

SECTION 700 - TRAFFIC TECHNICAL SPECIFICATIONS

TABLE OF CONTENTS

	PAGE
701 GENERAL PROVISIONS	700-1
701.1 Definitions	700-1
701.2 Regulations and Codes	700-1
701.3 General Plan Notes – Traffic	700-1
702 TRAFFIC SIGNALS	700-2
702.1 Condition of Materials Furnished	700-2
702.2 Required Documents	700-2
702.3 Maintaining Existing Traffic Signal Operations	700-3
702.4 Field Tests of Equipment	700-3
702.5 Activation of Traffic Signal Equipment	700-4
702.6 Traffic Signal Conduit	700-4
702.7 Pull Boxes	700-6
702.8 Standard Type Poles	700-7
702.9 Protective Coatings for Signal Poles with Mast Arms and Pedestal Poles	700-8
702.10 Conductors and Cables	700-11
703 DETECTION – SIGNAL HEAD – CONTROLLER CABINET	700-12
703.1 General	700-12
703.2 Installation	700-12
703.3 Loop Detectors	700-13
703.4 Push Button Stations	700-14
703.5 Signal Heads	700-14
703.6 Pedestrian Signal Heads	700-15
703.7 Mounting Hardware	700-15
703.8 Backplates	700-15
703.9 Emergency Vehicle Pre-Empt Detection	700-16
703.10 Controller Specifications	700-16
703.11 Cabinet Specifications	700-16
703.12 Communication Interface	700-18
703.13 Continuous Power System (Uninterrupted Power)	700-27
703.14 Illuminated Overhead Signage	700-27
704 TRAFFIC SIGNING STANDARDS	700-28
704.1 General	700-28
704.2 Signing Layouts	700-28
704.3 Variance Requirements	700-28
704.4 Sign Fabrication	700-28
704.5 Sign Installation	700-29
704.6 Sign Maintenance	700-31
704.7 Fire Lane Designations	700-31

705	PAVEMENT MARKINGS	700-31
705.1	General	700-31
705.2	Preformed Plastic Pavement Markings and Legends	700-32
705.3	Marking Paint	700-32
705.4	Thermoplastic Marking	700-32
705.5	Reflectorized Glass Beads	700-33
706	STREET LIGHTING	700-33
706.1	Street lighting	700-33
706.2	Street Lighting Luminaires	700-33
706.3	Arterial and Collector Poles and Luminaires Arms	700-36
706.4	Residential and Trail Poles	700-37
706.5	Street Light Pole Foundations	700-37
706.6	Breakaway Support	700-38
706.7	Street Light Pole Grounding	700-38
706.8	Street Light Wiring	700-38
706.9	Arterial and Collector Pole Painting	700-38
706.10	Street Light Pole Submittals	700-34
707	SCHOOL ZONE FLASHING LIGHTS	700-39
708	GLOBAL POSITIONING SYSTEM	700-40

DETAIL DRAWINGS

700-1	Typical Signal Installation Detail
700-2	Typical Pedestrian Pole Installation Detail
700-3	Typical Traffic Signal Pole Footing Installation Detail
700-4	Typical Pedestrian Pole Footing Installation Detail
700-5	Exterior Colors Washington St Corridor Detail
700-6	Typical Loop Placement Detail
700-7	Typical Alternative Round Loop Layout Detail
700-8	333 Controller Cabinet Foundation Details
700-9	336 Controller Cabinet Foundation Details
700-10	Typical Illuminated Street Sign Installation Detail
700-11	Sign Post Anchor Detail
700-12	Sign Assembly Detail
700-13	Fire Lane No Parking Regulatory Sign Detail
700-13A	Snow Route No Parking Regulatory Sign Detail
700-14	Pavement Markings and Sign Locations Detail
700-15A	Traffic Circle Sign and Pavement Marking Detail
700-15B	Traffic Circle Multi-Lane Signs and Pavement Marking Detail
700-15C	Typical Yield Lane Layout for Streets and Highways Detail
700-16A	Crosswalk and Stop Bar Pavement Marking Detail
700-16B	Stop Bar Layout for Double Left Turns Detail
700-17	Turn Arrow Pavement Marking Detail

700-18	Crosswalk Pavement Marking Detail
700-19A	Intersection Lane Use Control Pavement Marking Detail
700-19B	Lane Drop Pavement Marking Detail
700-20A	Typical Speed Table Detail
700-20B	Typical Speed Table Detail
700-21	Street Lights Detail
700-22	Street Lights for Washington St Corridor Detail
700-23	Control Cabinet Beacon Wiring Detail
700-24	Pedestrian Traffic Signal, Sign and Push Button

THIS PAGE IS A BLANK PLACEHOLDER FOR DOUBLE-SIDED PRINTING.

SECTION 700 - TRAFFIC TECHNICAL SPECIFICATIONS**701 General Provisions**

- A. These specifications for traffic signals, signs, and pavement markings supplement the roadway design specifications and shall govern the materials used for the installation of traffic control signals, signs, and pavement markings.
- B. Work shall be done in accordance with these Standards and Specifications, the latest edition of the MUTCD, the latest revision of the Colorado Supplement thereto, and in conformity with the details as shown on the traffic signal plans.

701.1 Definitions**A. General**

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

701.2 Regulations and Codes

- A. In addition to the requirements of the approved plans and these Standards and Specifications, items and workmanship shall conform to the requirements of the NEC; Rules for Overhead Electrical Line Construction of the Colorado Public Utilities Commission; standards of ASTM, ANSI, and any local ordinances which may apply.
- B. Wherever reference is made to any of the standards mentioned above, the reference shall be construed to mean the NEC, order, or standard that is in effect on the date of plan approval by the City.

701.3 General Plan Notes - Traffic

The following notes shall be used on the traffic signal plans.

A. New Traffic Signal Installations

1. Conduit, Pole, Pull Boxes and Controller locations are approximate. Exact locations shall be marked by the Responsible Party and approved in the field by the City.
2. All existing utility locations are approximate. The Responsible Party shall field verify the exact location of all utilities before commencing work and agrees to be fully responsible for any damages which may occur by the Responsible Party's failure to exactly locate and preserve any and all underground utilities.
3. Except as modified in the plans, all work shall be in accordance with the City of Thornton's Standards and Specifications for the Design and Construction of Public and Private Improvements. The Responsible Party shall contact the Development Engineering Manager a minimum of 48 hours and a maximum of 96 hours prior to starting traffic signal construction.
4. The Responsible Party shall submit a traffic control plan for construction to the City with the permit application. A public right of way work permit will not be issued without an approved traffic control permit for traffic control during construction.
5. Upon completion of work, the Responsible Party shall submit record drawings, corrected plans and any additional data required by the City showing in detail all construction changes.
6. All signal heads shall be polycarbonate type and black in color.
7. All signal indications and luminaires shall be approved LED type.
8. Cabinet foundations shall be concrete.
9. All signal heads shall be wired separately from the signal head to hand hole above grade at base of signal pole with no overhead splices.
10. All new signal heads and all reset signal heads shall be positioned in the center of the lane.
11. Internally illuminated street name signs shall be approved LED type and mounted on the mast arm at a minimum of two (2) from the signal pole.

12. When the project is complete, two (2) keys for each controller cabinet and Police Panel shall be delivered to the Development Engineering Manager. The Instruction Manual for the controller shall be left inside the controller cabinet.
- B. Modified Traffic Signal Installations
1. All salvaged signal equipment shall be delivered to the Infrastructure Maintenance Center, 12450 N. Washington Street.
 2. If an existing traffic signal must be turned off, two (2) weeks minimum notice shall be given the City and arrangements made at the expense of the Responsible Party for police officers to direct traffic in the intersection.
- C. Sign Installations
1. All traffic control signing shall conform to Section 704 of these Standards and Specifications
 2. When sign poles are to be installed in an area that will be surrounded by concrete, an eight (8) inch diameter sleeve shall be installed to provide a space to install the sign pole base.
 3. Mounting order of signs on sign pole from top to bottom: Dead End plaques, Street Name signs, other signs. Dead End plaques and Street Name signs shall be mounted using bolts only. All other signs shall be installed with a bolt, washer and nut for the top hole and a drive rivet for the bottom hole.
 4. All signs shall be fabricated using 3M Diamond Grade retro-reflective sheeting, or approved equal. All signs shall have a 3M #1160 protective clear overlay (graffiti protection), or approved equal, applied to the face of the sign.
 5. All Stop signs and Street Name signs shall be installed as per Detail 700-12.
 6. All salvaged signs shall be delivered to the Infrastructure Maintenance Center, 12450 N. Washington Street.
- D. Pavement Marking Installations
1. All pavement markings shall be field marked and shall be approved in the field by the Development Engineering Manager before installation of pavement marking materials.
 2. All material shall be installed as per the manufacturer's recommendations and City of Thornton Standards and Specifications for the Design and Construction of Public and Private Improvements.
 3. Paint shall not be used for permanent markings.

702 TRAFFIC SIGNAL STANDARDS

702.1 Conditions of Materials Furnished

- A. Items furnished shall be new equipment and materials. The Responsible Party shall submit to the City a list of equipment and materials which is proposed to be installed for review and approval by the Development Engineering Manager prior to the Responsible Party ordering such materials. Submittals shall consist of product cut sheets and necessary supporting material. Each item shall be identified by the trade name, size, and catalog number.
- B. 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, controller cabinet traffic control equipment furnished by the Responsible Party shall be compatible with existing equipment to be retained.
- C. When the project is complete, two (2) keys for each controller cabinet and Police Panel shall be delivered to the Development Engineering Manager. The Instruction Manual for the controller shall be left inside the controller cabinet.

702.2 Required Documents

- A. The Responsible Party 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 Development Engineering Manager with a copy of the Technician's certification prior to the start of work.
- B. Upon completion of the work, the Responsible Party shall submit as-built drawings or corrected plans and/or additional data required by the Development Engineering Manager to show in detail the

construction changes. This shall include but not be limited to: wiring, cable, location, depth of conduit and modifications to original cabinet wiring.

- C. The Responsible Party shall submit two (2) sets of schematic wiring diagrams to the Development Engineering Manager 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.
- D. Diagrams, plans and drawings shall be prepared using graphic symbols shown in ANSI Y32.2, "Graphic Symbols for Electrical and Electronic Diagrams."
- E. One (1) copy of the controller cabinet diagram and the intersection and phase diagram, as approved by the Development Engineering Manager 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 the initial acceptance of the project.

702.3 Maintaining Existing Traffic Signal Operations

- A. Existing traffic signals shall be kept in effective operation for the benefit of the traveling public by the Responsible Party.
- B. At intersections where power to signals must be turned off, the Responsible Party shall make arrangements to have a Thornton Police Officer control the intersection. The Responsible Party must request a police officer at least two (2) weeks prior to the time the officer is needed. Requests for Thornton Police Officers must be made through the Development Engineering Manager and coordinated with the Development Engineering Manager.
- C. The above does not apply to intersections which are completely closed to traffic due to construction.
- D. The Responsible Party shall maintain a minimum of two (2) three (3) 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 Responsible Party shall be responsible for furnishing materials, equipment, tools, and labor necessary to install and maintain the temporary signals. The Responsible Party shall furnish electrical energy for operation of a temporary signal.
- E. Temporary span-wire traffic signal installations are not permitted unless specifically approved in writing by the Development Engineering Manager.

702.4 Field Tests of Equipment

- A. Prior to completion of work, the Responsible Party shall make the following tests on traffic signal circuits, in the presence of the Development Engineering Manager and the controller representative, if a new controller is used (the Responsible Party shall notify the Development Engineering Manager a minimum of 48 hours prior to conducting the tests):
 - 1. Each circuit shall be tested for continuity.
 - 2. Each circuit shall be tested for grounds.
 - 3. An insulation resistance test shall be made on each circuit between the circuit and a ground. The insulation resistance shall not be less than the values specified in the provisions of the NEC.
- B. 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.
- C. Louvers, hoods, and signal heads shall be directed to provide maximum visibility.
- D. Initial activation shall be between Monday and Thursday, between 9:00 a.m. and 2:00 p.m... Prior to activation, the equipment as shown on the plans shall be installed and operable. This includes, but is not limited to: pedestrian signals; pedestrian push buttons; vehicle detectors; system communications; and Opticom.
- E. Flash and permanent activation shall have City Traffic Engineering and Operations personnel present.
- F. The signal shall be run on flash cycle for a minimum of 24 hours prior to turn-on, with the exception of pre-existing signalized intersections. After flash operations, a functional test shall be made which demonstrates that every part of the system functions as specified herein. The functional test for each traffic signal system shall consist of at least five (5) 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 (5) days of continuous, satisfactory operation is obtained.

- G. Prior to the functional test, the Responsible Party will 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 Development Engineering Manager prior to the functional tests being performed.
- H. Functional tests shall start on any working day except Friday, the day preceding a legal holiday, or a legal holiday. The City reserves the right to activate the test on any day of the calendar week.
- I. During the test period, the City shall provide the electrical energy. Repair of any damage caused by public traffic is the responsibility of the Responsible Party. Other maintenance shall be the responsibility of the Responsible Party.

702.5 Activation of Traffic Signal Equipment

Activation of new or modified signal systems shall be made only after traffic signal circuits have been thoroughly tested as specified in Subsection 702.4 and the Development Engineering Manager concurs with the activation.

702.6 Traffic Signal, Lighting, and Communication Conduit

A. General

1. Underground utility information shown on the plans is for information only. The Responsible Party is responsible for field locating and verifying utility information before starting installation of underground conduit runs and traffic signal pole foundations.
2. Responsible Party shall cooperate, as directed by Development Engineering and/or the Development Engineering Manager, with any other Responsible Party under contract to the City or with the Utility Companies providing services to the City while installing underground conduit runs.
3. Electrical conduit shall be installed in accordance with the applicable requirements described in the latest revision of the CDOT Utility Manual, as amended.
4. Larger size conduit can be used, at the Responsible Party's option and own expense. 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 shall be permitted in any conduit run.
5. When specified, conduits shall be installed under existing pavement by jacking or drilling operations. Where plans show that existing pavement is to be removed, jacking the conduit shall not be required. Jacking or drilling pits shall be kept a minimum of two (2) feet clear of the edge of pavement whenever possible. Water shall not be permitted as an aid in jacking or drilling operations.
6. Conduits shall be of the rigid plastic PVC type conforming to the approved construction drawings and these Standards and Specifications. GRC type conduit shall only be used as indicated in the approved construction drawings and shall be in conformance with these Standards and Specifications. Conduit runs shown on the plans are tentative as to routing and may be changed as directed by the Development Engineering Manager 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 necessary details and as-built drawings shall be submitted to the Development Engineering Manager.
7. Conduit installation shall include the installation of marking tape laid in the backfilled trench at a depth not more than eight (8) inches or less than four (4) inches below finished grade. Heavy gauge polyethylene film (0.004"0 tape, with legend "Caution Buried Electric Line Below", shall be used. Where tape length ends and conduit run continues, lapping of not less than six (6) inches shall be provided. No glue or adhesive shall be allowed to join separate tape sections.
8. Conduits shall have a one-eighth (1/8) inch nylon rope for future wire installation and 14 gauge copper stranded tracer wire. The sheathing for the tracer wire shall be purple in color. A minimum of two (2) feet of pull rope shall be doubled back into the conduit at each termination. A minimum of two (2) feet of slack tracer wire shall be left in each pull box and in the controller cabinet.

B. Nonmetallic Conduit (PVC)

1. Rigid PVC conduit shall be Schedule 40, Type 2 and shall be manufactured of high-impact PVC, and shall conform to industry standards and commercial standards No. CS-207-60. Schedule 80 may be used as an alternate. Each length of PVC conduit and the various PVC fittings (coupling, adapter, etc.) shall bear the label of UL or be approved by the Development Engineering Manager. The conduit shall be of the size or sizes shown on the plans or indicated in these specifications.

2. Rigid PVC conduit ends shall be squared and trimmed after cutting to remove rough edges. Connections shall be of solvent weld type except where PVC is to be connected to a steel conduit, in which case the coupling or adapter shall be threaded on the steel conduit side.
 3. Solvent weld joints shall be made in accordance with the PVC manufacturer's recommendations. Rigid PVC conduit shall only be used for underground installations; conduit used above ground shall be galvanized rigid steel.
- C. Galvanized Rigid Conduit Steel GRC
1. 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 and exterior of a six (6) inch sample cut from a center of a standard length of a conduit, when tested in accordance with the applicable portion of ASTM Designation A239, shall not show a fixed deposit of copper after four (4) - one (1) 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 UL and shall conform to appropriate articles of the NEC.
 2. 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 shall butt or come together for the full circumference. Slip joints or running thread shall not be permitted for coupling conduit. When a standard coupling cannot be used, weatherproofed threaded three (3) piece union shall be used. Three (3) piece unions must be threaded; non-threaded couplings shall not be accepted.
 3. The threads on conduits shall be well-painted with a good quality lead or rust-preventive paint before couplings are made up. Couplings shall be tightened until the ends of the conduits are brought together so that a good electrical connection shall 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 a good quality asphalt bituminous or other paint suitable for the purpose.
- D. Installation Methods
1. Conduit sizes and locations shall be as shown on the plans. Conduit shall be stubbed and capped for future use where shown on the plans or where specified in these specifications.
 2. 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.
 3. Conduits terminating in poles, cabinets or pedestal bases shall extend a maximum of three (3) inches and a minimum of two (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 two (2) inches and a maximum of three (3) inches above the bottom of the box.
 4. Conduit ends shall be accomplished by 90 degree elbow with a minimum radius of 48 inches. Where two (2) or more conduits meet, 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 of wire.
 5. Conduits required to be terminated, stubbed and plugged shall be as shown on the plans and as directed by the Development Engineering Manager. 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 three (3) inches high, cut into the face of the curb, gutter or structure directly above the conduit.
 6. Metal type conduit ends 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. Non-metallic type conduit ends shall be capped with a standard PVC cap until conductors are in place.
 7. Conduit under railroad tracks shall not be less than 42 inches below the bottom of the ties and/or as specified by railroad code. It shall be the responsibility of the Responsible Party to obtain clearance

from the railroad company prior to performing any work within the boundaries of the railroad ROW. The minimum size of conduit to be used shall be as shown on the plans.

8. 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.

702.7 Pull Boxes

A. General

1. Pull box locations shall be depicted on the approved plans. These shall be located in the field by the Responsible Party and approved by the Development Engineering Manager prior to installation. Pull boxes for traffic signal conduit shall not be spaced more than 150 feet apart from each other.
2. It shall be the option of the Responsible Party, to install additional pull boxes desired to facilitate its work, at the expense of the Responsible Party.
3. Pull boxes used for loop detectors or sampling stations shall be a minimum of 12 inches wide by 16 inches long by 12 inches deep. Pull boxes used at junctions of roadway conduit crossing and at the controller cabinet shall be a minimum of 20 inches long by 33 inches wide by 15 inches deep. Pull boxes used for traffic signal communication interconnect shall be a minimum of 24 inches long by 36 inches wide by 24 inches deep. Pull boxes at the controller cabinet shall be a minimum of 30 inches long by 48 inches wide by 24 inches deep. Use of two (2) pull boxes in place of the larger one shall not be permitted.
4. Pull boxes shall be or equal to the 'Composolite' by Quazite. Enclosure and covers shall be concrete gray color and rated for no less than 8,000 lbs over a 10 inch by 10 inch area and tested to a temperature of -50° F. Material compressive strength shall be no less than 11,000 psi. Pull boxes shall have lids with the words "Traffic Signal" printed on them and be gray in color. Lids for pull boxes sized 30 inches long by 48 inches wide by 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.
5. Pull Box-Special shall be installed in street and shall be a water valve stem type pull box made of cast-iron or steel. The pull box shall have the capability of accepting riser rings for future overlays. The lid shall have the word "Traffic" cast into lid.

B. Installation

1. Pull boxes shown in the vicinity of curbs and gutters shall be placed adjacent to the back of the curb. Pull boxes adjacent to light standards shall be placed along the side of foundations as shown on the plans.
2. The cover of the pull box shall be installed level with the finish grade. The bottom of pull boxes shall rest on firm ground with 12 inches of three-fourths (3/4) inch to two (2) inch fractured rock below pull box for drainage. Pull boxes installed in a sidewalk shall be tied into the sidewalk to prevent the boxes from being pushed down below the top of the sidewalk.
3. Pull boxes installed in dirt or landscaped areas shall have a 12 inch wide by six 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, latest revision.

702.8 Standard Type Poles

- A. Traffic signal poles and mast arms shall be structurally engineered by the manufacturer in the United States to carry the proposed weight load as to signal heads with five (5) inch backplates, mounting hardware and traffic control and street name signs; The poles and mast arms shall be structurally engineered in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 90 mph wind velocity. AASHTO Fatigue Category II shall be used in design. The minimum design life for the poles and mast arms shall be 50 years. A minimum gust effect factor, G, of 1.14 shall be used in design. A speed of 55 mph shall be used to calculate truck-induced gust loads..
- B. Poles shall be furnished with anchor bolts, nuts and washers; pole caps; door covers; anchor bolt nut covers; rebar cages in conformance with these Standards and Specifications (except 10 foot poles). Mast arm traffic signal poles shall be one of the following, or approved equivalent:

Valmont Poles - Drawing DB00991, Rev. B, Dated February 27, 2012, (City)

Union Metal Corporation (Design Number 50700 B1011)

- C. Roadway clearance at end of signal mast arm shall be 21 feet from roadway with side slope of two (2) to three (3) percent to the mast arm/pole connection.
- D. Traffic signal poles and mast arms shall be of like manufacture. The pole types shown on the plans are for illustrative purposes only and are not to be construed as representative of one manufacturer. Workmanship and finish shall be equal to the best general practice of metal fabrication shops.

1. Standard Poles

- a. Pole shafts shall be straight, with a permissive variation not to exceed one (1) inch measured at the midpoint of a 30 foot or longer pole, and not to exceed three fourths (3/4) inch measured, at the midpoint of a pole shorter than 30 feet.
- b. Standard poles with mast arms shall have a two hand holes. One hand hole shall be at the bottom of the pole, 180 degrees from the mast arm mounting location at a height of 1.5 feet from the ground surface to the center of the hand hole. The other hand hole shall be located directly opposite and in line with the mast arm mounting location.
- c. 10 foot and 15 foot signal poles shall be capable of supporting a signal head using a standard pole top mount and two (2) pedestrian signal heads using side of pole mount.

2. Signal Mast Arms

Traffic signal mast arms shall be furnished with end caps. Mast arms shall not have tenons unless a written request is approved in advance by the Development Engineering Manager. If, while being installed, an arm is determined to be shortened, the Responsible Party must fabricate and install a new end cap.

3. Luminaire Mast Arms

Luminaire mast arms shall be of the single arching type, and straight, angled or ornamental types shall be acceptable. These mast arms are to be standard 15 foot arms unless it is a double mast arm pole, then the luminaire mast arms shall be 12 feet.

4. Pole Foundations

- a. Foundations shall be Portland cement concrete conforming to the applicable requirements of Class BZ, as referenced in the CDOT SSRBC. (Foundation dimensions shall be determined by the Responsible Party's design engineer and reviewed by the Development Engineering Manager.)
- b. The bottom of concrete foundations shall rest on firm ground. Foundations shall be poured monolithically where practicable. For poles or pedestal, the top four (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.
- c. Tops of foundations, except as noted on the plans, shall be finished to curb or sidewalk grade, or as ordered. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed in design position and to design height, and shall be held in place by means of a template until the concrete sets.
- d. Both forms and ground, which will be in contact with the concrete shall be thoroughly moistened before placing concrete.
- e. Where obstructions prevent construction of a planned foundation, the Responsible Party shall construct an effective foundation as directed by the Development Engineering Manager.
- f. 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.
- g. Anchor bolts provided by the manufacturer of the pole shall conform to Subsection 715.02 of the CDOT SSRBC, and shall be provided with two (2) washers and two (2) nuts 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 shall be permitted only when approved by the Development Engineering Manager.

- h. 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 shall not cause damage or obstruction to vehicular and pedestrian traffic, or interfere with surface drainage.
- i. Foundation holes that have been excavated, and will not be filled with concrete immediately, shall be covered with a solid surface covering and barricaded until concrete is poured. Foundation holes shall not be drilled more than 24 hours prior to placement of concrete.

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

A. Scope

The specification is designed for the use of Valmont triglycidyl isocyanurate (TGIC) or super durable polyester powder (Valmont part number 250257 for mocha brown or 349235 for beige) or approved equivalent in conjunction with Valmont dark gray high build epoxy powder (Valmont 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.

B. General

In order to be acceptable, poles and component parts furnished on this project by a manufacturer, or their authorized representative, shall be in accordance with the terms and requirements as set forth herein. Other comparable coating systems that comply with these specifications may be acceptable, subject to the approval of the Development Engineering Manager. The Responsible Party 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 Standards and Specifications and is free of defective workmanship.

C. 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 bottom to the top of the hand hole opening, shall receive the same treatment. Rough and sharp edges shall be rounded off. Weld splatter, flux and slag around the base plate, hand hole, 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.

D. 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.

E. Requirement of Exterior Protective Coating System

1. 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.
2. 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.
3. 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 equal) 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) mils dry 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.

4. The primer and topcoat for exterior application shall be supplied by the same coating manufacturer to ensure a compatible protective coating system resistant to corrosion, abrasion and impact.
5. 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 in the area defined in the detail sheet at the end of this section.

