and component parts shall be abrasive blasted in accordance with coating manufacturer's recommendations. Rolled-in mill scale, impurities, and non-metallics shall be removed. The lower interior portions of the shaft, from the base plate to the top of the handhole opening, shall receive the same treatment. Rough and sharp edges shall be rounded off. Weld splatter, flux, and slag around the base plate, handhole, arm connections and other areas of welding shall be removed. Drilling of holes and welding of tenons or hubs shall be done prior to abrasive blasting.

4.5.4 Requirement of Interior Protective Primer System

The interior surface of the pole shaft shall be thoroughly cleaned, dried, and free of mill scale, rust, oil, grease, and dirt, or other contaminants before interior primer is applied. Primer shall conform with Federal Specification TTP-645, yellow or red oxide. Minimum dry film thickness shall be two and one-half (2-1/2) mils.

4.5.5 Requirement of Exterior Protective Coating System

After abrasive blast, exterior steel surfaces shall hot dip galvanized in accordance with ASTM A123. All threaded holes shall be plugged prior to galvanizing. All holes shall be free of excess galvanizing. Galvanized steel surfaces shall be kept indoors and free from moisture and other foreign materials prior to prime painting. Prior to powder coating, poles, mast arms, and luminaire arms shall be brushblast to a uniform dull appearance from of any shine and preheat. Mechanically galvanized parts do not require brushblast.

After exterior steel surfaces have been galvanized, an epoxy prime coat consisting of Valmont dark gray high build epoxy powder (part number 347380) or approved equivalent shall be applied. A minimum dry film thickness for the high build epoxy powder of five (5) mils shall be required for the bottom eight (8) feet of the pole. A minimum dry film thickness of three (3) mils shall be required for the remaining surfaces of the pole above eight (8) feet and mast arms and luminaire arms. Metal cure temperature shall be 300 degrees Fahrenheit.

The color topcoat shall consist of two (2) coats of Valmont triglycidyl isocyanurate (TGIC) or super durable polyester powder (part number 250257 for mocha brown or 349235 for beige) or approved equivalent at a minimum of one and one-half (1.5) mils dry film thickness for a total minimum dry film thickness of three (3) mils. The total exterior coating system shall consist of a minimum of eight (8) milsdry film thickness for the bottom eight (8) feet of the pole and a minimum dry film thickness of six (6) mils for the remaining surfaces of the pole above eight (8) feet and mast arms and luminaire arms. The coating shall form a satin finish with lasting color, resistant to fumes, splash and spillage of acids and alkalis.

The primer and topcoat for exterior application shall be supplied by the same manufacturer to ensure a compatible protective coating system resistant to corrosion, abrasion and impact.

Color for finish topcoat shall conform to City requirements. Color shall meet Federal Standard 595C Colors (January 2008). Color number 10075, satin finish “Mocha Brown”, or Color 20227, semi-gloss finish “Beige”. Beige shall only be used if specified on the plans.

4.5.6 Application

The prime coat and color topcoat shall be strictly applied according to manufacturer's recommendation. The lower interior portion of the shaft, from the bottom of the base plate to the top of the handhole opening, shall receive the same application treatment. Surfaces shall be kept free of moisture, oil, grease and other organic matter until coated. Failure to do so will prevent proper adhesion and shall require the abrasive blast procedure to be repeated. Solvent wiping is not satisfactory as contamination may be spread and not be removed. Prior to applying top coat, repair any surface imperfections such as sags or runs by light sanding to obtain a uniform surface. Apply prime paint as necessary to any voids or areas having less than the required thickness. Powder application shall be with electrostatic spray equipment.

4.5.7 Drying and Curing Time

Drying time for the application of each primer coat and color topcoat application shall be per the coating manufacturer’s specifications.

Curing time after final color topcoat and prior to packaging, loading and shipment shall be per the coating manufacturer’s specifications to ensure complete dry-through time.

4.5.8 Wrapping and Packaging

Upon completion of the coating system, and prior to shipment, poles and arms shall have

protective wrapping with two (2) inch minimum overlap applied at contact points with cushioned dunnage during transport. This wrapping shall be cushioned material, be a minimum one-eighth (1/8) of an inch thick and twenty-four (24) inches wide, be applied at contact points, and extend a minimum of eighteen (18) inches on either side of dunnage locations at poles and arms. Minimum thickness of wrap shall be three-eighth (3/8) of an inch at contact points. Component parts shall be individually wrapped with heavy kraft paper and boxed for shipment.

4.5.9 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. No handling should be allowed until dry-through condition has been achieved with the coating.

4.5.10 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.

Mast arms shall not be installed to block visibility of existing span wire mounted signal heads. If pole locations require mast arms to be located in front of span wire mounted heads, the arm shall not be installed until the span wire, and signal heads are removed. The mast arm shall be pre-wired on the ground prior to completed installation to hasten installation time in this instance.