F. 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 hand hole 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

G. Drying and Curing Time

1. Drying time for the application of each primer coat and color topcoat application shall be per the coating manufacturer's specifications.
2. 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.

H. 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 24 inches wide, be applied at contact points, and extend a minimum of 18 inches on either side of dunnage locations at poles and arms. Minimum thickness of wrap shall be three-eighths (3/8) of an inch at contact points. Component parts shall be individually wrapped with heavy kraft paper and boxed for shipment.

I. Handling and Shipment

Poles 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 three-fourths (3/4) of an inch diameter or larger nonabrasive nylon rope or equivalent nylon belting may 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 shall be allowed until "dry-through" condition has been achieved with the coating.

J. Delivery, Installation, and Acceptance of Poles

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

K. Procedure for Field Touch-Up

The Responsible Party shall utilize a pole manufacturer who will furnish extra primer and color coat paint 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 shall be clean and dry before repair application. Field touch-up shall follow the directions of the pole manufacturer or an authorized representative in order to guarantee manufacturer's warranty.

L. Warranty

1. A minimum three (3) year warranty (at no additional cost) shall be provided for the exterior protective coating system.
2. 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.

3. 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.

702.10 Conductors and Cables

A. Installation and Identification

1. 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.
2. Identification shall be by bands fastened to the conductors in such a manner that they will not move along the conductors.
3. Cables and conductors not shown on the plans as imbedded loop detector shall be installed in conduit unless installed in poles, pedestals or mast arms.

B. Applicable Codes

1. Grounds and bonding wire, straps, and electrodes shall conform to NEC Article 250.
2. Wiring and splices shall conform to appropriate article of the NEC. Wiring within cabinets, hand holes, etc., shall be neatly arranged and shall be laced within cabinets.
3. Conductors shall be stranded, tinned copper wire, rated at 600 volts and individually insulated with heat stabilized polyethylene. Conductors and cables shall conform to specifications 19-1 of the IMSA.

C. Bonding and Grounding

1. 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 American Wire Gauge (AWG). Sheath for detectors shall be grounded in the control cabinet only. The other end of the sheath shall be taped and left ungrounded.
2. 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 three-sixteenths (3/16) inch or larger brass or bronze bolt installed in the lower portion of the shaft.
3. A ground electrode shall be installed at each control box. Each ground electrode shall be one-piece copper-weld rod of five-eighths (5/8) of an inch diameter and eight (8) feet in length, driven to a depth of at least eight (8) feet below the surface of the ground (top of rod flush with ground or top of cabinet base).
4. The ground terminal of controller shall be connected to the ground rod with a No. 8 AWG bare copper wire with a ground rod clamp approved by the Development Engineering Manager.

D. Wire Splices

Splices in underground systems shall be hermetically sealed. Splices shall be waterproofed. Splices shall be made in the hand holes or cabinet. No splices shall be allowed in pull boxes or conduit unless authorized in writing by the Development Engineering Manager. The splice method shall be approved by the Development Engineering Manager.

E. Installation Method

1. Sufficient signal light conductors shall be provided to perform the functional operation of signal system. 19 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.
2. Signal light conductors shall conform to the Red-Yellow-Green color sequencing with different colored tracers for each phase provided.

3. All signal light cable conductors shall have individual terminal lugs for connection to terminal strips in cabinet.
4. When conductors and cables are pulled into the conduit, the ends of these conductors and cables 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.
5. Powdered soapstone, talc, or other approved lubricant shall be used in placing conductors in conduit.
6. One-eighth (1/8) inch nylon pull rope and tracer wire shall be installed in new conduit and existing conduit where a cable is added or an existing cable is replaced. At least two (2) feet of pull rope shall be doubled back into the conduit at each termination.
7. Five (5) feet of slack shall be left for each conductor at each support pole and two (2) feet of slack at each pull box containing cable connections.
8. At least two (2) feet 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.
9. Splicing of cable shall not be permitted in the conduit or outside of pull boxes, standards, or at the hand hole location in pedestals unless authorized by the Development Engineering Manager.
10. Multi-conductor cable shall be spliced and insulated to provide a water-tight joint to prevent absorption of moisture by the cable.

F. Meter

The Responsible Party shall install a meter housing as required for the project. The Responsible Party 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.

703 DETECTION – SIGNAL HEAD – CONTROLLER CABINET

703.1 General

- A. Video detection shall be used for vehicle detection unless other methods are approved by the Development Engineering Manager.
- B. Traffic signal equipment shall be manufactured in the United States using domestic materials and be designed to operate from a 115 volt 60 cycle single phase source.
- C. Traffic signal equipment shall be designed to operate between an ambient temperature of -30° F to +165° F, with relative humidity up to 95%.
- D. The video detection system shall consist of one (1) video camera, a video detection processor (VDP), which mounts in a standard detector rack, a detector rack mounted extension module (EM), a detector rack mounted remote communications module (RCM), a pointing device, and a four channel color video monitor mounted inside the controller cabinet. The video camera shall be Iteris Vantage or approved equal. The VDP and EM shall be Iteris Vantage Edge 2 or approved equal. The RCM shall be Iteris Vantage EdgeConnect or approved equal.
- E. 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 point 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.

703.2 Installation

- A. The coaxial cable to be used between the camera and the VDP in the traffic cabinet shall be Belden 8281 or a 75 ohm, precision video cable with 20 gauge solid bare copper conductor (9.9 ohms/M), solid polyethylene insulating dielectric, 98% (min) tinned copper double-braided shield, and black polyethylene outer covering. The signal attenuation shall not exceed 0.78 dB per 100 feet at 10 MHz. Nominal outside diameter is 0.304 inches. The coax cable shall be a continuous unbroken run from the camera to the VDP. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. 75-Ohm BNC plug connectors should be used at both the Camera and Cabinet ends. The coaxial cable, BNC connector, and crimping tool shall be approved by the supplier of the video detection system, and the manufacturer's instructions must be followed to ensure proper connection.

- B. The power cabling shall be 16 AWG three (3) conductor SJOW type cable. The cabling shall comply with the NEC, as well as local electrical codes.
- C. The video detection system shall be installed and adjusted by supplier factory certified installers and as recommended by the supplier and documented in installation materials provided by the supplier. The preferred location is on the traffic signal mast arm. If mounted on the traffic signal mast arm, the bracket shall be a PELCO #AB-0170-74 (with stainless steel straps, not cables), or approved equal, 74 inches in length. Mounting on the luminaire requires approval of the Development Engineering Manager.

703.3 Loop Detectors

A. General

- 1. Loop detectors shall be installed in the configuration shown on the plans. Actual layout shall be determined by the Development Engineering Manager. A complete installation consists of a conductor loop or group of loops installed in saw cuts in the roadway, lead-in Beldon cable and a sensor unit with power supply installed in the traffic signal controller cabinet.
- 2. Low voltage signal circuits shall have no more than one (1) splice in each detector sensing circuit.
- 3. Cable sheath for detectors shall be grounded in control cabinet only; the other end of the sheath shall be taped and ungrounded.
- 4. Loops shall be made using duct-type wire, 14THHN copper stranded inside a one-half (1/2) inch O.D. Polyethylene jacket or a one-half (1/2) inch O.D. PVC jacket.
- 5. Loop Detector amplifiers shall be two (2) channel plug-in type, which incorporates digital output timing functions. Amplifiers shall have both pulse and presence for each channel to be set by thumb wheel switching only. Amplifiers shall have sequential scanning for elimination of cross talk.

B. Installation Method

- 1. The saw cut shall be made one-half (1/2) inch wide and minimum of three (3) inches deep. The slot shall be straight and shall not vary more than one-half (1/2) inch when checked with a 10 foot straightedge.
- 2. Saw cuts shall be blown free of standing water and debris with compressed air. The cut shall be dry prior to placement of wire.
- 3. After saw cut is cleaned of debris, the wire shall be placed in the loop by pushing it into the slot with a blunt non-metallic object. A screwdriver or other sharp tool shall not be used. Care shall be used to avoid abrading or damaging the insulation.
- 4. One (1) continuous length of wire shall be used for each loop from the pull box around the loop with the specified number of turns and back to the pull box. There shall be three (3) twists per foot in the loop wire when pulling the wire through the conduit into the pull box.
- 5. After the loops are properly seated, they shall be tested for continuity and proper loop inductance. The loop slots shall then be sealed with a high grade sealant. Sealant shall be a one part formula only (3M Sealant or approved equivalent) made specifically for sealing traffic signal loops. This sealant shall remain permanently flexible and be non-shrinking to assure maximum protection after installation.
- 6. The loop detector wires shall be spliced to the shielded lead-in cable in the pull box and pulled into the controller cabinet via the shortest possible distance using existing conduit. A minimum of three (3) feet of slack shall be provided in the controller cabinet for attachment to the detector amplifier. Each detector cable shall be clearly labeled in the cabinet identifying phase relationship and approach leg.
- 7. A minimum one and one-half (1-1/2) inch conduit shall be placed under the curb and into a pull box to accommodate detector loop wires. Conduit shall have a drain "T and Weep Hole" at the lowest point of the run under the curb to facilitate drainage. Conduit may be "pushed" or trench-laid depending on conditions at project site, and upon approval from the Development Engineering Manager. Special traffic type loop pull boxes in the roadway shall be installed at the locations shown on the traffic signal plans.

C. Detector Lead-In

1. Detector lead-in cable shall consist of two (2) No. 14 AWG copper conductors with each conductor insulated with high molecular weight, heat stabilized, colored polyethylene. The conductors shall be a twisted pair (Belden 8720) and shall be protected with a shield of tinned copper-brass or aluminum-polyester. A No. 16 AWG minimum, stranded tinned copper ground wire shall be provided. The cable shall be provided with a chrome vinyl outer jacket with a minimum thickness of 37 mils, suitable for use in conduit or for direct burial when used in conjunction with magnetic or magnetometer detectors.
 2. Sampling station detection shall be through separate lead-ins for each lane of detection. Sampling stations shall not consist of loops tied together and run into the controller on a single lead-in pair.
- D. Alternative Round Loop Detector Configuration
1. As an alternative to the six (6) foot by 40 foot rectangular shaped loop detectors, three (3)-six (6) foot round loop detector configurations may be proposed by the Responsible Party.
 2. A plan of the alternative loop detector configurations and pull box locations shall be prepared by the Responsible Party for approval by the Development Engineering Manager prior to installation. If proposed, the six (6) foot round traffic loop detector cable shall conform to the following specifications:
 3. The Responsible Party shall core drill a round traffic signal loop to be six (6) feet in diameter by one-half (1/2) inch width by three (3) inches in depth. A saw cut shall be provided to the appropriate pull box within 50 feet. The saw cut shall be one-fourth (1/4) inch in width by three and one-half (3.5) inches in depth.
 4. Cuts shall be washed clean. Water and slurry shall be vacuumed out leaving a clean and dry loop area.
 5. A preformed loop wire made of Detecta-Duct Traffic Signal loop wire or approved equivalent shall be stacked in the cuts and secured from footing. Cuts shall be sealed with a high grade sealant. Sealant shall be one part formula only made specifically for sealing traffic signal loops.
 6. A preformed loop shall consist of three (3) - six (6) foot diameter turns of loop wire, laid one loop on top of the other and glued so each loop remains in place. The tails in the loop that run to the pull box shall be approximately 50 feet.

703.4 Push Button Stations

- A. Pedestrian push buttons shall be of the direct push button contact type. 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. Push buttons shall be Polara Bulldog part number BDLM2 or approved equal.
- B. The assembly shall be weatherproof and constructed so it shall be impossible to receive any electrical shock under any weather conditions.
- C. The pedestrian push button instruction sign shall include informational text as shown in the Detail 700-24
- D. Sign dimensions shall conform to mounting frames as shown in the Detail 700-24.

703.5 Signal Heads

- A. 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.

B. 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.

C. 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.

D. 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 (5) years without exhibiting evidence of deterioration.

E. Lamp Construction

1. The LED signal shall be a self-contained device not requiring on-site assembly and be capable of withstanding mechanical shock and vibration.
2. 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.
3. Polycarbonate type vehicular or pedestrian signal heads shall be colored Federal Highway (black) for standard installation.
4. Signal hardware to be furnished 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.
5. 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° about a vertical axis.
6. Unless otherwise shown on the approved plans, traffic signal faces shall be 12-inch LED and shall contain three (3) sections arranged vertically; red--top; yellow--center; green--bottom.
7. All Vehicle signal faces shall be focused to allow maximum visibility to approaching motorists. Signal heads installed at any one intersection shall be of the same make and type, unless otherwise approved by the Development Engineering Manager.

703.6 Pedestrian Signal Heads

Pedestrian signal heads shall be polycarbonate or 18 inch clamshell mounting type, (Portland Orange and Lunar White). Units shall be highway black in color. Units shall come complete with a combination cut out and/or honeycombed visor, to prevent sun washout. Units are to be LED, with a Handman and Countdown display.

703.7 Mounting Hardware

A. Mast Arm Mounts

Signal head placement as shown on the plans are representative only. Mast arm signal head mounts shall be of an Sky Bracket mount or approved equal. Each head shall be mounted with a separate mount. Horizontal clustering of two (2) arrowed heads next to a three (3) section standard head shall be permitted on one Sky Bracket type signal mast arm mount or approved equal.

B. Side of Pole and Top of Pole Mounts

One-way side and top mounts shall be either bronze or malleable iron 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 bronze or malleable iron, 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.

703.8 Backplates

- A. Backplates shall be furnished and installed on vehicular signal heads. No background light shall show between the backplates and the signal face or between sections of the signal head.

- B. Backplates shall be either one piece or sectional. Sectional backplates shall be riveted together. No screws shall be allowed for putting backplates together.
- C. Backplates shall be five (5) inches in width unless otherwise approved by the Development Engineering Manager.
- D. Backplates shall be louvered to allow air flow and yet not permit background light to be visible to the motorist.
- E. Backplates shall be aluminum painted flat black.
- F. Backplates shall be attached to the signal head using the appropriate screws and one-fourth (¼) inch zinc plated flat washers.

703.9 Emergency Vehicle Pre-empt Detection

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

703.10 Controller Specifications

170E Controller Model HC-11 system module with a minimum of 64K EPROM and 32K ZRAM. Controller shall operate the Wapiti (W4IKS Rev. 18p) software program. Controller shall have four ACIA ports.

703.11 Cabinet Specifications

A. General

1. A 333SD-ITS Cabinet with uninterrupted power supply shall be used at intersections and other locations as determined by the Development Engineering Manager.
2. Cabinets shall have the following items included in addition to the items specified for each cabinet.
3. The cabinet shall be natural aluminum with no anti-graffiti coating and no powder coated finish.
4. 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 (2) 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.
5. 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.
6. 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 24V DC cabinet power supply.
7. Electrical characteristics of the device that will be used for series transient protection on the 332 and 336S cabinet system shall include tests run using a Velonex 587 surge generator and Tektronix oscilloscope type 2430 or equivalent hardware. Using ANSI/IEEE 062 41-1980 waveforms for normal mode and common mode ring wave and impulse tests.
8. Each unit shall comply with the following:
 - a. Clamping level 400V peak normal mode and 500V peak common mode. Trace photos and other test related information will be available upon request.
 - b. EMI/EFI noise rejection derived via standardized 50 ohm insertion loss tests shall have amplitude of at least -20db over a minimum spectrum from 50 KHZ with a -40db being the most desirable.
 - c. Diagnostics indicators shall clearly display the status of the suppression circuit. The indication shall warn of the loss of protection.
 - d. Transient energy suppression shall be in excess of 250 Joules.

- e. Rated voltage is 120V AC with rated output current minimum 10 amperes single phase operation.
- 9. All of the above components provided on the project, excluding the signal monitor unit, shall be on the Colorado and California Qualified Products listing.
- 10. The cabinet drawings shall be non-fading prints using xerography method. No blue line drawings shall be acceptable.
- 11. The Responsible Party, shall provide the Development Engineering Manager, a computer printout of the complete environmental testing results.
- 12. Serial connections shall use a standard RJ – type quick lock connection.
- 13. The power distribution assembly shall have over current indicators added to the four (4) gang 15 ampere signal circuit breaker. When the current in the monitored circuit exceeds 13 amperes for 160 milliseconds or greater, the circuit shall be latched open, the indicator shall be on, and can only be reset by a mechanical reset button.
- 14. One (1) Set of anchor bolts.

B. 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 210E 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	External Whelen 2015 Yellow Beacon (not on 336S or 303 cabinet)
1	Output File (not in the 303 Cabinet) with terminal strips (not Phoenix connectors)
8	Flash Program Blocks – 6 in the 303 Cabinet
2	Model 762 Opticom discriminators or approved equal

* As required per plans.

- 1. 333SD-ITS Cabinet shall consist of the following in addition to Section 703.11A:
 - a. The controller cabinet shall be a four (4) 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:
 - i. Cabinet dimensions: 54" X 43" X 26" D
 - ii. All four doors shall have Corbin #2 locks installed.
 - iii. A minimum of 12 selections are required; eight (8) phase selections and four (4) overlap selections shall be provided with jumper selections.
 - iv. Split input file shall be an SF 170 that will also operate in the 332/336S cabinets.
 - v. 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.

- vi. The input file shall be divided into two (2) partitions. The first partition shall include the first eight (8) slots from the left; the second partition shall include the next six (6) slots. All 14 slots shall be able to be tied to one common communication drop if desired.
- vii. The serial/ITL Transmit and receive pairs shall be wired across the back panel. TX0, DX0, Ground0 serve the first eight (8) slots. TX1, DX1, and Ground1 serve the next six (6) slots. Back plane addressing is automatically assigned in the rear of the input file, such that:
 - (1) Slot 1 = Address 0
 - (2) Slot 2 = Address 1 Slot 8 = Address 7 (all three (3) line low)
 - (3) Addressing from the front of any input device shall override the back plane addressing.
- b. 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.
- c. Surge suppression for the field wiring shall be installed on the back of the output file.
- d. 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 twenty-four (24) 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 eighteen (18) gauge wire. An outdoor silicone caulk bead shall be applied between the beacon and the cabinet to prevent water intrusion
- C. A 336S Cabinet Assembly shall not be permitted. Contact the Development Engineering Manager for 336S Cabinet specifications.
- D. 303/8 Traffic Signal Control Cabinet shall not be permitted. Contact the Development Engineering Manager for 303/8 Traffic Signal Control Cabinet specifications.

703.12 Communication Interface

A. General

- 1. 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 these Standards and Specifications. 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. The Responsible Party shall provide the Development Engineering Manager with two (2) copies of the cable manufacturer's installation instructions. 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.
- 2. No cutting or splicing of the interconnect cable will be allowed unless shown in the plans or otherwise authorized by the Development Engineering Manager.

B. Radio

- 1. Radio communication shall be accomplished using an ENCOM 5200 Radio or approved equal. The Responsible Party shall supply and install all required antennae, harnesses, connectors, and lightning suppression. Antennae wiring shall be LMR-400 DB low loss flexible coaxial communications cable or approved equal, unless otherwise specified in the plans or by the Development Engineering Manager. Antennae of the directional type shall be pointed as shown on the plans or directed by the Development Engineering Manager. At radio/fiber or fiber/radio master locations the Responsible Party shall supply and install a Traffic Fiber Systems FO-512 interface unit and a Traffic Fiber Systems FO-400 fiber modem or approved equals with appropriate connectors and harnesses.
- 2. The Responsible Party is responsible for supplying and installing a working system that is compatible with the Thornton Traffic Signal System.

C. Fiber

1. Fiber shall be the number of strands indicated on the plans.
2. 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".
3. Fiber Characteristics

All fibers in the cable must be usable fibers and meet these Standards and 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.

- a. The SM fiber utilized in the cable specified herein shall conform to the following specifications:
 - i. Typical Core Diameter 8.3 micrometer.
 - ii. Cladding Diameter 125 +/- 1.0 micrometer.
 - iii. Core to Cladding Offset ≤ 0.6 micrometer.
 - iv. Cladding Non-Circularity $\leq 1.0\%$. (Defined as $[1 - (\text{min. Cladding dia.} + \text{max. Cladding dia.})] \times 100$).
 - v. Coating Diameter 245 +/- 10 micrometer.
 - vi. Colored Fiber Diameter nominal 250 micrometer.
 - vii. Attenuation Uniformity – No point discontinuity > 0.10 dB at either 1310nm or 1550 nm.
 - viii. Attenuation at the Water Peak – The attenuation at 1383 +/- 3nm shall not exceed 2.1 dB/km.
 - ix. Cutoff Wavelength – The cabled fiber cutoff wavelength shall be ≤ 1250 nm.
 - x. Mode-Field Diameter (Petermann II): 9.30 +/- 0.50 micrometer at 1310nm; 10.50 +/- 1.00 micrometer at 1550nm.
 - xi. Zero Dispersion Wavelength ≤ 1321.5 nm and ≥ 1301.5 nm.
 - xii. Zero Dispersion Slope (S_o): ≤ 0.092 ps/(nm²/km).
- b. The coating shall be a dual layered, UV cured acrylate applied by the fiber manufacturer. Coating shall be mechanically strippable without damaging fiber.

4. Fiber Specification Parameters

All fibers in the cable shall meet the requirements of this specification.

- a. 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°C to +70°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.
- b. Required fiber grade = Maximum Individual Fiber Attenuation.
- c. The maximum dispersion shall be ≤ 3.3 ps/(nm km) for 1285 nm through 1330 nm and ≤ 18 ps/(nm km) at 1550 nm.

5. Specifications for Outdoor Cables

- a. Optical fibers shall be placed inside a loose buffer tube. The fibers shall not adhere to the inside of the buffer tube.
 - b. 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.
 - c. 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.
 - d. 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.
 - e. Buffer tubes shall be of a dual-layer construction with the inner layer made of polycarbonate and the outer layer made of polyester.
 - f. Fillers may be included in the cable core to lend symmetry to the cable cross-section.
 - g. 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.
 - h. 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.
 - i. 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.
 - j. 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.
 - k. Cable shall contain at least one ripcord under the sheath for easy sheath removal.
 - l. 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.
 - m. 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.
 - n. 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 zero (0) to one (1)% of the length markings. The marking shall be in contrasting color to the cable jacket. The height of the marking shall be approximately two and one half (2.5) mm.
 - o. The maximum pulling tension shall be 2,700 N (608 lbf) during installation (short term) and 890 N (200 lbf) long term installed.
 - p. 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.
6. General Cable Performance Specifications

The un-aged cable shall withstand water penetration when tested with a one (1) meter static head or equivalent continuous pressure applied at one end of a one (1) meter length of filled cable for 24 hours. No water shall leak through the open cable end. When a one (1) meter static head or equivalent continuous pressure is applied at one end of a one (1) meter length of aged cable for one

(1) 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".

- a. 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.
- b. 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.
- c. 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 ≤ 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.
- d. 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.
- e. 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.
- f. 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 (1) 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° 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.
- g. 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.
- h. 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 ≥ 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.

7. 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.

8. 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.

9. Miscellaneous

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

- a. The Responsible Party shall terminate all fibers on the patch panel provided by the Responsible Party in the controller cabinets indicated on the plans.
- b. The Responsible Party 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.
- c. Cable shall be installed using appropriate strain relief in the cabinet (through cable ties) at a minimum of three (3) locations.
- d. Prior to installation, the Responsible Party shall submit a schematic interconnect diagram to the Development Engineering Manager 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 Development Engineering Manager.
- e. The same color coded pairs of fibers and/or wires shall be used throughout the entire project.
- f. At the terminal points the jackets shall be stripped and the ends taped. Gel filling compound shall be removed using filled cable cleaner.
- g. Cable shall be installed in new conduit or existing conduit as depicted in the plans. The Responsible Party shall be required to leave a minimum of 50 feet coiled and laced slack lateral cable in each traffic signal controller cabinet; 50 feet coiled and laced slack cable in pull boxes where the lateral cable is spliced; 50 feet coiled and laced slack backbone cable in pull boxes where the backbone is broken out; and 50 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.
- h. For all fiber optic cables, each fiber shall be checked with an OTDR and full traces documenting fiber performance shall be provided to the Development Engineering Manager 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 Development Engineering Manager prior to completion of the project.
- i. 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.
- j. Sufficient slack shall be pulled to allow cable cutting and connection to communications equipment.
- k. 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 Responsible Party shall secure each section of inner duct to prevent it from being pulled with the cables.
- l. 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 Responsible Party 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.

- m. Personnel equipped with two (2) 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.
- n. 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 Development Engineering Manager 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.
- o. The Responsible Party 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.
- p. 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.

10. Splices and Splice Closures

Splices are not allowed without the written authorization of the Development Engineering Manager. If splices are authorized, each such splice shall occur in a new pull box to be installed by the Responsible Party 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.

- a. Following successful splicing, said splice closure shall be placed inside the described pull box or manhole. The Responsible Party 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.

11. Testing

Cable reels shall be tested for attenuation prior to installation. The Responsible Party 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 Responsible Party, the Responsible Party shall ensure that specifications for fiber optic cable have been met prior to installation.

12. Buffer Tube Fan-Out

The Responsible Party 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 termination enclosure furnished by the Responsible Party. 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.

13. Termination Enclosure

The Responsible Party 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. The Responsible Party shall furnish and install all connectors, adaptors, jumpers, and/or pigtails required to establish the final connection to the controller. The Responsible Party 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.

14. 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° C to +60° C.

- a. 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 ST style connectors.

- b. Fiber optic patch cord cables shall be a minimum of six (6) feet in length 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.
- c. Appropriate strain relief in the cabinet (through cable ties) shall be installed at a minimum of three (3) 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.

15. Connectors

The connector shall have a ceramic ferrule with a nickel-plated nut and body. The connector shall be an ST style compatible field mounted connector. The connector shall be compatible with a physical contact finish.

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

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

- d. 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.

D. Conductor Cable

- 1. Five (5) feet of slack shall be left for each conductor at each support pole and two (2) feet of slack at each pull box containing cable connections.
- 2. See Section 702.11 – Conductors and Cables for additional conductor specifications.

E. Fiber Optic Modems

- 1. Fiber optic modems shall be a Traffic Fiber Systems FO-400, or approved equal. The modem shall be capable of meeting the following requirements:
 - a. The modem shall be compatible with, and installed in, the Model 170E controller. It shall be capable of operating in full duplex mode, using asynchronous RS-232 data link protocols up to a 19.2k baud rate. RS-232 signals shall be converted to light and transmitted from modem to modem until the light is reconverted to RS-232 electrical signals directed to a particular controller. Modems shall operate in a daisy-chained communications mode.
 - b. Modem shall be a printed circuit board assembly fitting in the 400 modem slot of the controller. On the assembly there shall be an edge connector which shall mate with the internal connector on the controller mother board. On this assembly, there shall be two (2) pairs of optical emitters and detectors labeled pair "1" and pair "2", designed to attach to standard ST connectors. There shall be two (1) LEDs provided, one labeled "T" for transmit and one labeled "R" for receive. These LEDs shall illuminate when the fiber optic modem is either receiving or transmitting at the local site. There shall be a slide switch labeled "M" for master operation and "L" for local operation. In the master position, electrical data signals entering the fiber optic modem via the edge connector shall be transmitted as optical signals in a parallel mode from each of the two emitters. Optical signals received by the two detectors shall be converted to electrical signals and sent in parallel to the controller via the edge connector. In the local mode of operation, optical signals received by detector 1 shall be converted to electrical signals and sent to the 170E controller via the edge connector. These same signals shall be regenerated and transmitted by emitter 2 to the next adjacent fiber optic modem downstream. Optical signals received by detector 2 shall be regenerated and transmitted to emitter 1 to the next adjacent

fiber optic modem upstream. Electrical signals received by emitter 1 from the controller shall be transmitted to the next adjacent fiber optic modem upstream.

- c. The fiber optic modem shall derive +12VDC for its operating power from the controller connector pins "C" and "D." Logic ground shall be on pins "A" and "B," DATA IN on pin "M" and DATA OUT on pin "P." To enable the ACIA, Request to Send pin "N" shall be jumpered to +12VDC pin "D".
 - d. An RJ11/4 jack J1 shall be available on the assembly. J1, in conjunction with slide switch S2, shall be used to interface an external data link, allowing fiber optic communications in 4 directions at either a master or local controller.
2. One (1) modem is required at the intersection locations specified in the plans, to be installed in accordance with the manufacturer's recommendations.

F. Fiber-to-Radio Modems

1. Fiber-to-radio modems shall be a Traffic Fiber Systems FO-512,, or approved equal. The modem shall be capable of meeting the following requirements:
 - a. The modem shall act as a stand alone interface for connecting fiber optic cables to RS232 ports and shall be capable of operating in full duplex, multi-drop/point-to-point, dual mode (master/local switch selectable) communications.
 - b. The modems printed circuit board shall be housed in a two (2) piece aluminum case. The front of the unit shall have 6 LED's labeled R1 (Receive 1), T1 (Transmit 1), P (Power-On), A (Anti-Stream), T2 (Transmit 2), and R2 (Receive 2). Two (2) pairs of optical emitters and detectors shall also be on the front and labeled E1 and E2 (Emitters) and D1 and D2 (Detectors). The emitters and detectors shall be designed to attach to standard ST connectors. The back of the unit shall have a connector (J1-primary port) for an interface cable, a RJII (J2-secondary port), a power receptacle, and a local/master switch (S1).
 - c. The modem shall derive +12VDC for operating power from the power receptacle (J3), interface (J1), or the internal battery.
2. One (1) modem is required at the intersection locations specified in the signal plans, to be installed in accordance with the manufacturer's recommendations.

G. Internal Ethernet Communications Modules

Internal Ethernet Communications Modules shall be used to enable the 170 controller to communicate over an Ethernet system. The modules shall be designed to plug into the modem slot of the 170 controller. Communication to the controller is through the RS232 serial port lines while the RJ-45 connector shall support the Ethernet interface. The modules shall meet the following specifications:

1. 170 Controller Interface:

Mode	Asynchronous RS232, modem slot compatible
Data Rates	1200 to 38.4 kbps
Characters	7 or 8 data bits
Parity	odd, even, none
Stop bits	1 or 2
Power	+12 volts @ 125 mA Max and -12 volts @ 25 mA Max
Indicators	Red Tx and Rx LEDs

2. Ethernet Device Interface:

Data Rates	300 to 230 kbps
Characters	7 or 8 data bits
Parity	odd, even, none
Stop Bits	1 or 2
Power	3.3 volts @ 210mA Max
Ethernet	10Base-T or 100Base-T Auto Sensing
Protocols	TCPIP, ARP, UDP, ICMP, Telnet, TFTP, DHCP, HTTP, SNMP
Connectors	RJ-45
Indicators	10Base-T or 100Base-T on RJ-45
Memory	256K bytes SRAM and 512K bytes Flash

H. Ethernet Field Switches

Ethernet field switches shall be used to facilitate communication between Internal Ethernet Communications Modules and an Ethernet system. The field ethernet switches shall be GarrettCom Magnum 6KQ industrial field switches or approved equal with eight (8) copper 10/100 RJ-45 Ethernet ports and eight (8) 100 Base FX(SM) fiber ports (four transmit and four receive).

At Ethernet/fiber or fiber/Ethernet locations, the Responsible Party shall supply an Internal Ethernet Communications Module, and an Ethernet Field Switch or approved equals with all necessary connectors and harnesses.

I. Ethernet Telemetry

1. Ethernet Telemetry shall consist of a 900 MHZ unlicensed Spread Spectrum Radio modem used to enable the 170 controller to communicate over an Ethernet system. The radio modem shall be Encom Wireless CommPak IP or approved equal.
2. Software shall be included to allow the Development Engineering Manager to configure the radios on an as-needed basis. All data shall be encrypted.
3. The radios are to be equipped with an external jack allowing the use of a directional yagi or omni-directional antenna.
4. Omni-directional and directional yagi antennas shall be furnished and installed per the Spread Spectrum Radio system manufacturer's recommendations for antenna, make, model, and installation.
5. The Responsible Party shall field test all radios and yagi antennas and provide compliance testing and approval verification to the Development Engineering Manager. The Responsible Party must provide a fully functional radio communication system for the project.
6. The Responsible Party shall test signal reception at all intersections to verify end-to-end communications system performance prior to physical installation. The Responsible Party shall notify the Development Engineering Manager of the intended implementation plan based on the findings of the initial reception test.

J. Rack Assembly

Rack assemblies shall be used at the central traffic signal system location for installation of fiber optic modems at the central location. The rack assembly shall be a Traffic Fiber Systems R400/16 or approved equal. The rack assembly shall be capable of being installed in a 19" EIA defined rail system. The rack assembly shall have 16 slots for installation of fiber optic modems. The rear panel of the assembly shall be wired with sixteen (16) DB25 female communication connectors for each of the sixteen slots. The power connection for the rack assembly shall be a four position terminal block that provides a means to attach +12VDC, -12VDC, and common wiring.

At the central traffic signal system location, the Responsible Party shall install a rack assembly with all necessary connectors and harnesses.

703.13 Uninterrupted Power Supply (Continuous Power System)

- A. 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 SP1000SR or approved equal. The amber beacon shall be illuminated at any time the permanent power supply is interrupted to the cabinet, and the signal is operating on the battery backup.

B. Battery System

1. 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.
2. 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.
3. Batteries shall be certified to operate at extreme temperatures from -40° C to +74° C.
4. The batteries shall be provided with appropriate interconnect wiring and a corrosion resistant mounting trays and/or brackets appropriate for the cabinet into which they will be installed.
5. The interconnect cable shall be protected with abrasion resistant nylon sheathing.

6. The interconnect cable shall connect to the base module via a quick-release circular connector.
7. 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.
8. Battery construction shall include heavy-duty, inter-cell connections for low-impedance between cells, and heavy-duty plates to withstand shock and vibration.
9. The top cover shall use tongue and groove construction and shall be epoxied to the battery case for maximum strength and durability.
10. An optional lifting handle shall be available on most battery models.

703.14 Illuminated Overhead Signage

- A. The internally illuminated signs shall be "Naim-Series-Inter Mark II signs manufactured by Nu-Art Lighting, Fullerton, California, or standard (96" L x 19" H x 9.375" D) signs manufactured by Southern Manufacturing, Orlando, Florida, or approved equal. Some manufacturers fabricate standard sizes of those signs required on the plans. Signs on any single project or at any specific location shall be from the same manufacturer or fabricator. Signs shall be eight (8) feet in length.
- B. 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.
- C. Colors shall be standard approved colors for highway signs. The colors shall be white, green, blue, and red applied on the interior sign face. Green shall be Pantone 3435c Emerald Green (3M 3630-126). The City of Thornton logo shall be Pantone 300 Intense Blue (3M 3630-127). Blue for highway shields shall be Pantone 294 Bristol Blue (3M 3630-097). Red shall be Pantone 485 (3M 3630-33). Color tint shall show as intended and be consistent regardless of whether the sign is lit or unlit.
- D. Capitalization of text on the internally illuminated sign shall be in compliance with the MUTCD, latest revision.
- E. The sign layout shall include all necessary text and logos on one or both sides of the sign assembly as indicated on the plans.
- F. 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 LEDs shall not alter the colors or background on the sign faces.
- G. Each sign shall have a plug in type photo cell. Photo-electric controls are required and shall be of the "hail-resistant" type, and meet the requirements of Section 706.2.4.
- H. The front sign panel of the case shall be hinged, either by a continuous hinge or extruded interlocking hinge, to provide access to the lamps. 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. Exterior hardware, hinges, etc., shall be painted in accordance with Section 702.9.
- I. The sign case shall be securely attached to the support structure. Close coordination shall be maintained between the sign fabricator and support fabricator to assure attachment devices are properly placed. Brackets shall be PELCO SP 5559 assembly or approved equal.
- J. An appropriately rated, in-line fuse shall be installed at the base of the pole where the sign feed connects to the power feed.
- K. An insulating grommet shall be installed where the illuminated street name sign wiring enters the signal pole.
- L. One galvanized ½-inch eyebolt with washer and nut shall be installed adjacent to each mounting bracket for installation of safety cable. An outdoor silicone caulk bead shall be applied at the entrance of the eyebolt into the sign to prevent water intrusion.

704 TRAFFIC SIGNING STANDARDS**704.1 General**

The City shall review and approve what type of controls and where they shall be installed based on standard City practices and the MUTCD. These controls shall include traffic control signs, street name signs, delineators, fiber markers, permanent barricades, and pavement markings.

A. Materials

Sign panels shall conform to City requirements for material composition and reflective sheeting. Items used in the fabrication, manufacturing, and installation of traffic control signing in the City shall be manufactured in the United States with domestic materials and parts. Domestic materials and parts are those which are melted, cast, formed, shaped, drawn, extruded, forged, fabricated, or otherwise processed in the United States using raw materials produced in the United States.

B. Sign Sizes

Sign sizes shall conform to the MUTCD sizes for conventional roads unless otherwise approved in writing by the Development Engineering Manager.

704.2 Signing Layouts

Sign staking shall be done by the Responsible Party and inspected by the City prior to installation.

704.3 Variance Requirements

The Responsible Party shall obtain a City traffic control permit prior to installation of any signs. This permit shall constitute City authorization for the Responsible Party to install official traffic controls on public ROW. Responsible Parties installing traffic controls within the City shall be annually licensed through the City to do work in the City.

A. Inspection

After installation, the signing Responsible Party shall notify the Development Engineering Manager. The Development Engineering Manager shall then inspect installations and notify the Responsible Party of any correction needed. A second inspection shall be made by the Development Engineering Manager at the time of the final walk-through of public ROW improvements. The Responsible Party shall correct signing problems.

B. Relocation

The Responsible Party is responsible for the removal and relocation of existing traffic signs on public ROW affected by the approved project.

704.4 Sign Fabrication

A. Standard control and street name signs shall be fabricated on .080/50-52 H 38 anodized aluminum blanks with standard radius corners.

B. Traffic control signs and street name signs shall be fabricated using 3M Company diamond grade retro-reflective sheeting or approved equivalent. Sign facings shall be covered with 3M #1160 protective overlay or approved equivalent.

C. Traffic control sign faces shall be screened in conformance with methods prescribed by 3M Company using 3M inks or approved equivalent. No substitutions shall be allowed unless approved by the Development Engineering Manager prior to fabrication in writing.

D. Standard signs, except street name signs, shall be fabricated to conform exactly to the detailed drawings of standard highway signs as shown and detailed in the latest Standard Highway Signs Manual as published by the U.S. Department of Transportation/Federal Highway Administration.

E. School, bicycle crossing, and pedestrian crossing signs shall be strong fluorescent yellow green. All warning signs shall be fluorescent yellow.

F. Street name signs shall be fabricated in accordance with these Standards and Specifications. The City shall furnish a sample of the City logo decals to be installed on street name signs.

G. Street name letter sizes shall be as follows:

Street Speed Limit	Street Name Number/Letter Size	Supplementary Number/Letter Size
25 & Under	4"	2"
30 – 35	6"	3"
40 & Above	8"	4"

- H. Capitalization of letters shall be in compliance with the MUTCD, latest revision.
- I. Signs shall be fabricated with new materials. No used or reconditioned sign blanks or outdated sheeting and/or precut letters or numbers shall be used.

704.5 Sign Installation

- A. Signs shall be installed in conformance with the latest edition of the MUTCD and Revisions. Signs shall be mounted on either the approved City breakaway supports, or banded to street light poles.
- B. Signs mounted to street light poles shall have the sign support banded to pole with two (2) one-half (1/2) inch stainless steel "band-it" straps.
- C. Mounting of signs to breakaway supports shall be accomplished by the following: Street signs must use five-sixteenths (5/16) inch nut and bolt. No rivets are allowed. Stop signs or equivalent must use five-sixteenths (5/16) inch nut bolt arrangement with a one and one-half (1½) inch washer to be used on top hole only, rivet to be used on bottom hole only.
- D. Assembly of the breakaway supports to the anchor shall be by using a corner bolt or a drive rivet, or by using a V-lock base.
- E. The Responsible Party shall, prior to installing sign support bases, contact utility agencies providing services, to locate buried services and to avoid damage when the base is installed. This shall include contacting the Utility Notification Center of Colorado.
- F. Support bases shall be installed with a stabilizer fin to prevent the support from turning, and/or easy removal by vandals. The stabilizer fin shall provide 360 degree stabilization.
- G. Single sign installations shall be on "TELESPAR" 16F 12 or equal, 10 foot support assemblies.
- H. Multiple sign installations shall be on "TELESPAR" 16F 10 or equal, 12 foot support assemblies.
- I. Sign support bases for standard sign installations shall be a "V-Lock" base, installed so that one (1) inch plus or minus one-half (1/2) inch protrudes above ground level.
- J. Sign supports for standard sign installations shall be installed so that a minimum of six (6) inches is inside of support base and the sign height conforms to the MUTCD.
- K. Sign supports shall be straight in alignment with the road and vertically straight from top and bottom. Bending of the support to achieve the vertical alignment shall not be permitted unless approved by the Development Engineering Manager.
- L. Delineator posts and fiber markers for interconnect conduit marking shall be Safe-Hit 48-inch flexible guide posts or approved equal, white in color with a three (3) inch x nine (9) inch high intensity reflective strip, to be installed with an 18 inch soil anchor. Delineators installed on traffic calming projects shall be of the Safe – Hit type one (1) foot tall with a three (3) inch by nine (9) inch band of reflective material at the top of pole.
- M. Permanent Type III Barricades installed shall meet all requirements of the MUTCD. All barricades shall be constructed using eight (8) inch by eight (8) foot by .010/50-52/H 38 anodized aluminum blanks with standard radius corners. The orange on white facing shall be 3M high intensity grade or equivalent.
- N. Permanent Type III Barricades shall be supported using "TELESPAR" No. 20F 10 or equal, six (6) foot support assemblies. All barricade supports shall have the same finish as standard sign supports, except the final outer finish shall be White Federal Standard No. 595A Powder Resin No. 17875, or an approved equivalent.
- O. Barricade support bases shall be the same as standard sign support bases.
- P. Barricade supports shall be installed six and three-fourths (6-3/4) inches from the edge of the panels to the center of the support.
- Q. Sign supports for standard sign installations shall meet or exceed the following specifications:

1. Tubing seam shall be welded in such a manner that the weld or flash shall not interfere with the telescoping of the tubing.
2. Support tubing size shall be one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) inch, U.S.S. 12 gauge, with a weight of 2.06 pounds per lineal foot.
3. The length of each post shall be as specified and have a permissible length tolerance of plus or minus one-fourth (1/4) inch.
4. The finished post shall be straight and shall have a smooth uniform finish.
5. It must be possible to telescope a one and one-half (1-1/2) inch by one and one-half (1-1/2) inch O.D. post into a one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) inch O.D. post.
6. It must be possible to telescope a one and three-fourths (1 3/4) inch by one and three-fourths (1 3/4) inch O.D. post into a two (2) inch by two (2) inch O.D. post.
7. The outside tolerance at sides and corners shall be as follows:
 - a. For one and one-half (1-1/2) inch by one and one-half (1-1/2) inch O.D. plus or minus six one-thousandths (.006) inch
 - b. For one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) O.D. plus or minus eight one-thousandths (.008) inch
 - c. For two (2) inch by two (2) O.D. plus or minus eight one-thousandths (.008) inch
8. The wall thickness shall fall between a plus .011 inch and a minus .008 inch of U.S.S. 12 gauge.
9. The maximum twist permissible in three (3) foot lengths for a standard one and three-fourths (1-3/4) inches by one and three-fourths (1-3/4) inch sign support is .062 inch.
10. The maximum tolerance in squareness for one and three-fourths (1-3/4) inch by one and three-fourths (1-3/4) inch supports is plus or minus .010 inch.
11. A maximum tolerance in straightness of one-sixteenth (1/16) of an inch in three (3) feet is permissible.
12. Supports shall be given a double outer finish. The first outer finish is galvanized and the second outer finish Mocha-Brown Federal Standard 595B No. 10075 polyester powder finish. The following specifications for the finishes shall be met:
 - a. Each square steel tube support shall be hot dipped galvanized, ASTM A-525 coating, designation G90, or given a triple coated protection by in-line application of hot dip galvanized zinc per AASHTO M-120 followed by a chromate conversion coating.
 - b. Sign supports shall receive a final outer finish of polyester. The polyester (thermoset) powder finish to be used shall provide a tough outside, weather resistant, highly mar-resistant coating able to withstand high impacts without chipping or cracking. Polyester required properties are:
 - i. Tensile strength of 7500 psi
 - ii. Impact resistance to not less than 160 pounds
 - iii. Hardness of 87 shore D Durometer
 - iv. Flexibility of 180° bend over one-fourth (1/4) inch diameter mandrel without cracking or loss of adhesion.
 - c. Dielectric strength of 1000 v/mil at 10 mils
 - d. Color of the outer finish shall be Mocha-Brown Federal Standard 595B Powder Resin No. 10075, or an approved equal, as determined by the Development Engineering Manager.
 - e. Application of final outer finish shall be accomplished by the following process:
 - i. Pretreating is required to remove grease, rust, and dirt and then a thin coat of iron or zinc phosphate shall be applied. This pretreatment is required to provide maximum adhesion and long term corrosion protection.

- ii. The powdered resins shall be applied to the cold support tubing through an electrostatic gun. The support shall then be baked in order to fuse the finish to the surface.
- iii. The outer finish shall have a minimum thickness of two (2) mils.

704.6 Sign Maintenance

It is the responsibility of the Responsible Party to maintain required signs after installation until the City has officially granted the initial acceptance of the adjacent ROW improvements. Signs installed under this standard shall be maintained during the development construction period in two manners.

- A. Signs damaged which do not constitute an immediate hazard to the public shall be repaired by the Responsible Party within a reasonable time, not to exceed 10 working days after Responsible Party has been notified.
- B. Signs damaged, which constitute an immediate hazard to the public, shall be repaired or replaced by City personnel. The Responsible Party shall be responsible for the cost of repairs and/or replacement.

704.7 Fire Lane Designations

A. General

Street signs and pavement marking specifications included with construction plans shall show the location of fire lane signs on all streets and areas designated by the Thornton Fire Department. Installation shall be in accordance with these Standards and Specifications.

B. Sign Installation

- 1. All signs shall be installed in strict conformance with the latest edition and revisions of the MUTCD.
- 2. Signs shall read "NO PARKING FIRE LANE" and may include directional arrows at the bottom of the sign, as shown in the detail at the end of this section.
- 3. Signs shall be mounted to a metal post, wall, or other approved device or surface. The height of the bottom of the sign shall no be less than seven (7) feet above the concrete curb, walkway, road surface, or landscaping. Signs mounted on buildings or other walls shall be installed not less than five (5) feet above the ground.
- 4. Signs shall be spaced at 100 to 200 foot intervals, depending on the road layout or configuration of the area being designated, so that it is obvious that parking is prohibited.

C. Inspection

Completed fire lane sign installations shall be reviewed/inspected by the Development Engineering Manager and Fire Department.

705 PAVEMENT MARKINGS

705.1 General

- A. The Responsible Party shall furnish pavement marking plans for each approved project to the Development Engineering Manager. The Development Engineering Manager shall review and approve the Responsible Party's pavement marking plans. Pavement marking plans shall include but are not limited to the designation of locations where crosswalks, exclusive right-turn lanes, exclusive left-turn lanes, edge lines, stop bars, white skip lines, solid double yellow lines, and yellow skips to be installed.
- B. The Responsible Party shall be responsible for the removal of any existing pavement markings necessary to install new markings for the approved development.
- C. It is the intent of these Standards and Specifications to describe the requirements for retro-reflective pavement marking thermoplastic (preformed) to be used on roadway surfaces within the City, to provide for the submission of samples, to describe the laboratory and service test procedure which must be used to rate the materials proposed for marking new city roads, and to describe the requirements for the actual field installation of proposed pavement markings. Alternative markings for temporary installations are also listed as traffic line paints, hot extruded thermoplastics and detour grade tapes, and shall be approved by the Development Engineering Manager.
- D. Pavement Marking Layout – The Responsible Party will layout in the field pavement marking locations prior to installation. Before installation, the lines must be approved by the Development Engineering Manager.

- E. Permanent pavement markings installed on new asphalt shall be inlaid and installed within four (4) hours of placement of the final lift of asphalt pavement. Pavement markings on existing and new concrete pavement shall be recessed in a one fourth ($\frac{1}{4}$) inch groove not to exceed one half ($\frac{1}{2}$) inch wider nor two (2) inches longer than the tape being laid and shall be glued with an epoxy binder. Permanent pavement markings on existing asphalt shall have an epoxy binder applied and be tape.

705.2 Preformed Plastic Pavement Markings and Legends

A. General

1. The prefabricated markings described shall consist of white or yellow pigmented plastic films with reflective glass spheres uniformly distributed throughout their entire cross-sectional area, and shall be capable of being affixed to bituminous or Portland cement concrete pavements by either a pressure sensitive pre-coated adhesive or liquid contact cement. The markings shall be provided in a complete form that shall facilitate rapid application and protect the markings in shipment and storage. The manufacturer shall identify proper solvents and/or adhesives to be applied at the time of application, the equipment necessary for proper application, and recommendations for application that shall assure an effective performance life. The marking film shall have resealing characteristics such that it shall fuse with itself and with previously applied marking materials of the same composition under normal conditions of use.
2. Prefabricated legends and symbols shall conform to the applicable shapes and sizes as outlined in the MUTCD.

B. Classification

The markings shall be highly durable retroreflective pliant polymer materials designed for longitudinal and word/symbol markings subjected to high traffic volumes and severe wear conditions, such as shear action from crossover, or encroachment on typical longitudinal configurations such as edge lines, barrier lines and lane lines.

- C. Symbols, legends, long lines, stop bars, and crosswalks shall be 3M Series 270 ES or approved equal. For concrete pavement, long lines, and skips shall be 3M Series 380I-5ES or approved equal.

705.3 Marking Paint

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

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

705.4 Thermoplastic Marking

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

B. Application

1. The pavement marking shall be applied to the pavement either to the right or left of the application unit, dependent upon roadway lane being used. The unit shall not occupy more than one lane of roadway while operating.
2. The finished lines shall have well defined edges and be free of waviness. Tolerance shall be one (1) inch longitudinally and one fourth ($\frac{1}{4}$) inch transversely. The minimum thickness of thermoplastic line shall be three thirty-secondths ($\frac{3}{32}$) inch at the edges, not less than one eighth ($\frac{1}{8}$) inch at the center. Measurements shall be taken as an average throughout any 10 foot section of the line. The material, when formed into traffic stripes, must be readily renewable by placing an overlay of new material directly over an old line of compatible material. Such new material shall bond itself to the old

line in such a manner that no splitting or separation takes place. All of the equipment necessary to the preheating and application of the material shall be so designed that the temperature of the material can be controlled within the limits necessary to its pourability for good application.