4.5.11 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 Warranty

A minimum three (3) year warranty (at no additional cost) shall be provided for the exterior protective coating system. The coating manufacturer shall warrant the coating to not be defectively manufactured and that the coating will prevent cracking, checking, blistering, flaking, peeling, or excessive chalking of the painted surface or excessive corrosion of the base metal on which the exterior protective coating system is applied for three years from date of application. The warranty shall not apply under conditions such as construction, physical or mechanical abuse, or falling objects and under conditions of normal wear and tear such as welding, civil disturbance, defacing, vandalism, fire, explosion, or catastrophe.

4.7 Owner Supply

Traffic signal poles, mast arms, luminaire extensions, and luminaire arms will be provided by the City of Thornton Traffic Engineering. No submittals are required.

4.8 Payment

Concrete replacement within intersection islands created by foundation installation will not be paid separately but included in the unit price for pole installation. Replacement of roadway, sidewalk, ADA ramps, 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. Concrete replacement shall consist of replacing entire concrete panels. ADA ramps replacements shall include a minimum of six feet of truncated domes.

Payment 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 each pole and mast arm type.

Payment for all poles shall include furnishing and 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.

Payment shall be made as follows:

Traffic Signal Pole, 30-foot Mast Arm w/ Lum. Ext. Arm (Install Only) = Each

Traffic Signal Pole, 45-foot Mast Arm w/ Lum. Ext. Arm (Install Only) = Each

Traffic Signal Pole, 55’ Double Mast Arm w/ Lum. Ext. Arm (Install Only) = Each

10’ Pedestrian Pole (Furnish and Install) = Each

15’ Pedestrian Pole (Furnish and Install) = Each

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 articles 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 a 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 a 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 the 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 using 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 as follows:

Intersection Wiring (per intersection) = Each

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 shall consist of one video camera, a video detection processor (CCU) which mounts in a standard cabinet rack. Two detector rack mounted Digital Video Processors (DVP). The video camera shall be Iteris Vantage NEXT and/or Vector camera or approved equal. The VDP and EM shall be Iteris Vantage Edge 2 or approved equal.

The software shall detect vehicles in multiple lanes using only the video image. Detection zones shall be defined using only an on board video menu and a pointing device to place the zones on a video image. Up to 24 detection zones per camera shall be available. A separate computer shall not be required to program the detection zones. Traffic counting ability shall be part of the system.

6.1 Installation

6.1.1 Category 5e cable to be used between the camera and the CCU in the traffic cabinet shall be direct bury shielded Cat5e. The cable shall be a continuous unbroken run from the camera to the cabinet. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. The cat5e cable and shielded connectors shall be installed per the manufacturer's specification.

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 (or cables), or approved equivalent, minimum 74 inches in length.

6.2 Owner Supply

Video detection will be provided by the City of Thornton Traffic Engineering. No submittals are required.

6.3 Measurement and Payment

Measurement and payment shall be based upon each video installed.

Payment shall be made as follows:

Modular Video Detection System (Install Only) = Lump Sum

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 iNS3 iNavigator 3-Wire Push Button Station 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 be MUTCD R10-3b 9”x12” and 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 Owner Supply

APS push buttons and instruction sign will be provided by the City of Thornton Traffic Engineering. No submittals are required.

7.2 Measurement and Payment

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

Payment shall be made as follows:

APS Pedestrian Push Button Station (Install Only) = Each

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.

All pedestrian hybrid beacon (HAWK) mast arm and side of pole mounts shall be Sky Bracket HAWK Beacon Mount, part number SS-SB29-HPB-18 or approved equal.

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. Backplates for signal heads mounted on mast arms shall have a two (2) inch yellow retroreflective border per backplate manufacturer design. Application of a retroreflective strip using pavement marking tape or other means shall not be acceptable. 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.

Payment shall be made as follows:

Traffic Signal Head, 3-Section, 12” Lenses (LED) = Each
Traffic Signal Head, 4-Section, 12” Lenses (LED) = Each
Traffic Signal Head w/backplate, 3-Section, 12” Lenses (LED) = Each
Traffic Signal Head w/backplate, 4-Section, 12” Lenses (LED) = Each

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.

Payment shall be made as follows:

Pedestrian Signal Head, Countdown (LED) = Each

END OF SECTION

SECTION 10

EMERGENCY VEHICLE PRE-EMPT DETECTION

10.0 General

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

Opticom 754 (Phase selector) (Miovision) unit or approved equal shall be used in the cabinet input file.

10.1 Payment

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

Payment shall be made as follows:

Opticom Detector = Each

END OF SECTION

SECTION 11

CONTROLLER AND CABINET SPECIFICATIONS

11.0 General – Controller Specifications

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

11.1 General – Cabinet Specifications

11.1.1 General

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

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 more than 250 Joules.