3. The marking material as specified shall be installed at the manufacturer's recommended temperature.
4. At the time of installation of thermoplastic materials, the pavement shall be clean, dry, and free of laitance, oil, dirt, grease, paint, or other foreign contaminants. Pavement and ambient temperatures shall be at least 50° F.
5. An epoxy resin primer shall be applied to concrete surfaces prior to the application of the thermoplastic pavement marking. The epoxy resin primer shall be installed per the thermoplastic manufacturer recommendations.
6. The marking material shall not be applied until the epoxy resin primer reaches the tacky stage. An infrared heating device may be employed to shorten the curing time of the epoxy.
7. If the Development Engineering Manager determines that a new asphalt surface has become soiled, prior to placement of the pavement markings, a pavement primer will be required and preformed plastic pavement markings shall be applied as approved.
8. The epoxy resin primer material may be accepted at the job site on the basis of a manufacturer's certification, or a sample may be sent to the laboratory for testing, in which case three (3) weeks shall be allowed between sampling and intended use.

705.5 Reflectorized Glass Beads

A. General

1. This specification is intended to cover free-flowing, water-proofed, reflectorizing glass beads for drop-on type application on highway traffic paint and thermoplastic for the production of a reflective surface improving night visibility of the painted markings without altering daytime visibility. The beads shall conform to the following specifications:
 - a. A blended material consisting of spheres containing refractive indices of 1.50 and 1.65 and conforming to the following specifications:
 - i. Manufactured from high grade optical crown glass of a composition designed to be highly resistant to traffic wear and to the effects of weathering.
 - ii. Colorless, clean and transparent.

B. Material

The reflectorizing glass beads shall conform to the following:

1. Refracture Index - When testing by the liquid immersion method at 77° F, 70% of the spheres shall have an average index of not less than 1.50, and 30% shall have an average index of not less than 1.65.

1.50 Index Glass Beads

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

1.65 Index Glass Beads

<u>U.S. Standard Sieve Number</u>	<u>% Passing by Weight</u>
50	100
80	90 - 100
100	75 - 90
200	0 - 5

706 STREET LIGHTING**706.1 Street Lighting**

Street lighting shall conform to Detail 700-21. In the Washington Street Corridor Area, shown in the details, the color shall be as specified on Details 700-5 and 700-22. For colors of poles, coordinate with the City Development Department.

706.2 Street Light Luminaires

A. Luminaires shall meet the following general requirements:

1. Luminaires shall be as specified for each type in the Luminaire Material Specification table.
2. Luminaires shall have an external label per ANSI C136.15.
3. Luminaires shall have an internal label per ANSI C136.22.
4. Luminaires shall have maximum nominal luminaire input wattage as specified for each luminaire type in the Luminaire Material Specification table.
5. Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.
6. Luminaires shall start and operate in -30°C to +40°C ambient.
7. Fully assembled luminaires shall be electrically tested before shipment from factory.
8. Effective Projected Area (EPA) and weight of the luminaires shall not exceed the values indicated in the Luminaire Material Specification table.
9. Luminaires shall be designed for ease of component replacement and end-of-life disassembly.
10. Luminaires shall be rated for the ANSI C136.31 Vibration Level indicated in the Luminaire Material Specification table.
11. LED light source(s) and driver(s) shall be RoHS compliant.
12. Luminaires shall be rated for a minimum operational life of 80,000 hours at an average operating time.
13. Lumen maintenance shall not decrease by more than 30 percent over the minimum operational life.
14. A minimum of 70 percent of original lumen output shall be maintained for operational life in excess of 80,000 hours.
15. Lumen maintenance shall be determined using criteria identified in LM-80, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources, latest revision and TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources, latest revision.
16. The driver shall:
 - a. Have a rated driver case temperature shall be suitable for operation in the luminaire operating in the ambient temperatures indicated above.
 - b. Accept the voltage or voltage range indicated in the Luminaire Material Specification table at 50/60 Hz, and shall operate normally for input voltage fluctuations of plus or minus 10 percent.
 - c. Have a minimum Power Factor (PF) of 0.90 at full input power and across the specified voltage range.
 - d. Have a UL Class I rating.
 - e. Have a UL outdoor, damp, location rating in compliance with International Electrotechnical Commission IP-66.
 - f. Be UL, cUL recognized.
 - g. Have a 1.5 maximum current crest factor.

- h. Have a Class A sound rating.
 - i. Have a life expectancy of 80,000 hours.
 - j. Provide constant light output over the life of the fixture.
 - k. Be solid state (electronic) type.
 - l. Be modular and removable without the use of special tools or disassembly of the luminaire.
17. Electromagnetic Interference
- a. Luminaires shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across the specified voltage range.
 - b. Luminaires shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
18. Luminaires shall be listed for wet locations by OSHA Nationally Recognized Testing Laboratories and have an International Electrotechnical Commission IP-66 rating.
19. Luminaire Housing
- a. The luminaire housing shall have a corrosion resistant finish providing protection against high concentrations of liquid and salt spray.
 - b. The finish shall exhibit no greater than 30% reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.
20. Thermal Management
- a. Mechanical design of any protruding external surfaces (heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
 - b. Moving parts shall be clearly indicated in submittals, be consistent with product testing, and shall be subject to review by the Owner.
 - c. Liquids shall not be used.
21. Backlight, Uplight, and Glare (BUG) Ratings
- a. BUG ratings shall be as specified for each luminaire in the Luminaire Material Specification Table.
 - b. Calculation of BUG Ratings shall be for initial (worse-case) values, i.e., Light Loss Factor (LLF) = 1.0.
 - c. If luminaires are tilted upward for calculations in photometric analysis, BUG ratings shall be calculated for the same angle(s) of tilt.
22. The vertical angle of cobra head luminaires shall be adjustable and the luminaire shall have a bubble level or gauge to assist in installing the fixture vertically plumb.
23. Minimum color rendering index (CRI) shall be 70.
24. Nominal Correlated Color Temperature (CCT) shall be 4000K. Allowable LM-79 chromaticity values shall be a measured CCT of 3710 to 4260K and a measured Duv of -0.005 to 0.007.
25. All wiring and grounding, terminal blocks from incoming AC lines, photo-electric control receptacle (if applicable), latching, hinging, and ingress protection shall be in accordance with ANSI C136.37.
26. All internal components shall be assembled and pre-wired using modular electrical connections.
27. No special tools shall be required for maintenance of the luminaire.
28. Luminaires shall contain no mercury.
29. At a minimum, the manufacturer or local sales representative shall provide installation and troubleshooting support via telephone and/or email.

Luminaire Material Specification Table

LED Luminaire Performance Criteria				
Luminaire Type		Post Top Decorative (Lantern)	Cobra Head (Type I)	Cobra Head (Type II)
Input Power	Max. Nominal Luminaire Input Power	70 W	130 W	200 W
High Pressure Sodium Wattage	Equivalent High Pressure Sodium Wattage	100 W	250 W	400 W
Typical Mounting Height		23 feet	32 feet	
IES Type		Type III		
Nominal CCT	Related Correlated Color Temperature	4000K		
Photopic Downward Luminaire Output	Minimum <i>Maintained</i> Luminaire Output Below Horizontal	3256 lm		
BUG Rating	Max. Nominal Backlight-Uplight-Glare Ratings	B1-U1-G1		
Voltage	Nominal Luminaire Input Voltage	100 – 277V (+10/-10%)		
Finish	Luminaire Housing Finish Color	Black	Gray	
Weight	Maximum Luminaire Weight	60 lb	60 lb	
EPA	Maximum Effective Projected Area	3.0 ft²	2.0 ft²	
Mounting	Mounting Method	Post Top	Side-arm	
	Tenon Nominal Pipe Size	3 inches	2 inches	
Vibration	ANSI Test Level	☑ Level 1 (normal) ☐ Level 2 (bridge/overpass)		

B. Submittals shall be required for each luminaire type. Submittals shall include:

1. Luminaire cut sheets
2. LED light source cut sheets (LED packages, modules, arrays)
3. LED driver(s) cut sheets (drivers and power supplies, if applicable)
4. Surge protection device cut sheets
5. Installation and maintenance instructions
6. Illuminating Engineering Society (IES) LM-79 luminaire photometric report. The “product families” method may be utilized for the LM-79 report if test data is lacking for a particular product configuration. The LM-79 report shall include:
 - a. Name of test laboratory (must be accredited by National Voluntary Laboratory Accreditation Program (NVLAP) for the IES LM-79 test procedure or must be qualified, verified, and recognized through the U.S. Department of Energy’s CALiPER program).
 - b. Report number
 - c. Report date
 - d. Complete luminaire catalog number

Provide clarification if catalog number in test report does not match catalog number of luminaire submitted (clarify if discrepancy does not affect performance)

- e. Description of luminaire, LED light source, and LED driver(s)

- f. Colorimetry
- 7. Computer generated point-by-point photometric analysis of maintained photopic light levels as per the Luminaire Material Specification table.
- 8. Calculations and supporting test data per LM-80.
- 9. Calculations and supporting test data per TM-21.
- 10. Written product warranty
- 11. Buy American documentation
 - a. Manufacturers listed on the current NEMA Listing of Companies Offering Outdoor Luminaires Manufactured in U.S.A. for Recovery Act Projects need only provide a copy of the document.
 - b. Other manufacturers shall submit documentation as per the Department of Energy Guidance on Documenting Compliance with the Recovery Act Buy American Provisions.
- 12. At the request of the Development Engineering Manager, a test sample of each proposed luminaire shall be provided to the City at no cost for review, testing, and evaluation.
- C. A minimum five (5) year warranty shall be provided for each luminaire, covering maintained integrity and functionality of:
 - 1. Luminaire housing, wiring, and connections
 - 2. LED light source(s)

Negligible light output from more than 10 percent of the LED packages constitutes luminaire failure.
 - 3. LED driver(s)
- A. The photo-electric control (photocell) shall be a standard NEMA three (3) pole locking type. The photo-electric control shall meet the following general requirements:
 - 1. Photo-electric controls shall be rated for a nominal input voltage of 120 – 277V.
 - 2. Photo-electric controls shall have built-in metal oxide varistor (MOV) surge protection.
 - 3. Photo-electric controls shall be time delayed for a minimum of fifteen (15) seconds.
 - 4. Photo-electric controls shall be UL tested for a minimum of five thousand (5,000) cycles (approximately 13.7 years) at one thousand (1,000) watt minimum tungsten and one thousand eight hundred (1,800) volt-amp minimum ballast loads.
 - 5. Photo-electric controls shall meet UL Standard 773 requirements.
 - 6. Photo-electric controls shall be in compliance with ANSI C136.10.

706.3 Arterial and Collector Poles and Luminaire Arms

- A. Poles for single luminaire arm and double luminaire arm arterial and collector street lighting shall be tapered tenon top steel poles galvanized per ASTM A123, latest revision or tapered tenon top seamless alloy aluminum poles. The poles and mast arms shall be of American steel or aluminum and shall be engineered by a manufacturer in the United States in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 100 mph wind velocity and minimum design life of 25 years. Poles shall be designed to carry the typical proposed weight as to luminaires, sign, banners, and mounting hardware. Banners are typically made of vinyl material two (2) feet in width and eight (8) feet in height, mounted via top and bottom arms at a height of fifteen (15) to twenty (20) feet from ground surface to bottom of the banner. Signs are typically made of 0.080/50-52 H 38 anodized aluminum material thirty-six (36) inches in width and forty-eight (48) inches in height, mounted via a top bolt and bottom rivet at a minimum height of seven (7) feet from ground surface to bottom of the sign. A complete set of Professional Engineer stamped structural engineering drawings and specifications for pole and mast arms shall be provided.
- B. Arterial and collector street light poles shall be thirty (30) feet in height from ground surface to base of tenon. The tenon at the top of the pole shall have a three (3) inch outside diameter. Each pole shall have a hand hole located a minimum of one foot to a maximum of one foot and six inches (1' – 6") from the

ground surface to the center of the hand hole. The hand hole shall be a minimum of four (4) inches wide and a minimum of five (5) inches in height.

- C. The anchor base for each pole shall be slotted for one inch diameter anchor bolts. The bolt circle for the anchor base shall be sized to be compatible with a twenty-four (24) inch diameter concrete foundation without overlap of the foundation.
- D. Luminaire arms shall be arching arms ten (10) feet in length. Steel arms shall be galvanized per ASTM A123, latest revision. Aluminum arms shall be seamless alloy aluminum. Truss arms shall not be used. The arching arm shall have a rise of two (2) feet. Attachment of the luminaire arm to the pole shall be via a slip fitting designed to mount to a three (3) inch outside diameter top mount tenon on top of the pole. Attachment of the luminaire to the luminaire arm shall be via a slip fitting designed to mount to a two (2) inch outside diameter side-arm tenon and the end of the luminaire arm.
- E. All poles shall be plumb when installation is complete.
- F. The use of steel poles and luminaire arms or aluminum poles and luminaire arms shall be as specified in the plans or at the direction of the Development Engineering Manager.
- G. All necessary hardware and attachments shall be bagged and secured within each pole.

706.4 Residential and Trail Poles

- A. Poles for residential or trail lighting shall be tapered fiberglass direct buried poles, black in color (natural finish) The poles shall be engineered in accordance with the latest edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals for a 100 mph wind velocity and minimum design life of 25 years. Poles shall be designed to carry the typical proposed weight as to luminaires and mounting hardware. The pole shaft length shall be 28 feet. Luminaire mounting height shall be 23 feet above ground surface. Each pole shall have a hand hole located a minimum of one (1) foot to a maximum of five (5) feet from the ground surface to the center of the hand hole. The hand hole shall be a minimum of three (3) inches wide and a minimum of five (5) inches in height.
- B. Mounting of the luminaire to the fiberglass pole shall be via a slip fitting designed to mount to a three (3) inch outside diameter top mount tenon on top of the pole.
- C. Holes for installation of fiberglass poles shall be made by hand or using a power augur. The diameter of the hole shall be approximately three (3) times the ground line diameter per pole manufacturer's specifications. Once the pole is installed, backfill material suitable for the soil's conditions and per pole manufacturer's recommendation shall be applied and firmly tamped every six (6) inches.
- D. All poles shall be plumb when installation is complete.
- E. All necessary hardware and attachments shall be bagged and secured within each pole.

706.5 Street Light Pole Foundations

- A. Arterial and collector pole shall have concrete foundations twenty-four (24) inches in diameter and forty-eight (48) inches in height. Concrete for the foundation shall be Class BZ per Colorado Department of Transportation SSRBC, latest revision.
- B. Four (4) steel anchor bolts conforming to ASTM F1554 Grade 55 shall be installed in the foundation. The foundation bolt circle shall be per manufacturer's specification for the light pole. The anchor bolts shall be L-shaped anchor bolts one (1) inch in diameter, thirty-six (36) inches in length, with a four (4) inch hook.
- C. Reinforcing steel for the foundation shall be seven (7) horizontal #4 rebar hoops at +/- six (6) inch vertical spacing and eight (8) vertical #4 rebar evenly spaced. The hoops shall have a minimum twelve (12) inch overlap. The bottom hoop shall be three (3) inches from the bottom of the foundation. A minimum one and one-half (1-1/2) inch clearance shall be provided between the hoops and the outer surface of the foundation. Two (2) #4 rebar stirrups shall be placed at +/- six (6) inches around the anchor bolts.
- D. Three 3-inch rigid conduits shall be installed down the center of the foundation, exiting the foundation a minimum of twenty-four (24) inches below ground surface. Each conduit exit shall be positioned a minimum of ninety degrees from the adjacent conduit exit. One additional one-half (1/2) inch conduit shall be run through the foundation for installation of ground wire.
- E. All necessary nuts, nut covers, and washers shall be supplied with the arterial and collector poles and shall be steel, galvanized per ASTM A153, latest revision. Anchor bolts shall be galvanized per ASTM A153 to a minimum of twelve (12) inches on the threaded end.

- F. The top of the pole foundation shall be flush with ground level.
- G. A professional structural engineer shall certify that the foundation will be adequate for the pole proposed by the Responsible Party. If it is determined that an alternate foundation design is required, it shall be provided by the Responsible Party's professional structural engineer.
- H. Foundations shall not be required for direct buried fiberglass poles.

706.6 Breakaway Support

- A. All arterial and collector street light poles shall use a breakaway support unless otherwise specified in the plans or at the direction of the Development Engineering Manager.
- B. Breakaway supports shall be frangible cast aluminum transformer bases designed in accordance with the 2009 edition of the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.

706.7 Street Light Pole Grounding

- A. A ground rod shall be installed adjacent to each arterial and collector pole. Each ground rod shall be one-piece copper-weld rod of 5/8-inch diameter and eight (8) feet in length, driven to a depth of at least eight (8) feet below the surface of the ground. The ground rod shall be a minimum of six (6") inches away from the foundation. The top of the ground rod shall be a minimum of four (4) inches below the ground surface.
- B. A ground rod shall not be required for direct buried fiberglass poles.
- C. A ground plate shall be located at the back of the hand hole of each arterial and collector pole. Ground wire shall be #4 copper wire run through a one-half (1/2) inch conduit in the foundation to the grounding plate. Ground wire shall not be exposed.
- D. In addition to the ground rod and wire for arterial and collector poles, a complete grounding system shall be provided for the entire lighting installation. Grounding shall consist of all necessary ground cables, conduits, ground rods, wires or straps, and ground fittings as required by the NEC and in conformance with the plans.

706.8 Street Light Wiring

- A. Wiring size and type for the street lighting circuit shall be as specified by the design engineer and in the plans.
- B. Lighting conduit shall be as specified in Section 702.6 Traffic Signal, Lighting, and Communication Conduit.
- C. One 20 amp in-line fuse shall be used per luminaire, located at the hand hole of each pole.

706.9 Arterial and Collector Pole Painting

A. General

Arterial and collector poles and luminaire arms shall not be painted unless otherwise specified in the plans or at the direction of the Development Engineering Manager. In order to be acceptable, painted poles and luminaire arms furnished by the Responsible Party 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 Development Engineering Manager. The Responsible Party shall be required to furnish the Development Engineering Manager with a notarized certificate of compliance from the pole and luminaire arm manufacturer that guarantees that the Capitalization of letters shall be in compliance with the MUTCD, latest revision. The coating system used is in compliance with these specifications and is free of defective workmanship.

B. Steel Pole and Luminaire Arm Painting

If painting is specified steel poles and luminaire arms, all exterior surfaces of steel poles and luminaire arms shall be primed and painted mocha-brown or beige, in accordance with Section 702.9 Protective Coatings for Signal Poles with Mast Arms and Pedestal Poles.

C. Aluminum Pole and Luminaire Arm Painting

Unpainted aluminum poles and luminaire arms shall have a clear natural anodized finish. If painting is specified for aluminum poles and luminaire arms, the requirements of this specification shall be met.

Wrapping and packaging, handling and shipment, delivery and acceptance of poles, field touch-up, and warranty shall be in accordance with Section 702.9 H, I, J, K, and L.

1. Surface Preparation for Aluminum Exterior Coating System
 - a. Exterior surfaces of poles shall be abrasive blasted in accordance with coating manufacturer's recommendations.
 - b. Luminaire arms and component parts shall be chemically cleaned with a suitable water based cleaner or solvent in accordance with coating manufacturer's recommendations.
2. Requirement of Aluminum Exterior Coating System
 - a. A primer coat is not required for above ground aluminum poles and luminaire arms. An epoxy primer shall be used on any pole surface embedded directly into soil.
 - b. The color topcoat shall consist of two (2) coats of triglycidyl isocyanurate (TGIC) Hybrid or super durable polyester powder 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 color topcoat shall meet the following requirements:
 - i. Have a pencil hardness of 1H.
 - ii. Have a minimum impact resistance of eighty (80) inch pounds.
 - iii. Have a minimum adhesion level of three (3).
 - iv. Have minimum salt spray resistance of 250 hours.
 - c. 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" shall be used as specified in the plans or at the direction of the Development Engineering Manager.
3. Application of Aluminum Exterior Coating System
 - a. The color topcoat shall be strictly applied according to manufacturer's recommendation.
 - b. 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 or chemical cleaning procedures to be repeated.
 - c. Powder application shall be with electrostatic spray equipment.
4. Aluminum Exterior Coating System Drying and Curing
 - a. The color topcoat shall be cured in a convection oven according to the specific cure temperature and cycle required by the power manufacturer to ensure complete dry-through time.

706.10 Street Light Pole Submittals

Submittals shall be required for each type of street light pole and mast arm (if applicable). Submittals shall include:

- A. Street light pole cut sheets
- B. Street light luminaire arm cut sheets (if applicable)
- C. Interior (if applicable) and exterior protective coating system cut sheets, specifications, and documentation
- D. Written product warranties

707 SCHOOL ZONE FLASHING LIGHTS

A. General

1. SZFL's shall be installed on new 15 foot pedestrian poles. Each SZFL assembly shall consist of:
 - a. Three (3) black 12 inch polycarbonate signal heads with tunnel visors and yellow LED faces.

- b. Three (3) Pelco upper and lower arm assemblies model number SE-3215 or approved equal. All mounting hardware to be black in color.
 - c. One (1) S5-1 School Speed sign. Sign to be 24 inches by 48 inches with diamond grade sheeting and 3M #1160 protective overlay. The sign shall be black lettering on a white background. The background for the word "SCHOOL" shall be fluorescent yellow.
 - d. One (1) R2-6 Fines Higher sign. Sign to be 24 inches by 10 inches with diamond grade sheeting and 3M #1160 protective overlay. The sign shall be black lettering and border on a white background.
- 2. Each AC-powered SZFL assembly shall also include one (1) Pelco cabinet, model number SE-1004 with Eltec NTC-17E clock, 204 flashers, and mounting hardware. All devices shall be mounted on a back plate and fully wired for operation. The cabinet shall be mounted to the side of a pedestrian pole. Mounting hardware for the cabinet shall be compatible with a four (4) inch diameter pedestrian pole.
 - 3. Each solar-powered SZFL assembly shall also include one (1) Eltec solar panel with mounting hardware and one (1) Eltec battery cabinet with mounting hardware, prewired and equipped with an Eltec NTC-17E clock, FS-2 flasher, Prostar controller, and AGM sealed deep cycle batteries. The number of batteries, the wattage of the Prostar controller, size of the solar panel shall be per manufacturer's recommendation to power three (3) twelve (12) inch yellow signal faces. The solar panel and battery cabinet shall be mounted to the side of a pedestrian pole. Mounting hardware for the solar panel and battery cabinet shall be compatible with a four (4) inch diameter pedestrian pole.
 - 4. The use of solar-powered SZFL assemblies shall only be approved specifically in writing by the Development Engineering Manager.

In United Power territory, the Responsible Party shall install a meter housing as required in the plans for the each AC-powered SZFL assembly or group of AC-powered SZFL assemblies. The Responsible Party shall coordinate with Xcel Energy or United Power 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.

- 6. All work shall be done in accordance with these specifications, the latest revision of the MUTCD published by the Federal Highway Administration and the latest Colorado supplement thereto, the SSRBC. The actual location for the SZFL assembly will be determined by the Development Engineering Manager at the time of construction.

B. Installation

- 1. Installation shall be in accordance with the plans, the manufacturer's recommendations, the MUTCD, and these Standards and Specifications.
- 2. Devices shall be covered until final activation.
- 3. Existing speed limit signs shall not be removed until final activation.

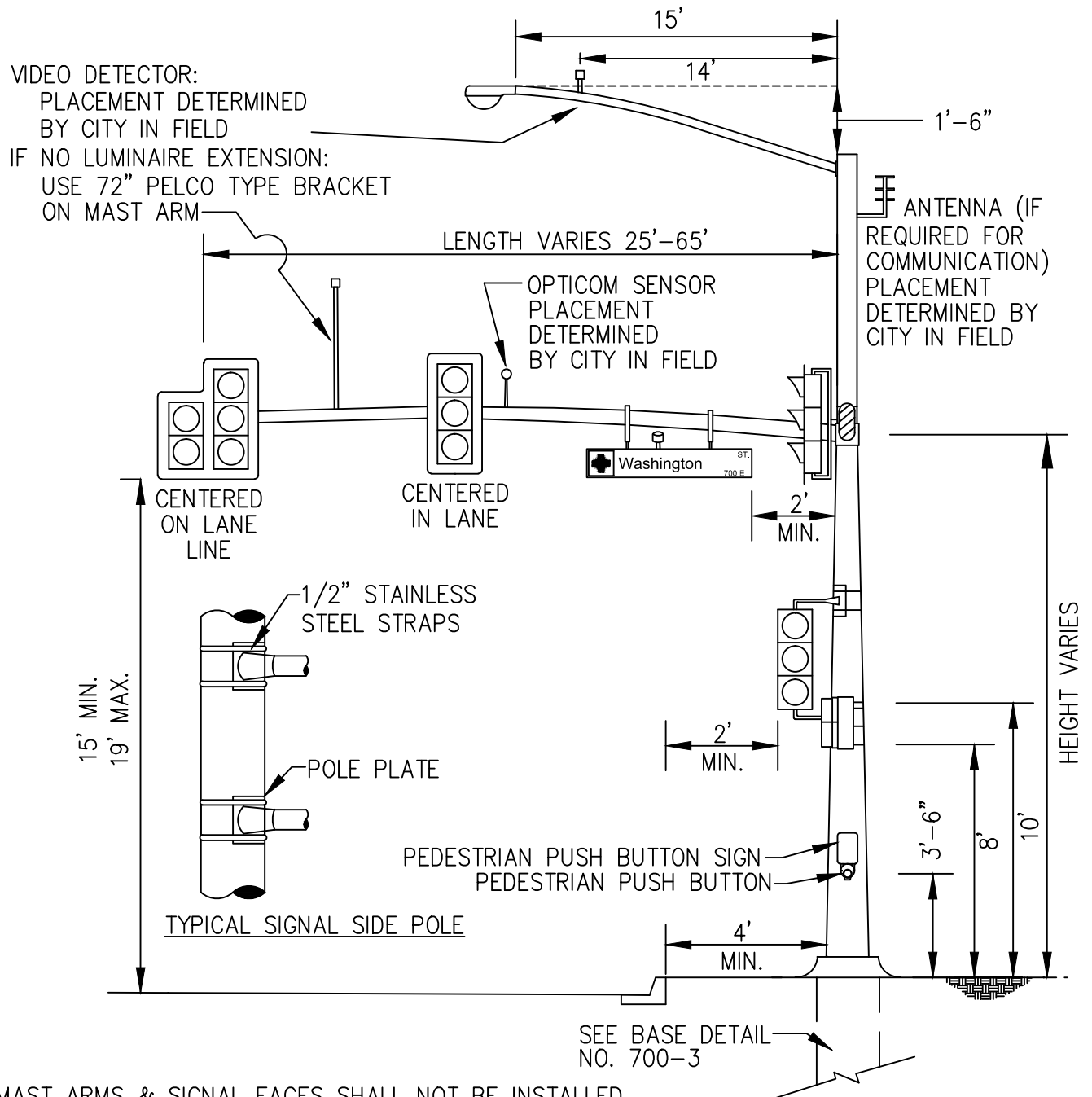
708 GLOBAL POSITIONING SYSTEM

- A. 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, and street light poles. The elevation datum shall be based upon the North American Vertical Datum 1988 (NAVD 88).
- B. The GPS data collected shall be provided to the City in an AutoCAD drawing format using model space.
- C. The AutoCAD drawings shall include a note describing how the coordinates were established along with the primary control points that were used.
- D. The AutoCAD information shall be incorporated into the asbuilts for the project.
- E. The horizontal and vertical positional accuracy of the data collected shall be within a tolerance of ± 0.3 feet.

THIS PAGE IS A BLANK PLACEHOLDER FOR DOUBLE-SIDED PRINTING

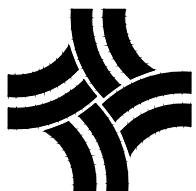
LUMINAIRE EXTENSION, ARM & WIRING TO BE INSTALLED BY CONTRACTOR

LUMINAIRE LIGHT, HOUSING, BULB, ETC., TO BE INSTALLED BY XCEL OR UNITED POWER



MAST ARMS & SIGNAL FACES SHALL NOT BE INSTALLED
UNTIL FIVE (5) DAYS OR LESS PRIOR TO ACTIVATION
UNLESS APPROVED BY THE TRAFFIC ENGINEER.

N.T.S.



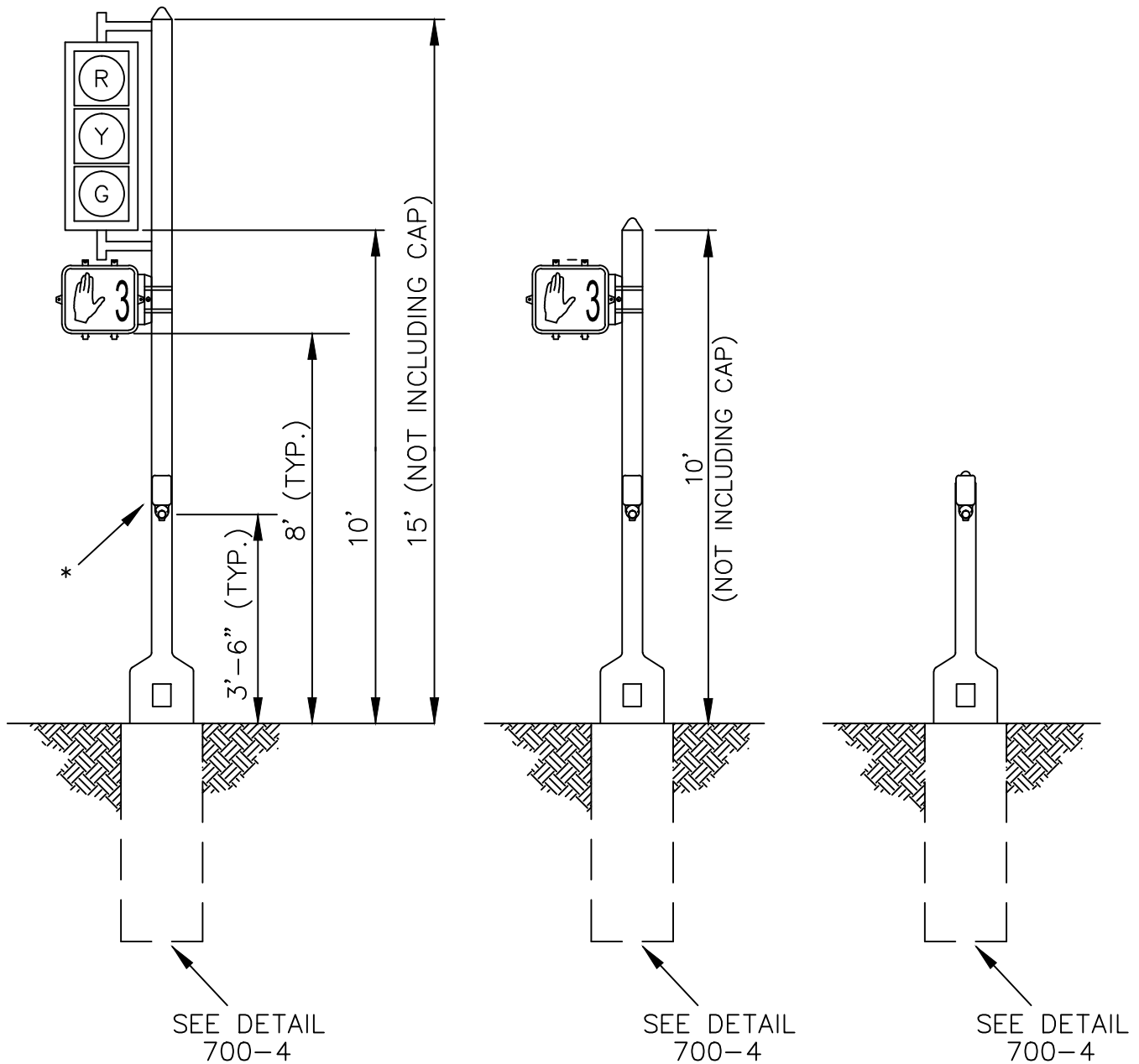
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL SIGNAL INSTALLATION

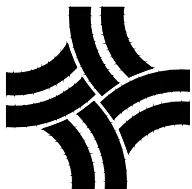
ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-1

* PEDESTRIAN PUSH BUTTON (TYPICAL)
 (PUSH BUTTON AND SIGN TO
 BE ORIENTED AS DIRECTED
 BY THE TRAFFIC ENGINEER)

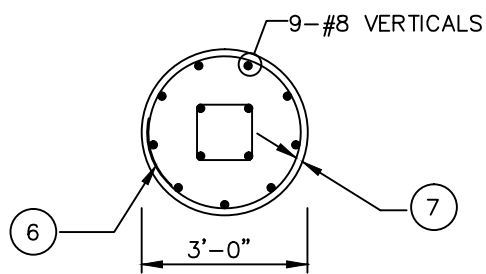


N.T.S.

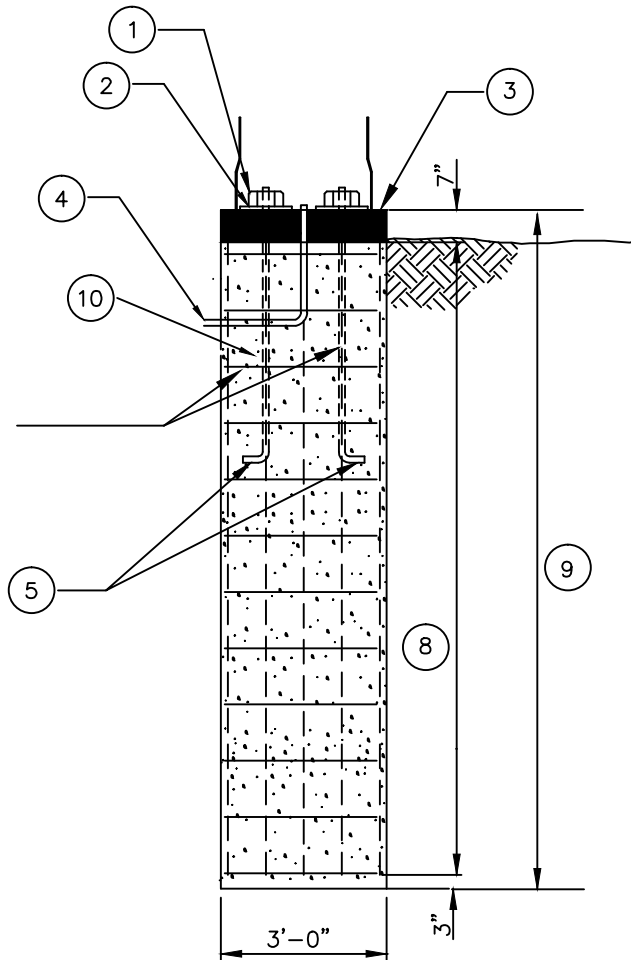


CITY OF THORNTON, COLORADO
 STANDARDS & SPECIFICATIONS
 TYPICAL PEDESTRIAN POLE
 INSTALLATION

ISSUED:
 FEBRUARY 2003
 REVISED:
 APRIL 2010
 DRAWING NO.
 700-2



2-#4 STIRRUPS
AT 6"± AROUND
ANCHOR BOLTS

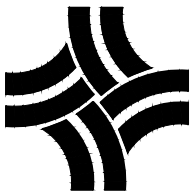


FOOTING NOTES

- | | |
|--|--|
| (1) HEX NUTS | (5) INSTALL ANCHOR BOLTS (FURNISHED WITH POLE) PER MANUFACTURER'S TEMPLATE PRINT (FURNISHED WITH ORDER) |
| (2) SQUARE NUTS | (6) MINIMUM OVERLAP 12" |
| (3) 4"-7" MIN. NON-SHRINKABLE GROUT OVER ROUGH FOUNDATION | (7) 1-1/2" CLEARANCE FOR HOOPS |
| (4) RIGID CONDUIT (24" MIN. DEPTH, 30" MIN. DEPTH UNDER ROADWAY) CONDUIT STUB FROM PULL BOX TO POLE SHALL BE 3" DIA. | (8) 15 - #4 HOOPS AT +/- 12" FOR 15' FTG.
12 - #4 HOOPS AT +/- 12" FOR 12' FTG. |
| | (9) USE 15' FOOTING FOR POLES WITH MAST ARMS 45' IN LENGTH OR LONGER.
USE 12' FOOTING FOR POLES WITH MAST ARMS LESS THAN 45' IN LENGTH. |
| | (10) ALL INSTALLATIONS TO BE PROPERLY GROUNDED. |

CAISSON DESIGNS REQUIRE THAT THE CAISSON BE FOUNDED IN COMPACT SAND, CLAY, OR SANDY CLAY. IF BY VISUAL INSPECTION OF THE HOLE OTHER MATERIAL IS PRESENT, THE CAISSON DESIGN SHALL BE MODIFIED AS DETERMINED BY THE RESPONSIBLE PARTY'S ENGINEER.

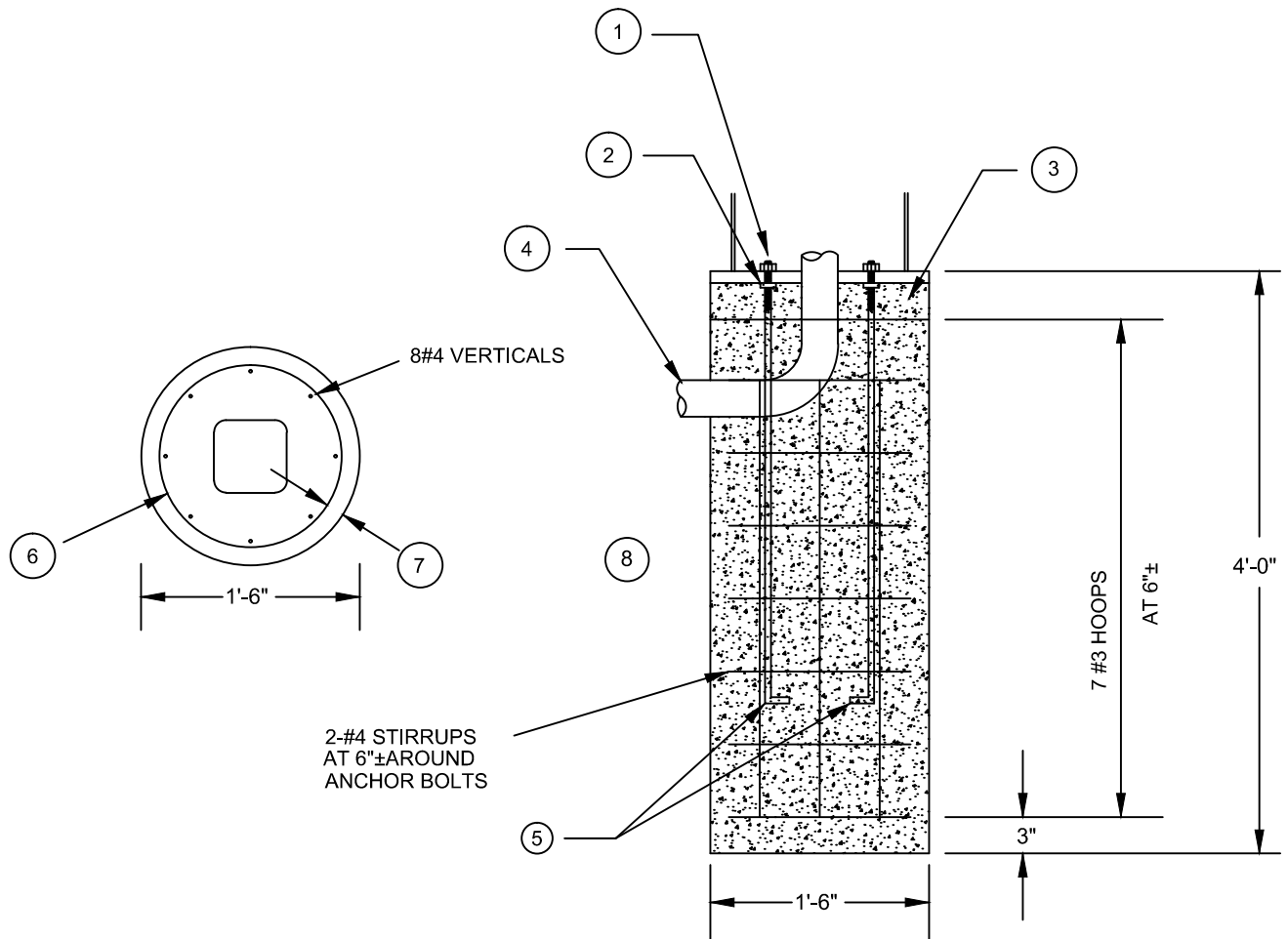
N.T.S.



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL TRAFFIC SIGNAL POLE FOOTING INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010
DRAWING NO.
700-3

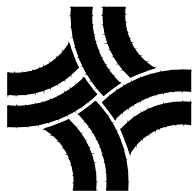


FOOTING NOTES

- | | |
|--|---|
| ① HEX NUTS | ⑤ INSTALL ANCHOR BOLTS (FURNISHED WITH POLE) PER MANUFACTURER'S TEMPLATE PRINT (FURNISHED WITH ORDER) |
| ② SQUARE NUTS | ⑥ MINIMUM OVERLAP 12" |
| ③ 4" - 7" MIN. NON-SHRINKABLE GROUT OVER ROUGH FOUNDATION | ⑦ 1-1/2" CLEARANCE FOR HOOPS |
| ④ RIGID CONDUIT (24" MIN. DEPTH, 30" MIN. DEPTH UNDER ROADWAY) CONDUIT STUB FROM PULL BOX TO POLE SHALL BE 3" DIA. | ⑧ ALL INSTALLATIONS TO BE PROPERLY GROUNDED. |

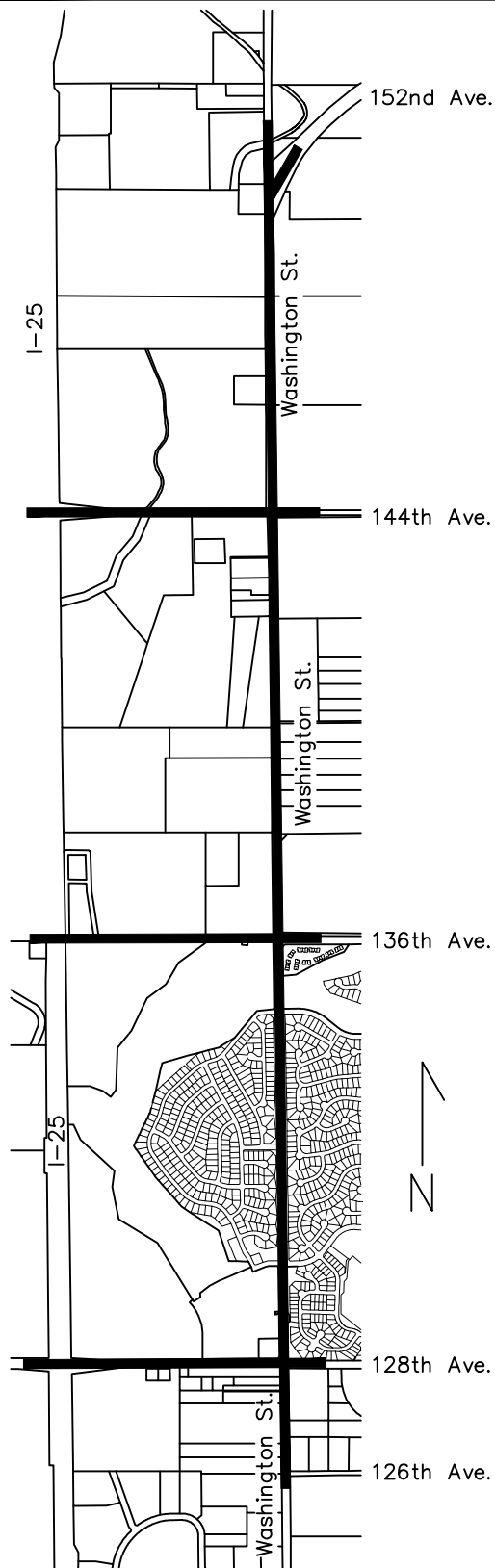
CAISSON DESIGNS REQUIRE THAT THE CAISSON BE FOUNDED IN COMPACT SAND, CLAY, OR SANDY CLAY. IF BY VISUAL INSPECTION OF THE HOLE OTHER MATERIAL IS PRESENT, THE CAISSON DESIGN SHALL BE MODIFIED AS DETERMINED BY THE RESPONSIBLE PARTY'S ENGINEER.

N.T.S.



CITY OF THORNTON, COLORADO STANDARDS & SPECIFICATIONS TYPICAL PEDESTRIAN POLE FOOTING INSTALLATION

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010
DRAWING NO.
700-4



STREET LIGHTS AND TRAFFIC SIGNAL POLES
AND MAST ARMS

TOP COAT BEIGE FEDERAL COLOR #20227
(SEMI-GLOSS), AMERCOAT #450GL
ALIPHATIC POLYURETHANE IN CONJUNCTION
WITH AMERCOAT #71 POLYAMIDE CURED
EPOXY PRIMER

TRAFFIC SIGN POLES

POWDER COATED MOCHA BROWN FEDERAL
COLOR #10075, POWDER RESIN #10075

STRUCTURAL CONCRETE

BEIGE FEDERAL COLOR #30450

I-25 AND BIG DRY CREEK BRIDGE GIRDERS

DARK BROWN FEDERAL COLOR #30117

LETTERING ON I-25 BRIDGE, LIGHT
SCULPTURE CRADLES AT I-25, BIG DRY
CREEK BRIDGE, CORNER MONUMENTS, AND
LETTERS ON THE THORNTON ENTRY SIGN

TIGER DRYLAC METALLIC, POWDER COAT,
#49/90620, ANTIQUE/VEIN COPPER
(SEMI-GLOSS)

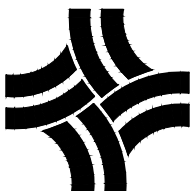
THORNTON ENTRY SIGN BACKGROUND COLOR

DAVIS COLOR MESA BUFF

WHITE SPHERE BRIDGE MONUMENTS

PPG GLACIER WHITE PEARL METALLIC,
CLEAR COAT: DELTA, #DCU 2070

N.T.S.



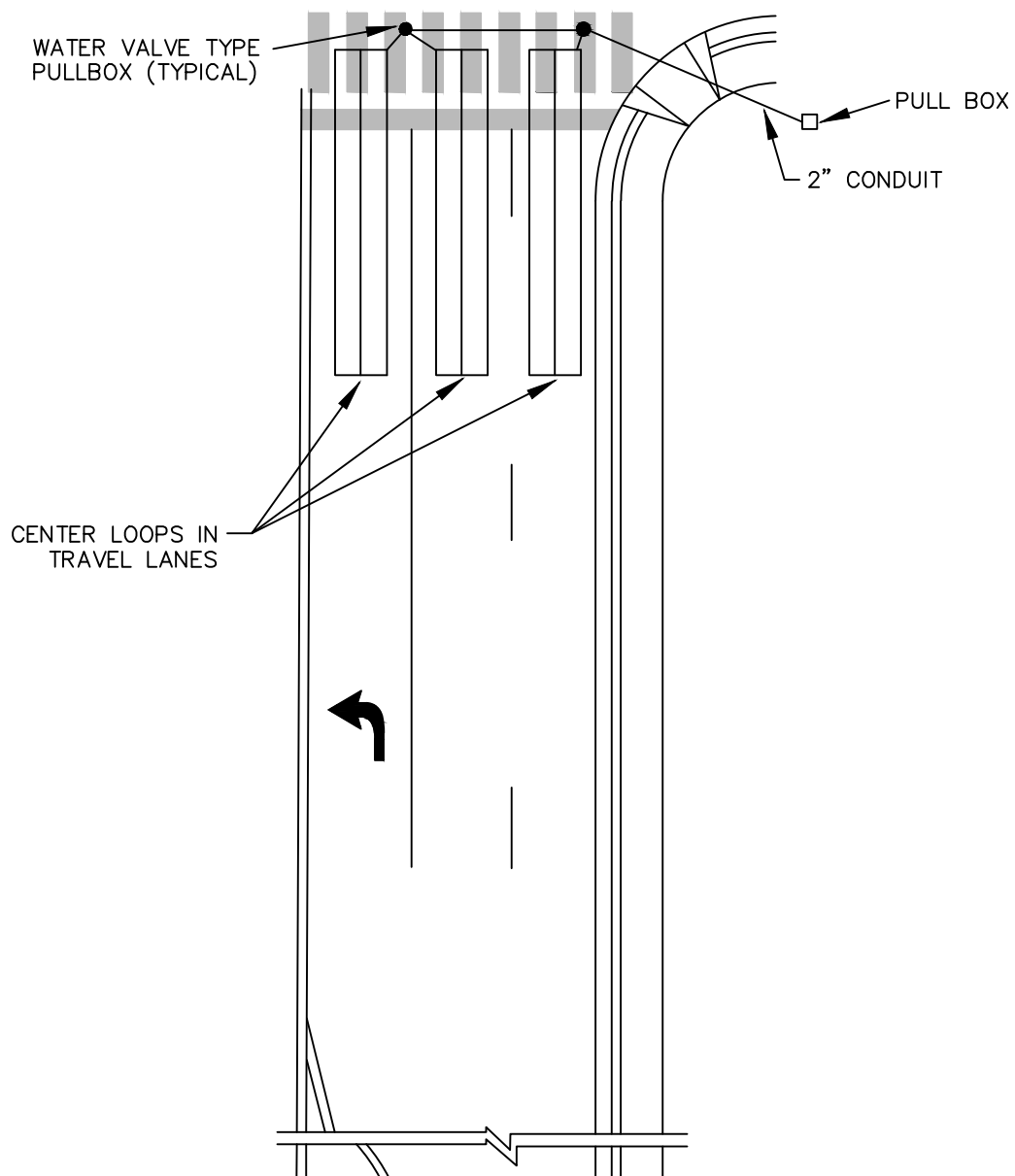
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

EXTERIOR COLORS
WASHINGTON ST CORRIDOR

ISSUED:
JANUARY 2005

REVISED:
APRIL 2010

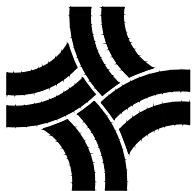
DRAWING NO.
700-5



NOTES:

1. THIS MAY ONLY BE USED WITH WRITTEN AUTHORIZATION OF THE TRAFFIC ENGINEER.
2. ALL LOOPS SHALL BE WIRED FOR SINGLE CHANNEL.
3. SEE PLANS FOR LOCATION AND LENGTH OF EACH DETECTOR.
4. CIRCULAR LOOPS MAY BE USED AS AN ALTERNATIVE.

N.T.S.