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

f. All 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, 1 for the 336S and 303 Cabinets
	Internal (front/back) fluorescent lamps - 4 for the 333SD-ITS, 2 for the 336S, 1 for the 303 Cabinets
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 for the 336S, and 0 for the 303 Cabinets
1	Transient Voltage Surge Suppression System
2	Split Input files – 333SD-ITS Cabinets only
1	Output File (not in the 303 Cabinet) with terminal strips (not Phoenix connectors)
8	Flash Program Blocks – 6 in the 303 Cabinet

* 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.

11.3 336S Cabinet Assembly

The 336S Cabinet Assembly shall consist of the following in addition to Section 11.1:

One (1) "M" base adaptor (attached) break-away type.

11.4 303/8 Cabinet Assembly

The 303/8 Traffic Signal Control Cabinet shall consist of the following in addition to Section 11.1:

Single door access
Side of pole mounting
Eight (8) slot input file.

11.5 Owner Supply

Controller and cabinet will be provided by the City of Thornton Traffic Engineering. No submittals are required.

11.6 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.

Payment shall be made as follows:

Traffic Signal Controller (Cobalt RM) and Cabinet (333SD-ITS) (Install Only) = Each

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 indentified 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 DYMEC KY-3170XM industrial field switch or approved equal with six (6) copper 10/100/1000 RJ-45 Ethernet ports and four (4) 1000/10000 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 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 with LC duplex connectors.
- 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; and
- 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 and One Access Point Radio
- One Station Radio with integrated Dish
- All other work and materials necessary to complete the item.

Payment shall be made as follows:

Ethernet Field Switch = Each
12-Strand Fiber Optical Cable = Linear Foot

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 Owner Supply

Uninterrupted Power Supply will be provided by the City of Thornton Traffic Engineering. No submittals are required.

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.

Payment shall be made as follows:

Incidental to cabinet install.

END OF SECTION

SECTION 14

ILLUMINATED OVERHEAD SIGNAGE

14.0 General

All internally illuminated street name signs and mounting brackets will be provided by the City of Thornton, unless noted otherwise.

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 orange applied on the interior sign face. Green shall be Pantone 7740 CP. Blue shall be Pantone 7693 CP and Pantone 2915 CP. Orange shall be Pantone 152 CP. 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 in a threaded hole 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. Safety cable shall be 5/16" stainless steel aircraft cable with crimp connectors. Safety cable shall be furnished and installed by the contractor. An outdoor silicone caulk bead shall be applied at the entrance of the eyebolt into the sign to prevent water intrusion.

14.1 Owner/Contractor Supply

Illuminated street name signs will be provided by the City of Thornton Traffic Engineering. No submittals are required.

Two safety cables per illuminated street name signs shall be furnished and installed by the contractor.

14.1 Payment

Payment for the internally illuminated street name signs shall be made as follows:

Street Name Sign (LED Internally Illuminated) (Install Only) = Each

END OF SECTION

SECTION 15

STREET LIGHTING

15.0 General

This work shall consist of the furnishing and installation of street light poles, luminaires, and foundations in conformance with the plans. All work shall be done in accordance with these specifications, the National Electrical Code, and in conformity with the details as shown in the plans.

15.1 Owner Supply

Luminaires will be provided by the City of Thornton Traffic Engineering. No submittals are required.

15.2 Payment

Payment for the luminaires shall be made as follows:

LED Luminaire (Install Only) = Each

END OF SECTION

SECTION 16

GLOBAL POSITIONING SYSTEM

16.0 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).

16.1 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 asbuilts for the project.

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

16.2 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 17

SPECIAL PROVISIONS
TRAFFIC CONTROL

17.0 General

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

17.1 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 shall only work between the hours of 8:00 p.m. and 5:00 a.m. on East 120th Avenue between I-25 and Washington Center Parkway, and on Washington Street between East 120th Avenue and Thorncreek Crossing Shopping Center Signal. 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.

17.2 Payment

Payment shall be made as follows:

Traffic Control = Lump Sum

END OF SECTION

APPENDIX A

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 B

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.

Concrete Mix Design (Class BZ)
Concrete Mix Design (Class D)
Conduit
Conduit Coupler
Emergency Vehicle Preemption
Ethernet Field Switch
Fiber Optical Cable
Fiber Optical Patch Panel
Fiber Optical Splice Enclosure
In-line Fuse
Meter Housing
Pull Boxes
Pedestrian Signal Head (including mounting hardware)
Pedestrian Signal Face
Signal Head (including mounting hardware)
Signal Indications
Signal Backplate
Wire (traffic signal conductors, pedestrian pushbutton. etc.)