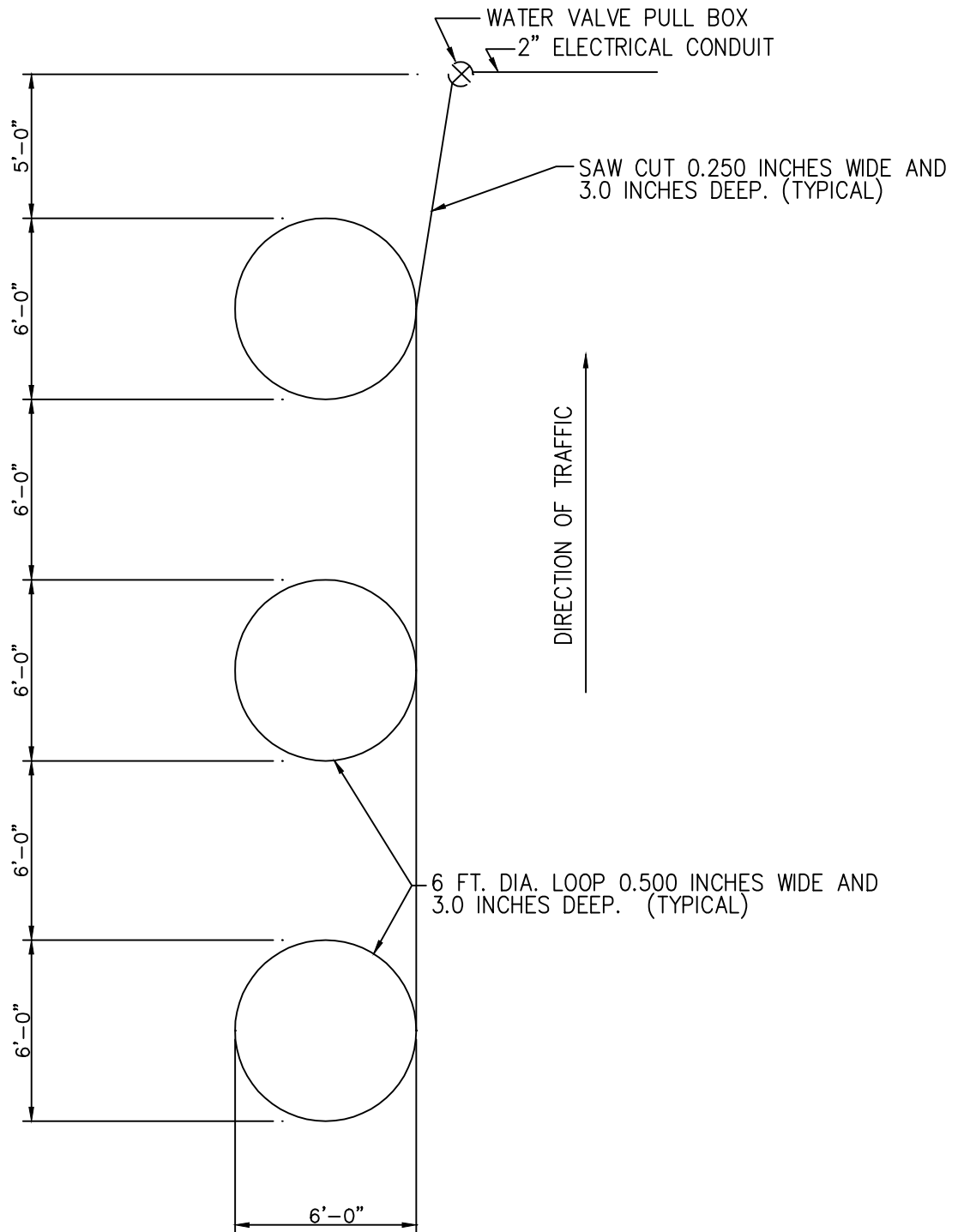


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL LOOP PLACEMENT DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

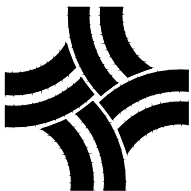
DRAWING NO.
700-6



NOTE:

THIS LOOP DETECTOR MAY ONLY BE USED WITH THE WRITTEN AUTHORIZATION OF THE TRAFFIC ENGINEER.
THIS LOOP DETECTOR CAN BE USED INSTEAD OF 6' x 40' QUADROPOLE LOOP SHOWN ON PLAN.

N.T.S.



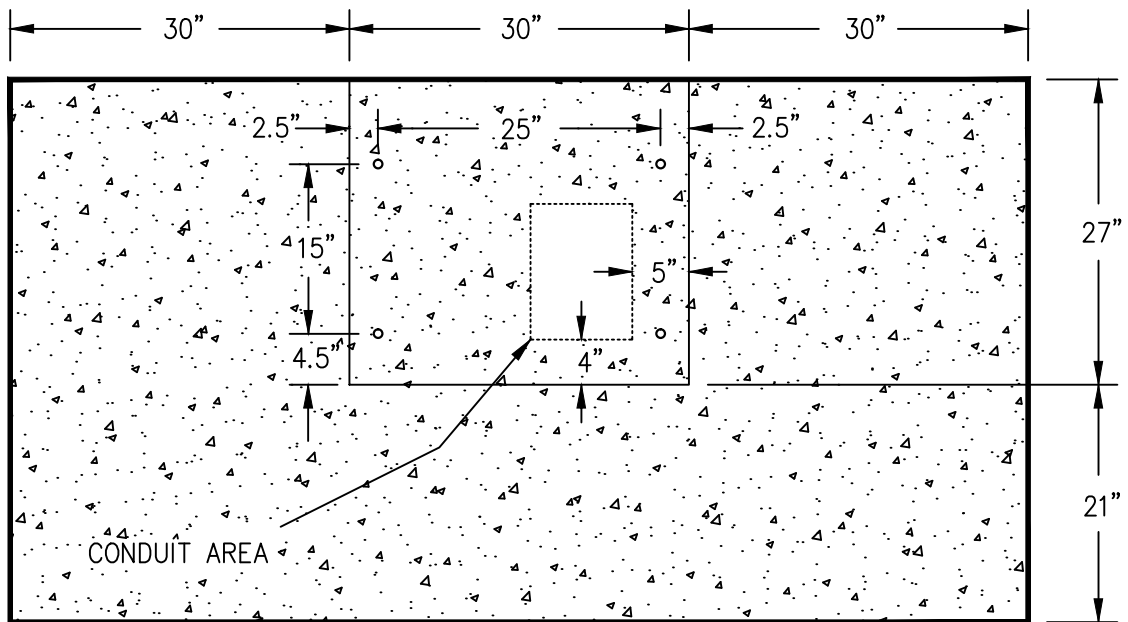
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL ALTERNATIVE ROUND
LOOP LAYOUT

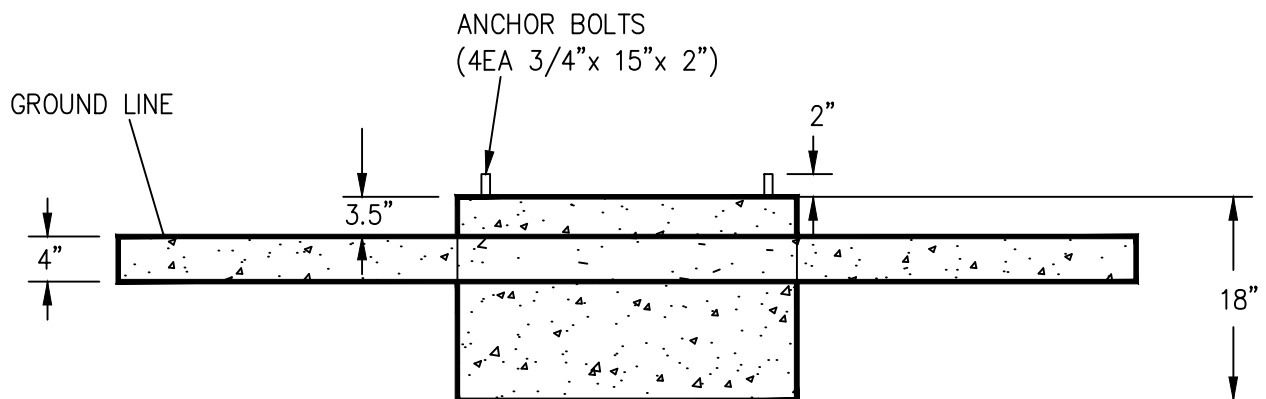
ISSUED:
FEBRUARY 2003

REVISED:
APRIL 2010

DRAWING NO.
700-7



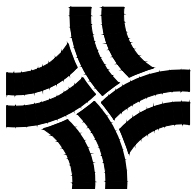
TOP VIEW



FRONT VIEW

NOTE: ALL CONCRETE TO BE CLASS D

N.T.S.



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS
336 CONTROLLER CABINET
FOUNDATION DETAILS

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010
DRAWING NO.
700-9

TYPICAL LAYOUT

COLORS:

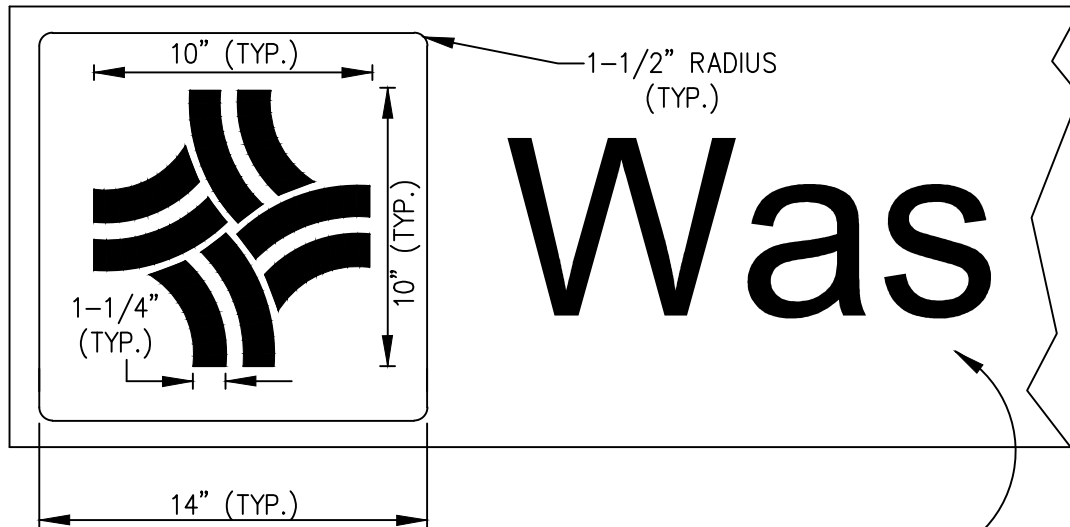
LOGO = PANTONE 300 INTENSE BLUE

LOGO BACKGROUND = WHITE

SIGN FIELD = PANTONE 3435c EMERALD GREEN

STREET NAME LETTERING = WHITE

HOUSING COLOR = PER DRAWING NO. 700-5



TEXT SIZE FOR STREET NAME TO AS LARGE AS POSSIBLE AND
AND STILL MAINTAIN A +/- 1" BORDER AROUND SIGN.

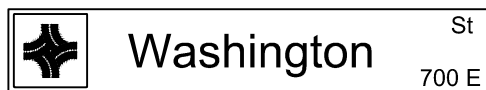
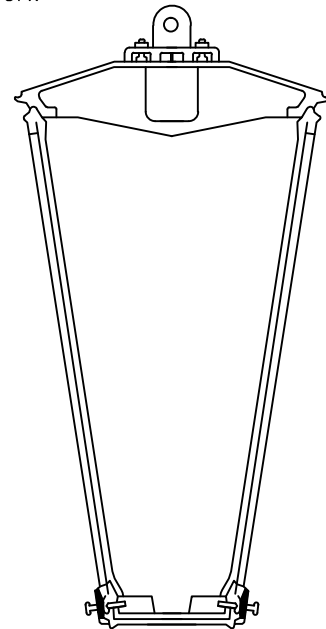
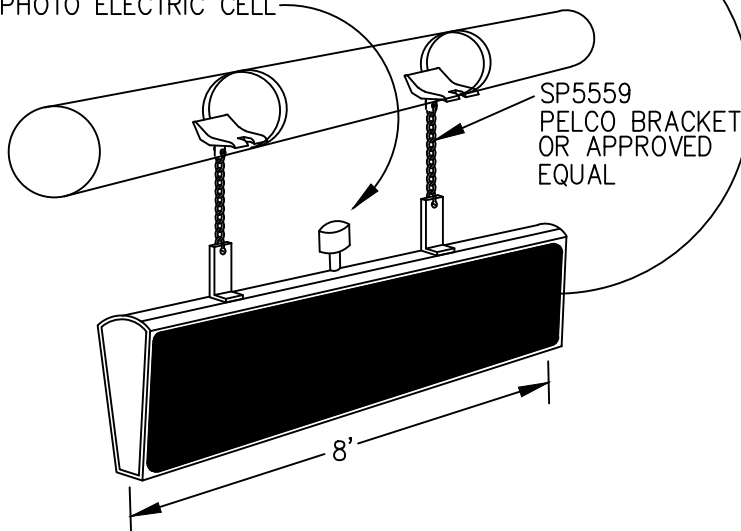
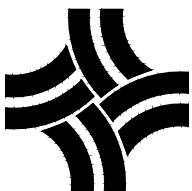


PHOTO ELECTRIC CELL



N.T.S.



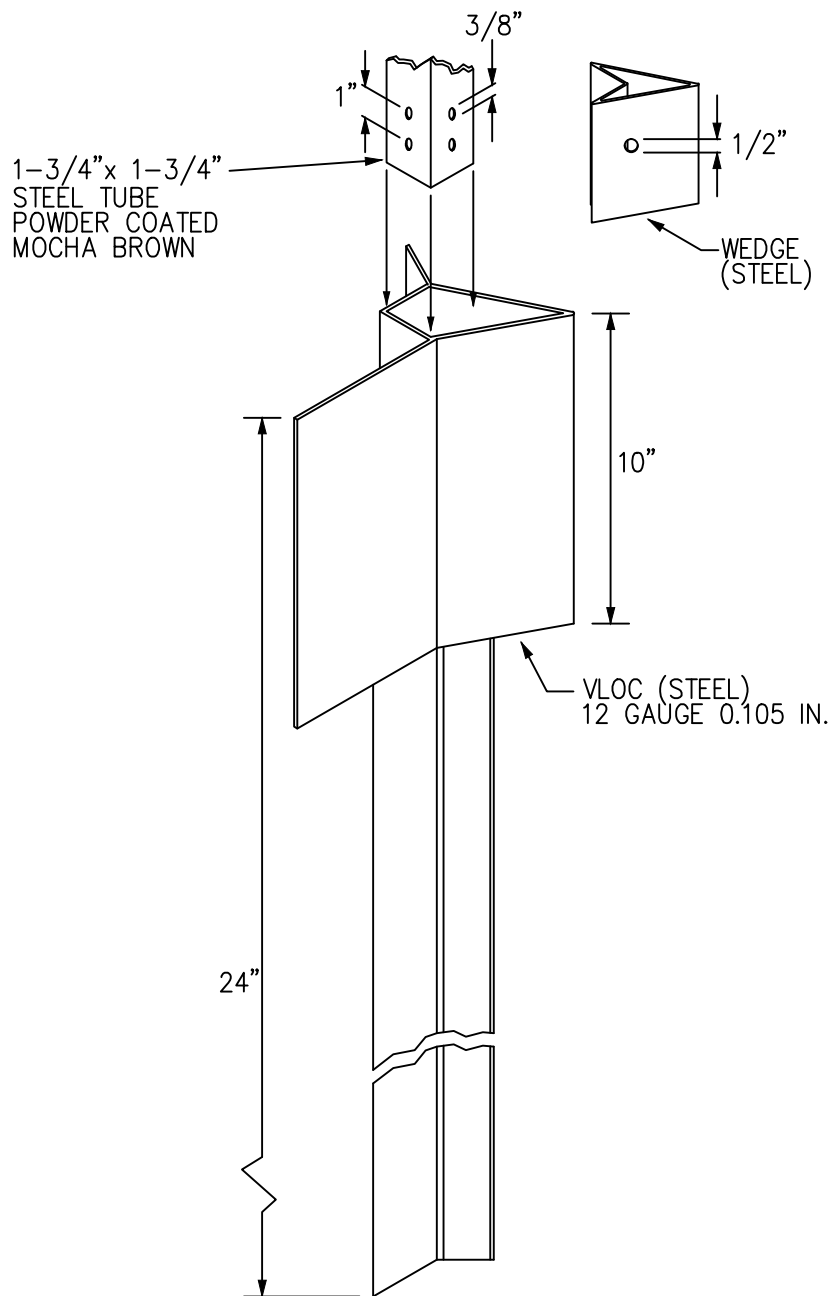
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL ILLUMINATED STREET
SIGN INSTALLATION

ISSUED:
FEBRUARY 2003

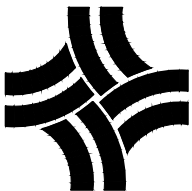
REVISED:
APRIL 2010

DRAWING NO.
700-10



- NOTE: ALL TUBINGS ARE #12 U.S. STD. GAUGE WALL THICKNESS.
SIGN POST INSTALLATION SHALL FOLLOW THE MANUFACTURER'S INSTRUCTIONS AND THESE SPECIFICATIONS:
1. THE SIGN POST ANCHOR SHALL BE DRIVEN INTO THE GROUND TO 1" ABOVE THE GROUND. SIDEWALK SHALL BE POURED AROUND SIGN POST ANCHOR OR EXISTING SIDEWALK SHALL BE CORE DRILLED AND SEALED AROUND THE POST ANCHOR.
 2. INSERT SIGN POST INTO ANCHOR ASSEMBLY 6 INCHES AND INSTALL WEDGE.
 3. INSTALLED SIGN AND POST SHALL BE PLUMB AND FREE OF VERTICAL AND LATERAL MOVEMENT.

N.T.S.

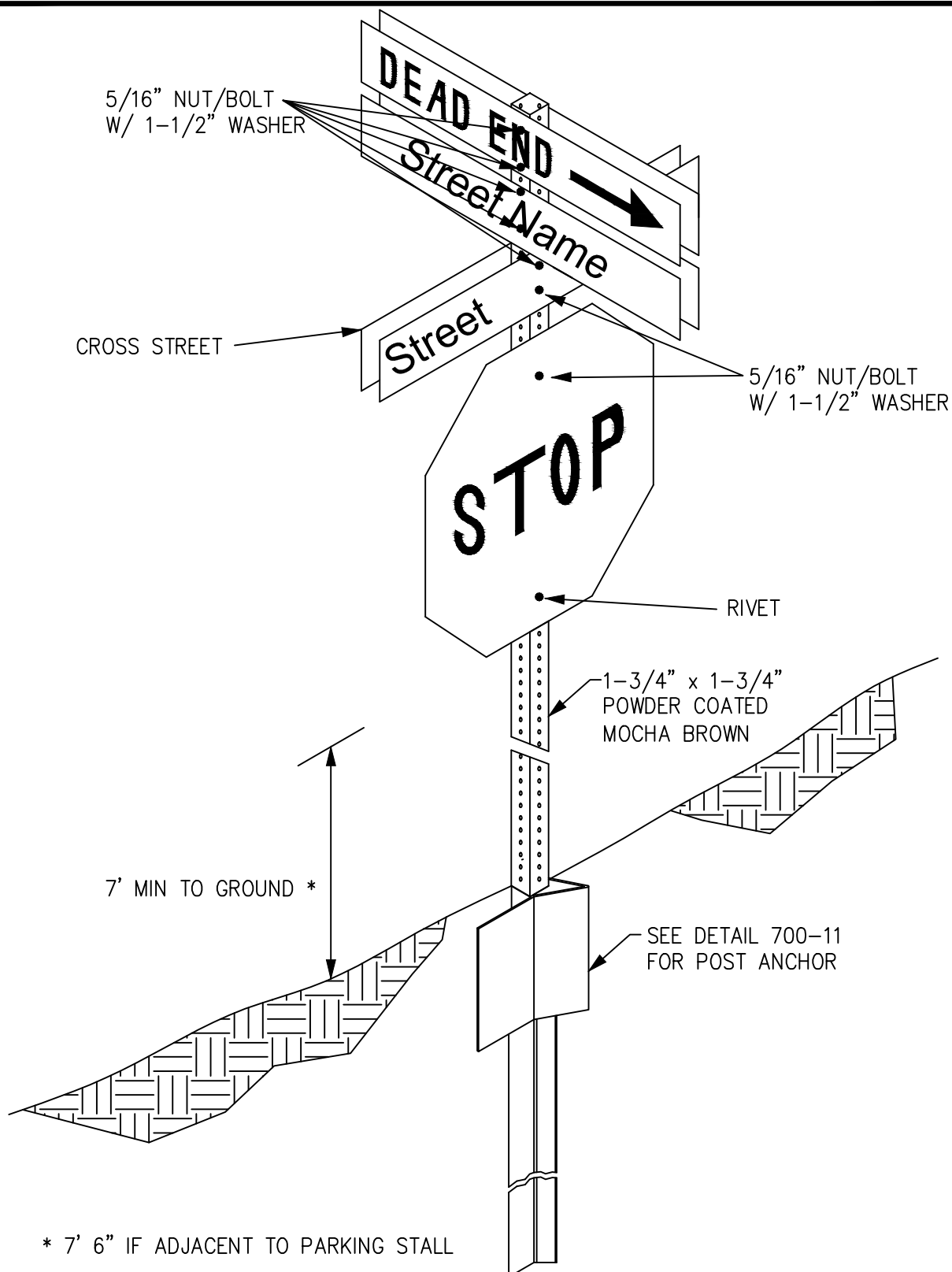


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SIGN POST ANCHOR DETAIL

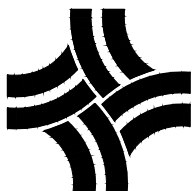
ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010

DRAWING NO.
700-11



NOTE: IF MOUNTED ON STREET LIGHT POLE, USE TWO (2) 1/2" BAND-IT STRAPS

N.T.S.

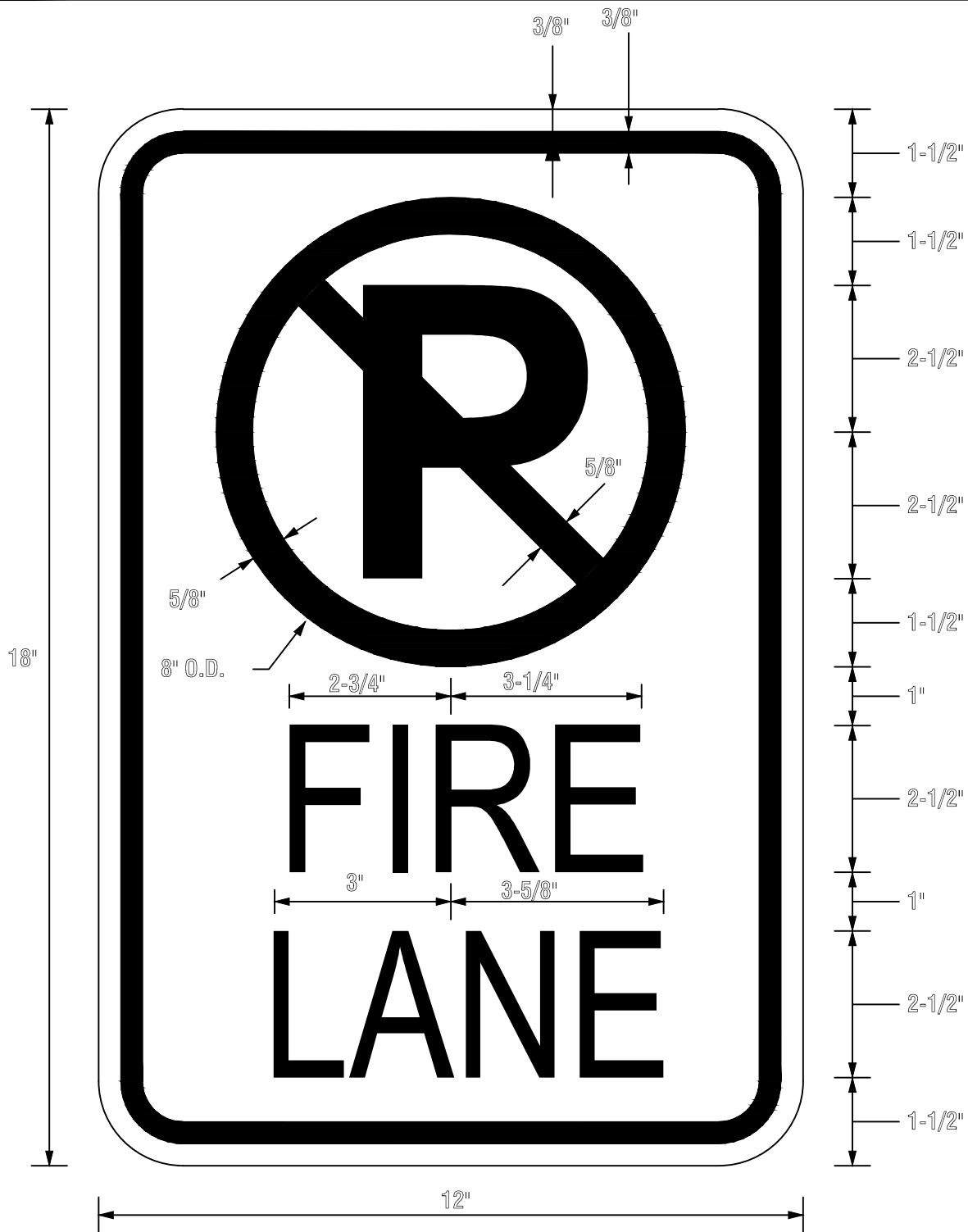


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SIGN ASSEMBLY DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
AUG 2012

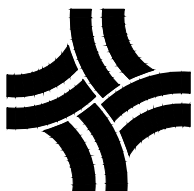
DRAWING NO.
700-12



COLORS:

FIRE LANE, CIRCLE, DIAGONAL - RED
 BACKGROUND - WHITE
 LETTER 'P', BORDER - BLACK

N.T.S.



CITY OF THORNTON, COLORADO
 STANDARDS & SPECIFICATIONS

FIRE LANE – NO PARKING
 REGULATORY SIGN

ISSUED:
 FEBRUARY 2005
 REVISED:
 APRIL 2010

DRAWING NO.
 700-13



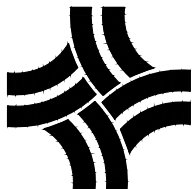
COLORS:

(TOP) RED BACKGROUND, WHITE LETTERING AND SNOWFLAKE

(MIDDLE) WHITE BACKGROUND, BLACK "P", RED CIRCLE & DIAGONAL

(BOTTOM) BLUE BACKGROUND, WHITE LETTERING

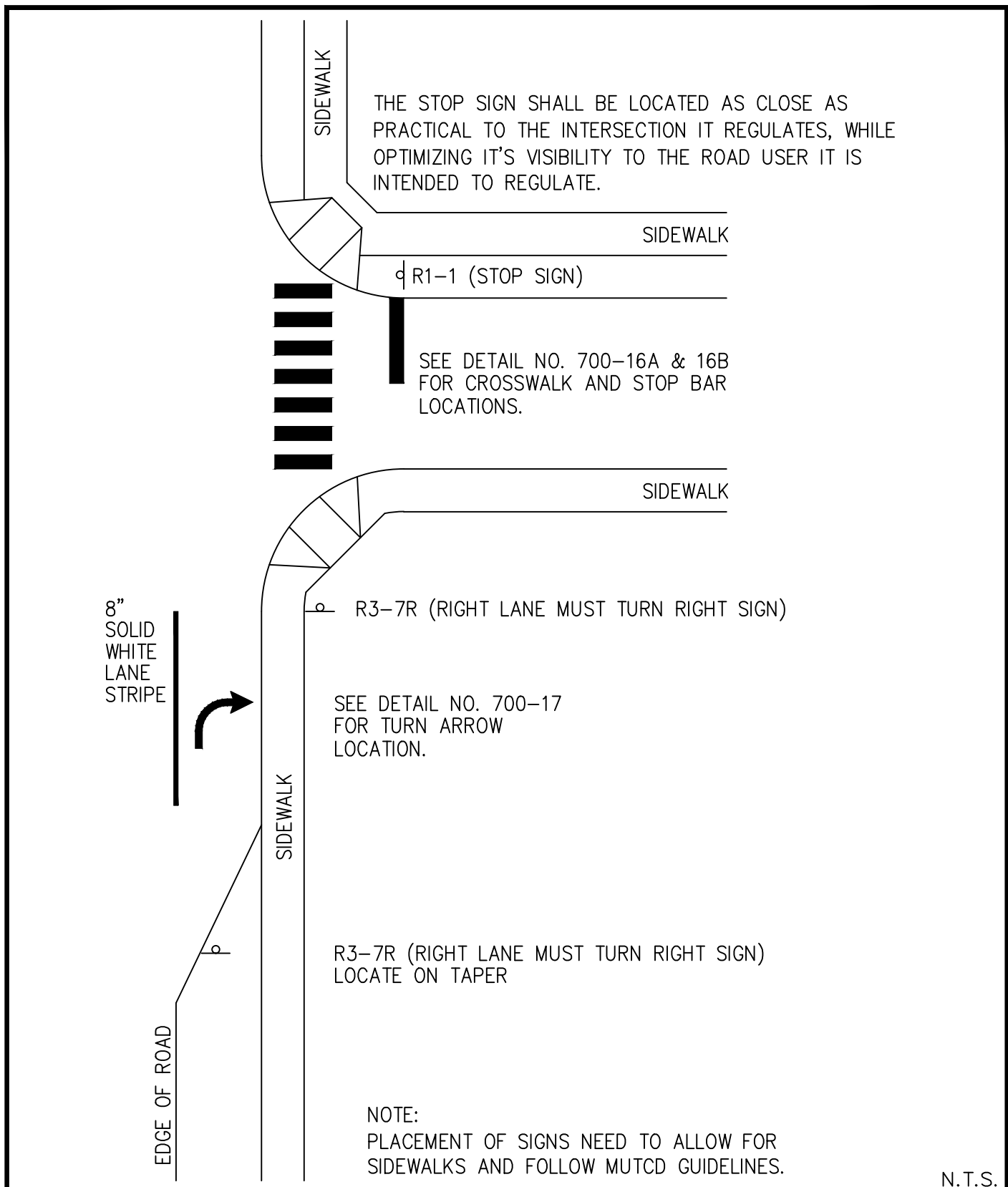
N.T.S.



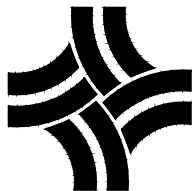
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

SNOW ROUTE – NO PARKING
REGULATORY SIGN

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010
DRAWING NO.
700-13A



N.T.S.



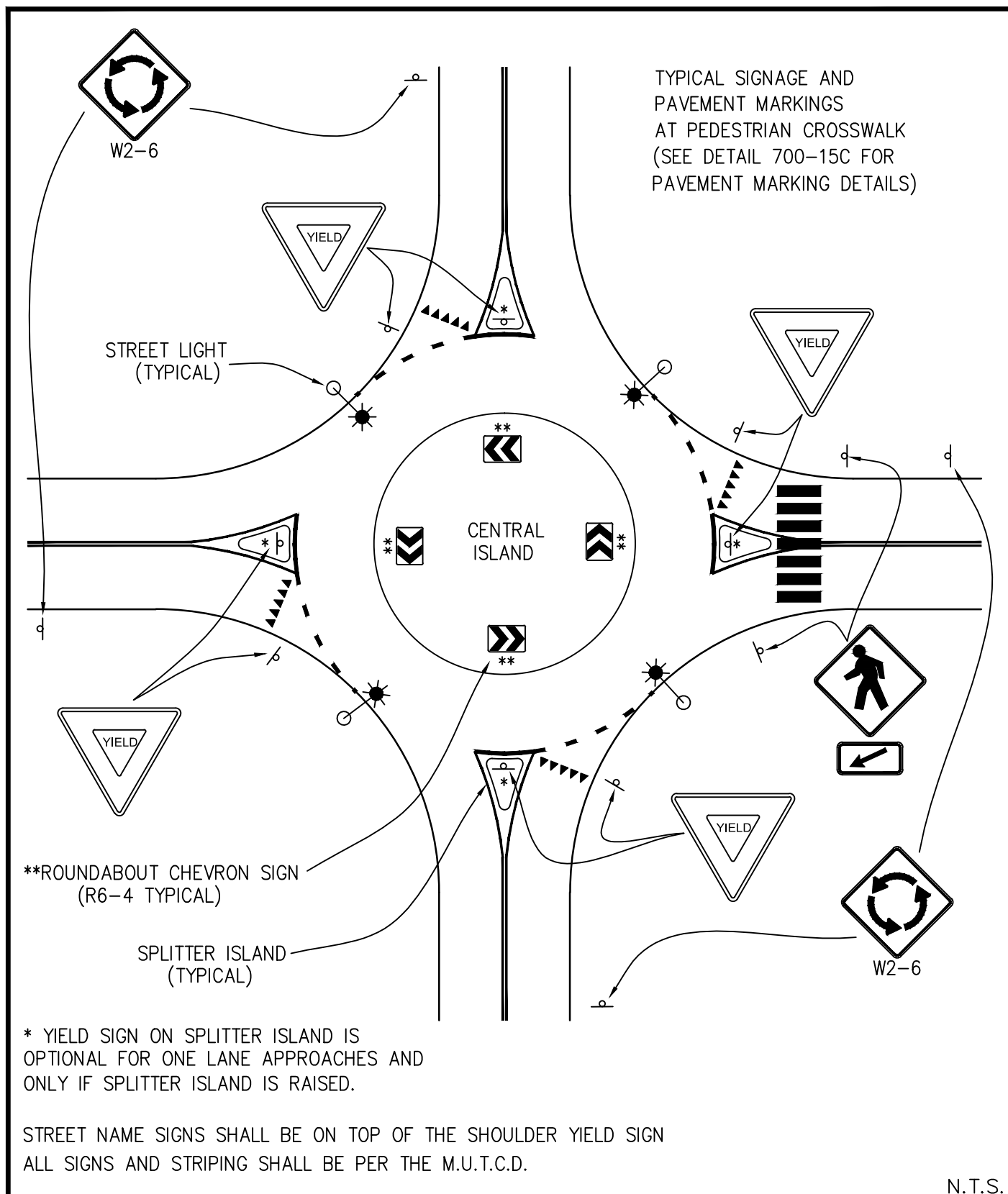
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

PAVEMENT MARKINGS AND SIGN LOCATIONS DETAIL

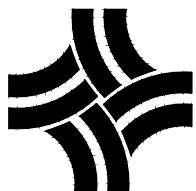
ISSUED:
FEBRUARY 2005

REVISED:
APRIL 2010

DRAWING NO.
700-14



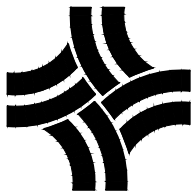
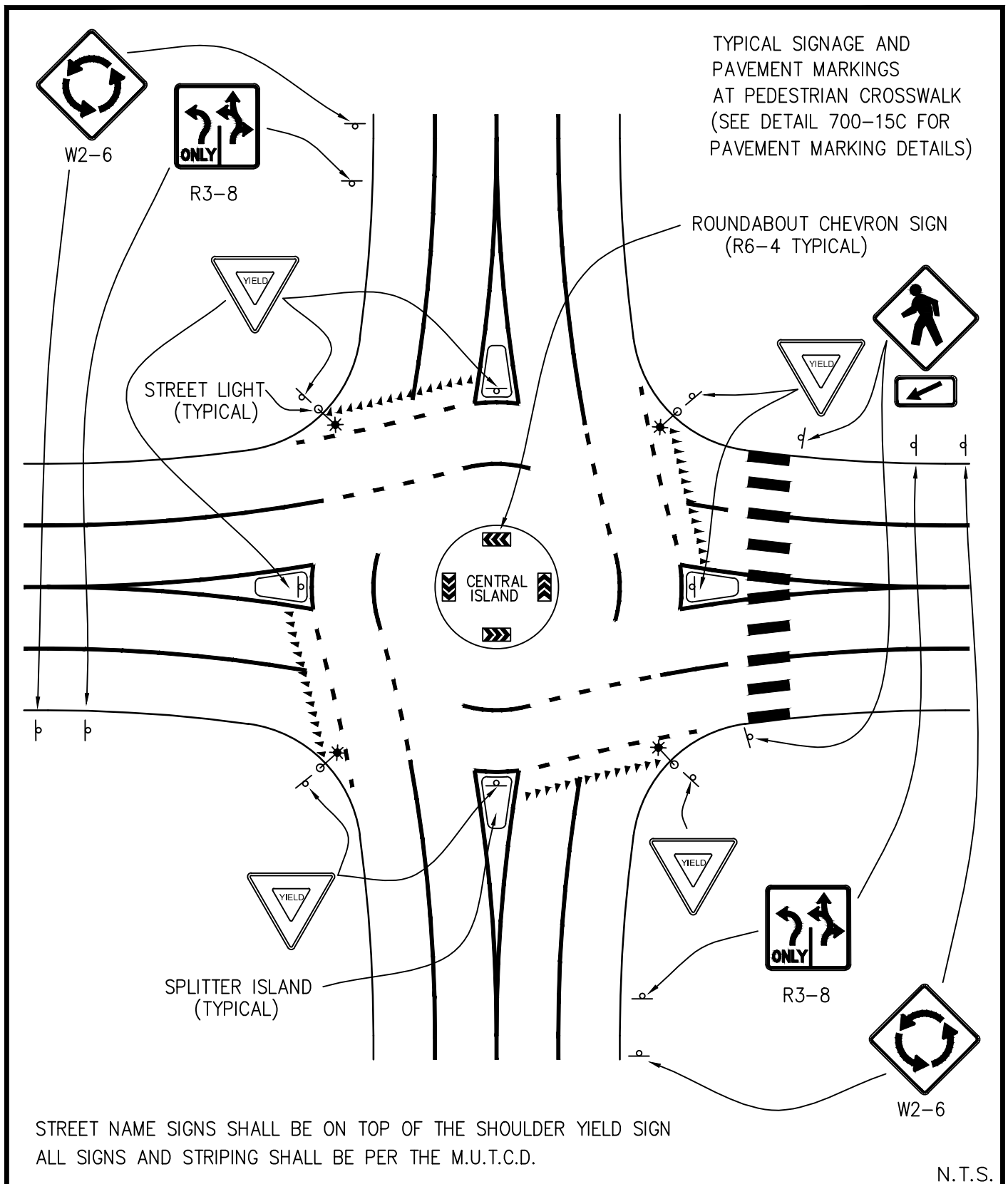
N.T.S.



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS
TRAFFIC CIRCLE SIGN AND
PAVEMENT MARKING STANDARDS
WITH STREET LIGHT PLACEMENT

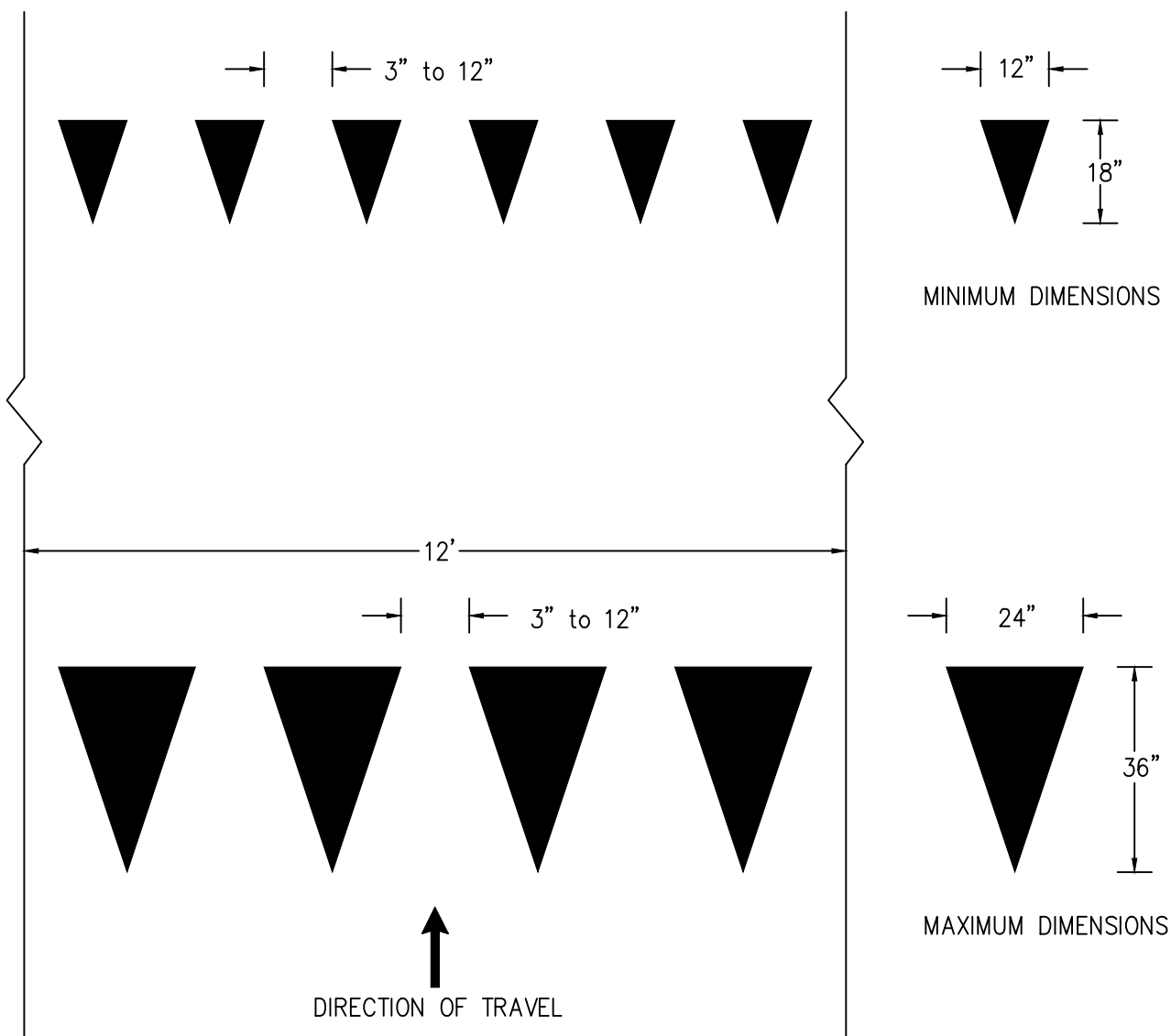
ISSUED:
FEBRUARY 2005
REVISED:
AUG 2012

DRAWING NO.
700-15A



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS
TRAFFIC CIRCLE/MULTI-LANE SIGNS &
PAVEMENT MARKING STANDARDS W/
STREET LIGHT PLACEMENT

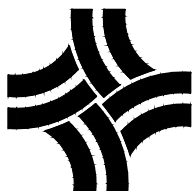
ISSUED:
JANUARY 2005
REVISED:
APRIL 2010
DRAWING NO.
700-15B



NOTES:

1. TRIANGLE LENGTH IS EQUAL TO 1.5 TIMES THE BASE DIMENSION.
2. YIELD LINES MAY BE SMALLER THAN SUGGESTED WHEN INSTALLED ON MUCH NARROWER, SLOW-SPEED FACILITIES SUCH AS SHARED-USE PATHS.

N.T.S.

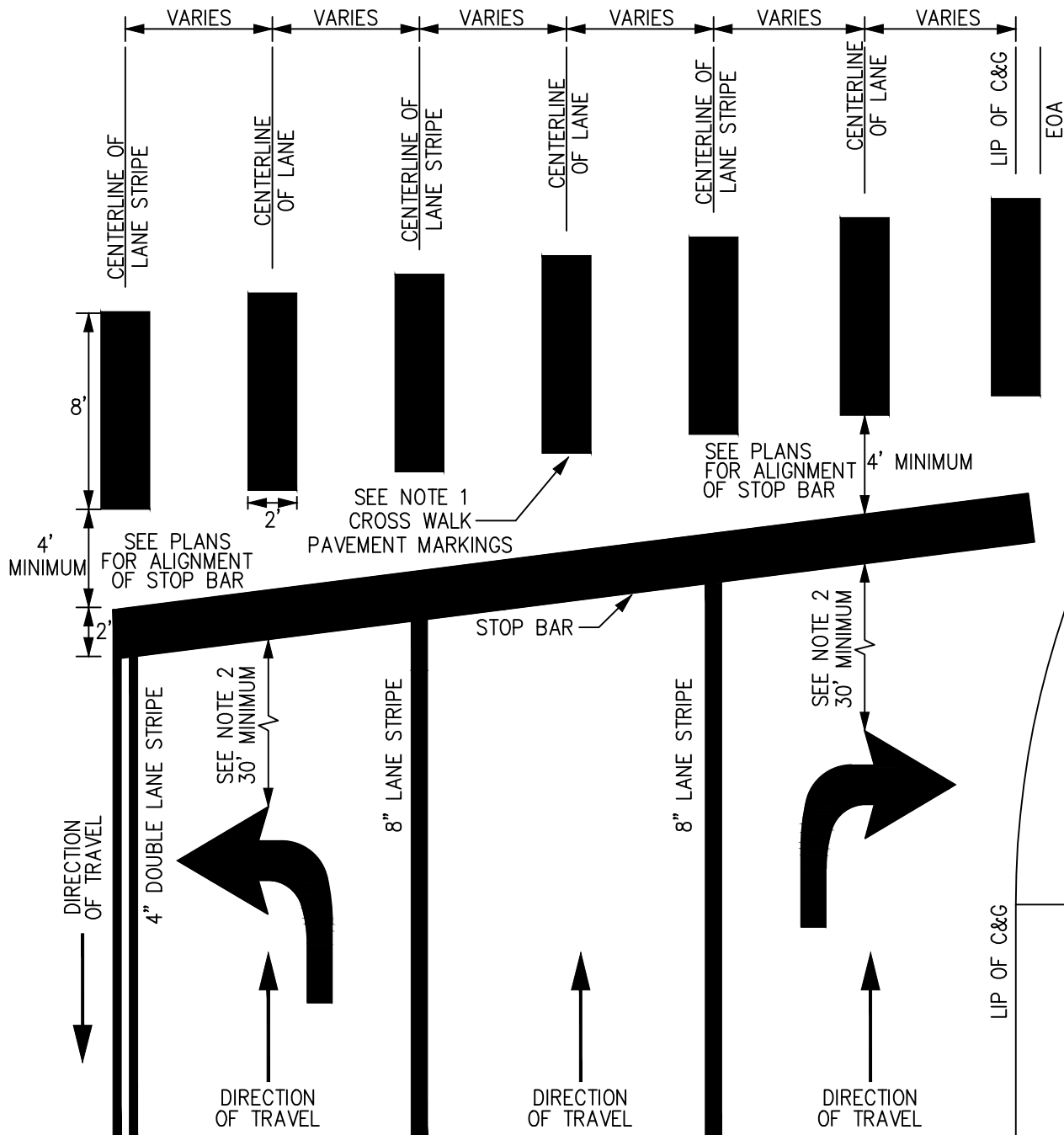


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL YIELD LINE LAYOUT FOR
STREETS AND HIGHWAYS

ISSUED:
JANUARY 2003
REVISED:
APRIL 2010

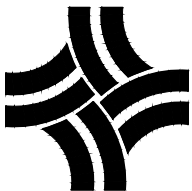
DRAWING NO.
700-15C



NOTES:

1. CROSS WALK PAVEMENT MARKINGS ARE TO BE ALIGNED PARALLEL WITH TRAFFIC FLOW AND CENTERED ON CENTERLINE OF PEDESTRIAN RAMP, UNLESS OTHERWISE DIRECTED.
2. 30' MINIMUM DISTANCE WHEN STORAGE LENGTH EXCEEDS 200 FEET, AND TWO TURN ARROWS ARE REQUIRED.

N.T.S.

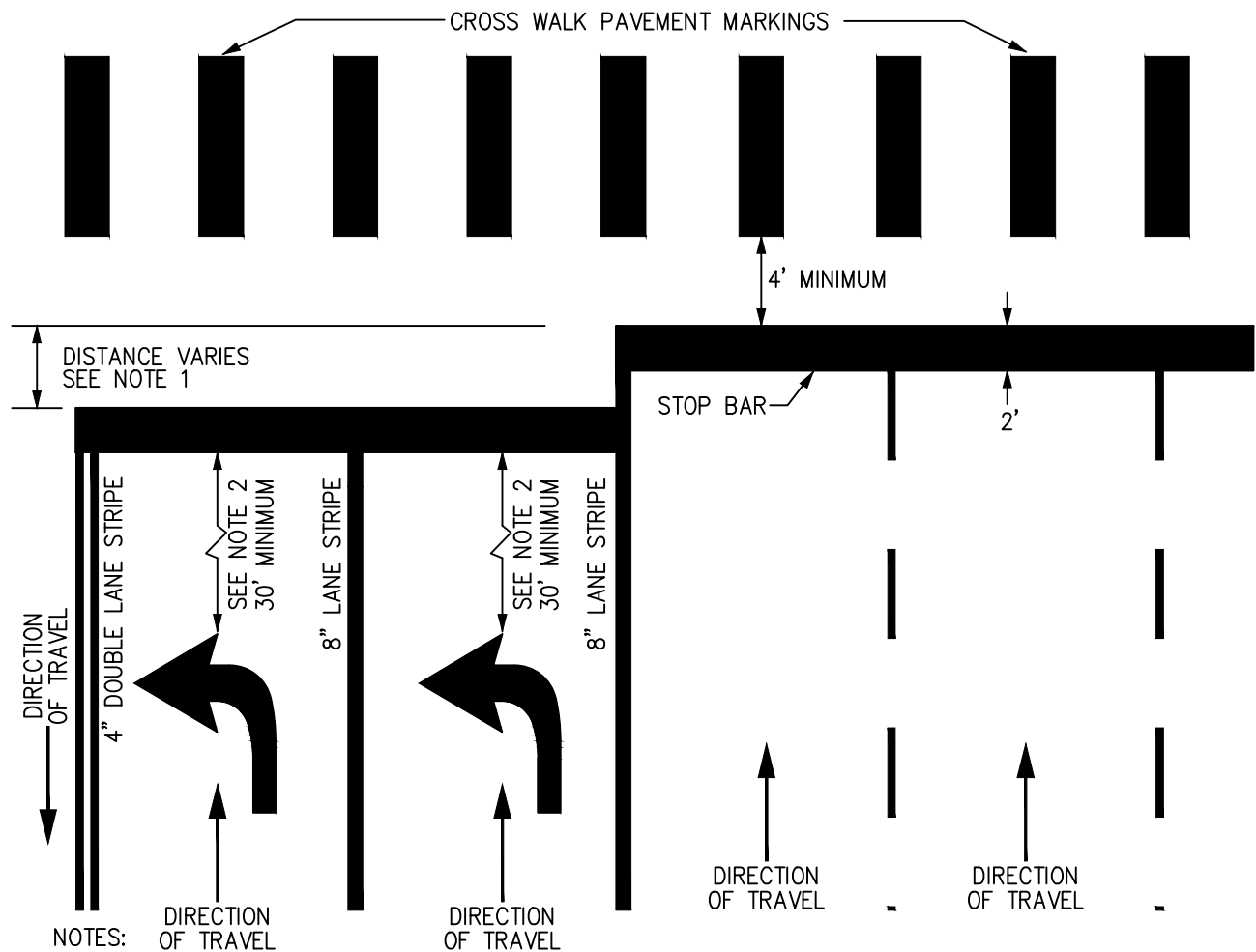


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

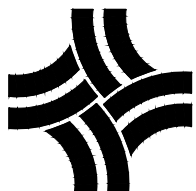
CROSSWALK & STOP BAR
PAVEMENT MARKING DETAIL

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-16A



N.T.S.



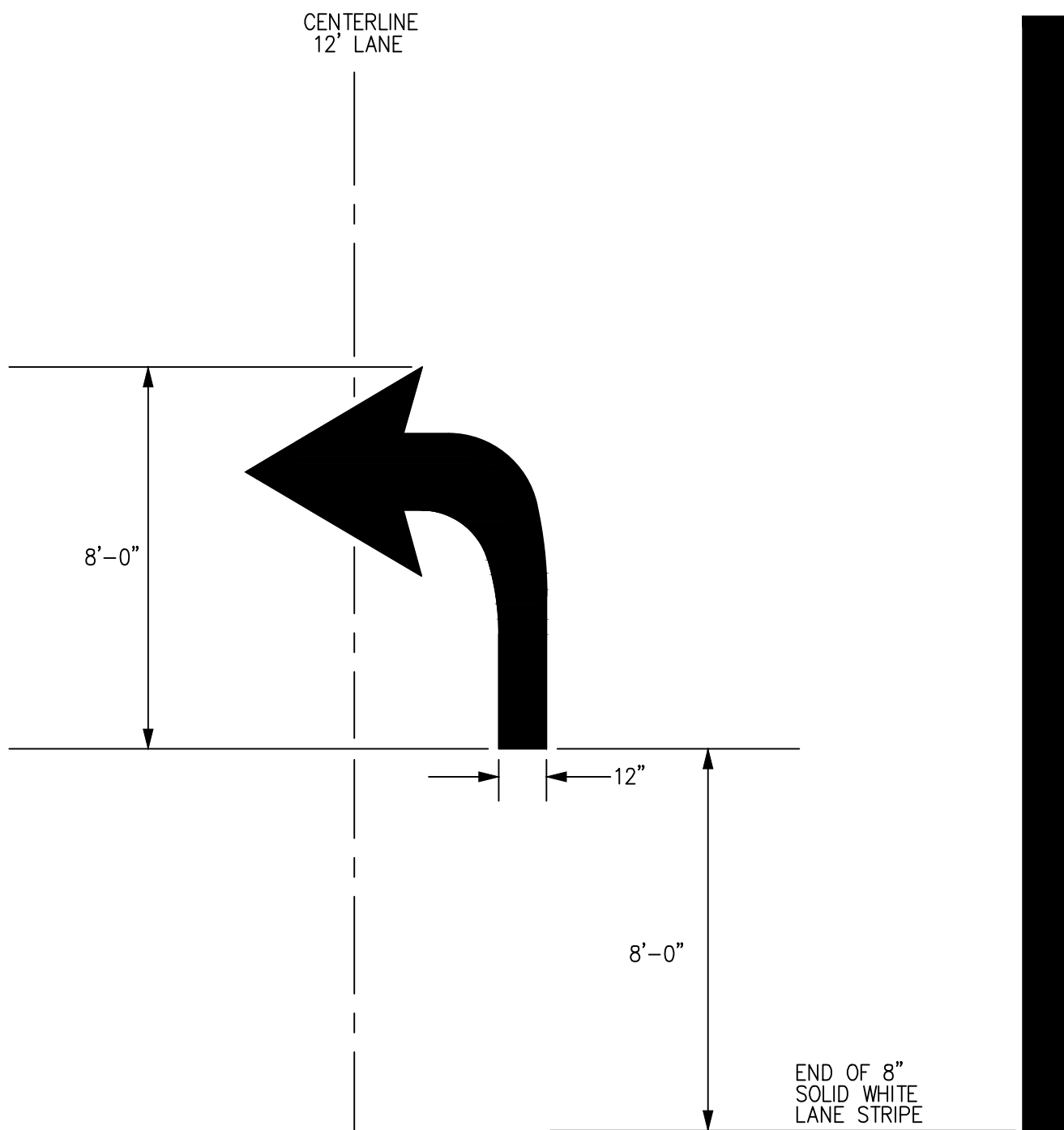
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STOP BAR LAYOUT FOR DOUBLE
LEFT TURNS

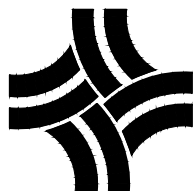
ISSUED:
FEBRUARY 2005

REVISED:
APRIL 2010

DRAWING NO.
700-16B



N.T.S.

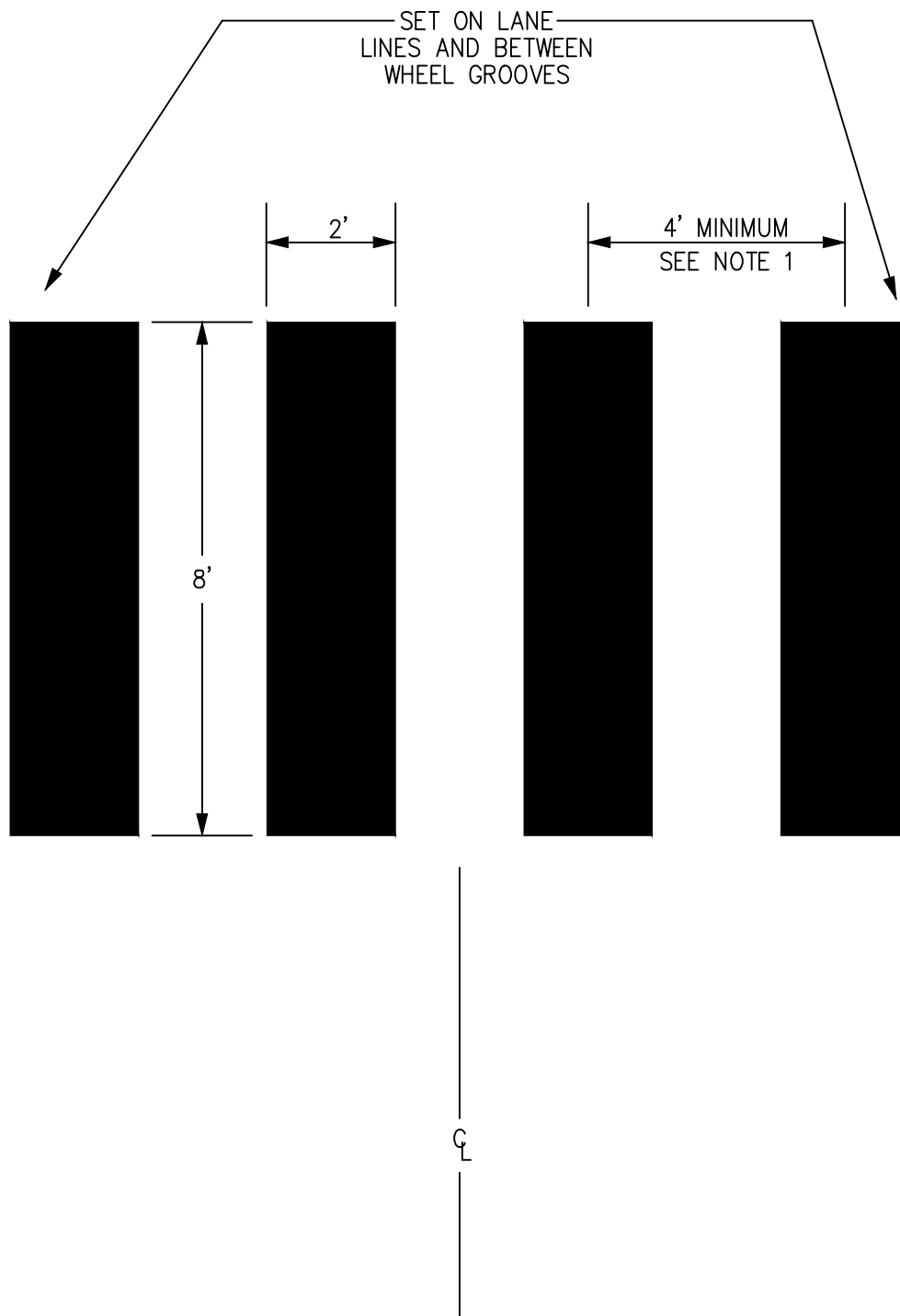
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TURN ARROW PAVEMENT MARKING DETAIL

ISSUED:
FEBRUARY 2003

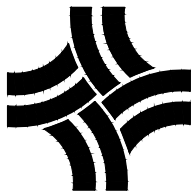
REVISED:
APRIL 2010

DRAWING NO.
700-17



FIELD ADJUST SPACING TO AVOID VEHICLE TIRE PATHS.

N.T.S.



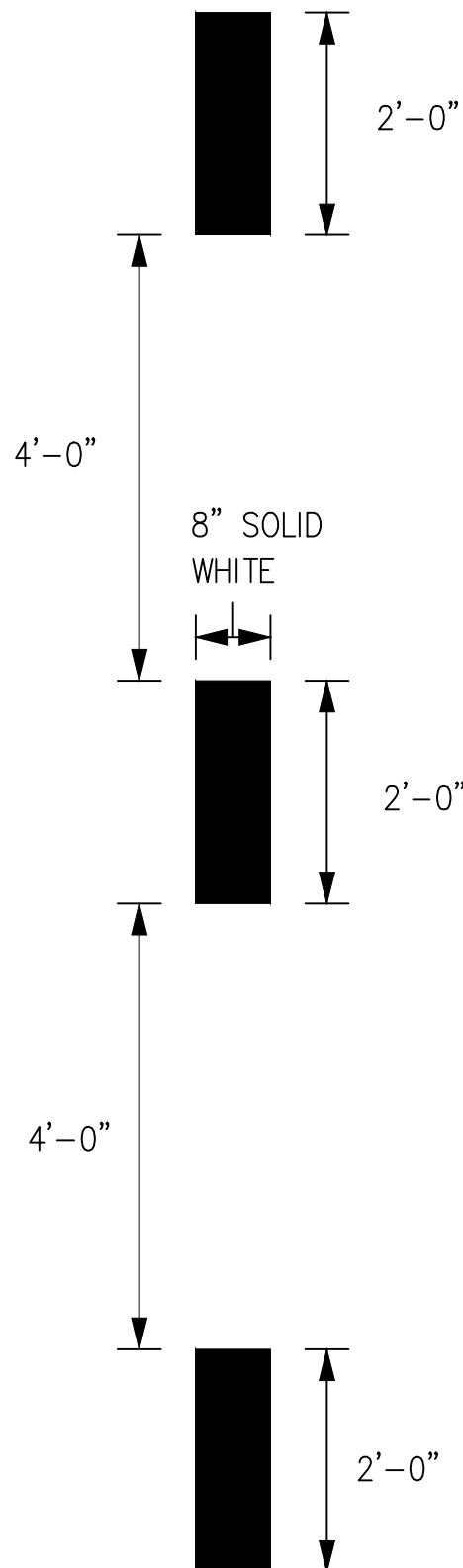
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

CROSSWALK PAVEMENT MARKING
DETAIL

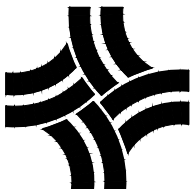
ISSUED:
FEBRUARY 2003

REVISED:
APRIL 2010

DRAWING NO.
700-18

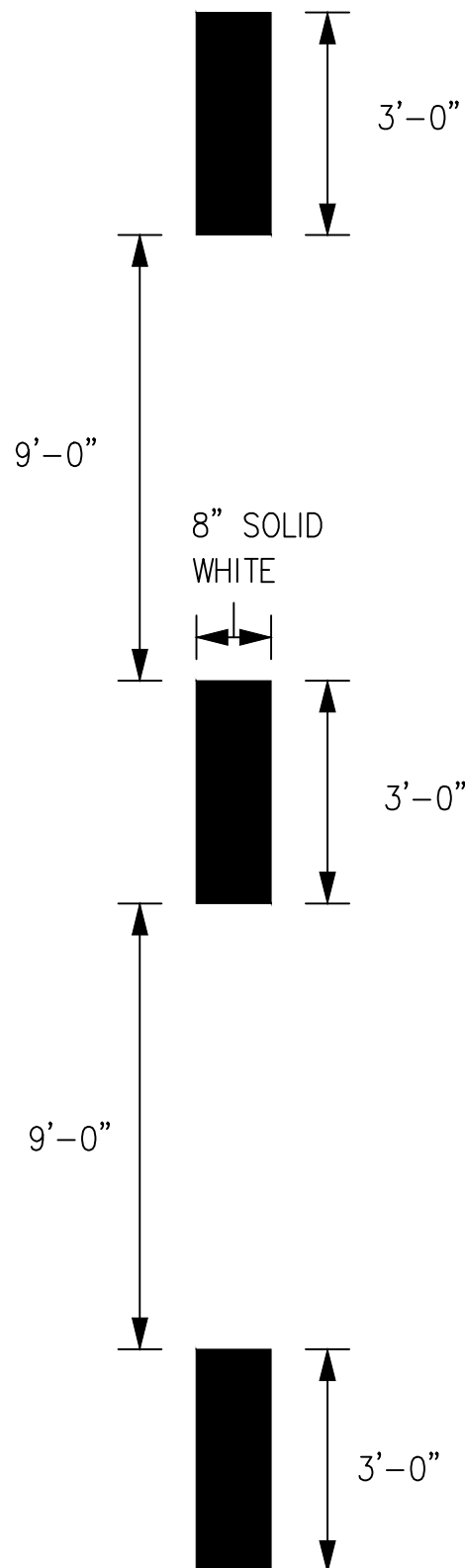


N.T.S.

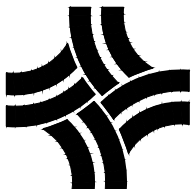


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS
INTERSECTION LANE USE
CONTROL PAVEMENT MARKING
DETAIL

ISSUED:
FEBRUARY 2003
REVISED:
APRIL 2010
DRAWING NO.
700-19A



N.T.S.

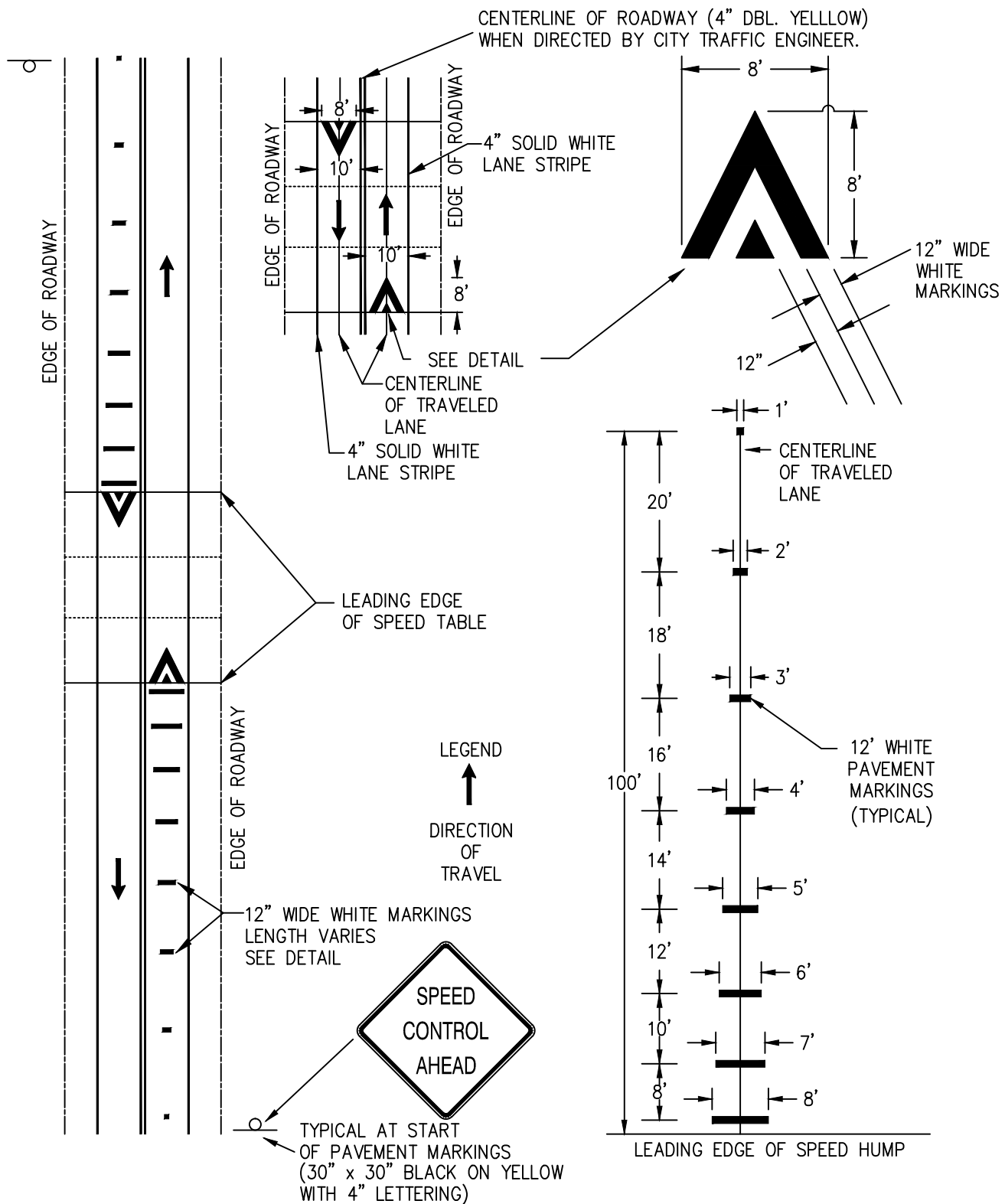


CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

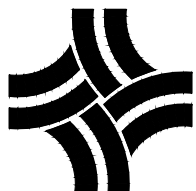
LANE DROP
PAVEMENT MARKING DETAIL

ISSUED:
SEPT 2012
REVISED:

DRAWING NO.
700-19B



N.T.S.



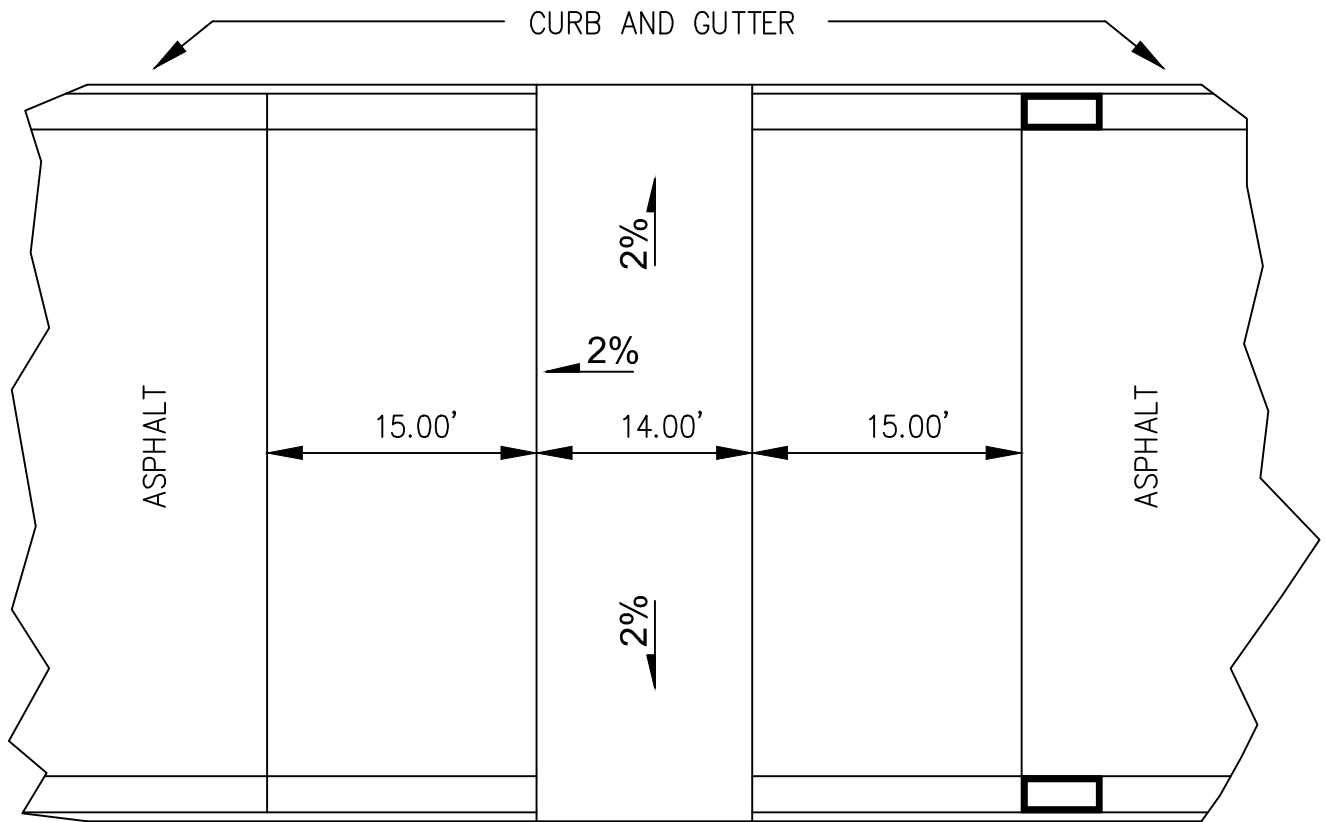
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL SPEED TABLE
(FOR 25 MPH SITE)

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-20A

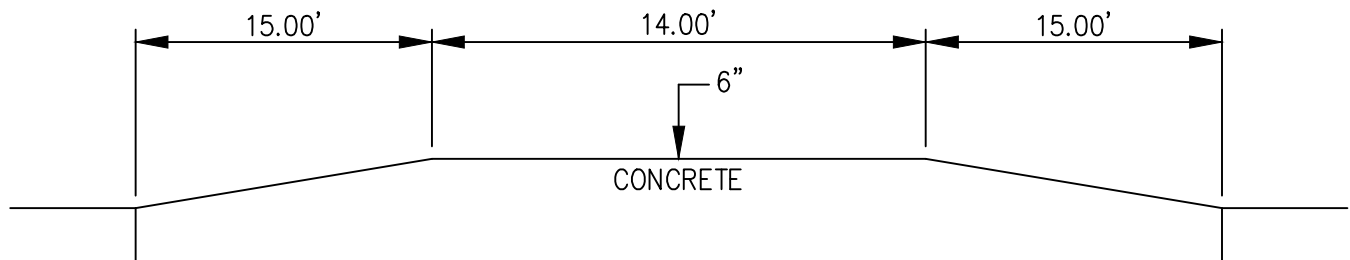
TYPICAL PLAN VIEW



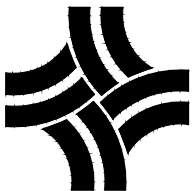
STORM INLETS REQUIRED AT
HIGH POINT OF APPROACH TO
SPEED TABLE

CHANGE IN GRADE AT SPEED TABLE RAMPS SHALL BE 3.33% \pm .25%

TYPICAL LONGITUDINAL SECTION



N.T.S.



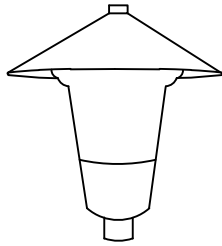
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

TYPICAL SPEED TABLE
(FOR 25 MPH SITE)

ISSUED:
FEBRUARY 2005
REVISED:
APRIL 2010

DRAWING NO.
700-20B

POST TOP LUMINAIRES



LUMINAIRE, POST TOP
MODERN STYLE
100 WATT COLOR BLACK

LUMINAIRES FOR STEEL DAVIT OR MAST ARM POLES



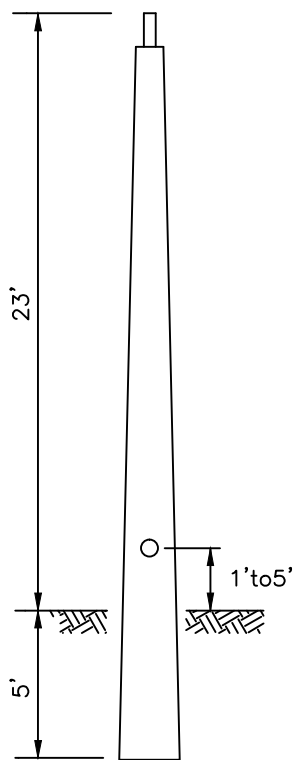
FLAT LENS

LIGHT EMITTING DIODE (LED) LUMINAIRES COLOR GRAY

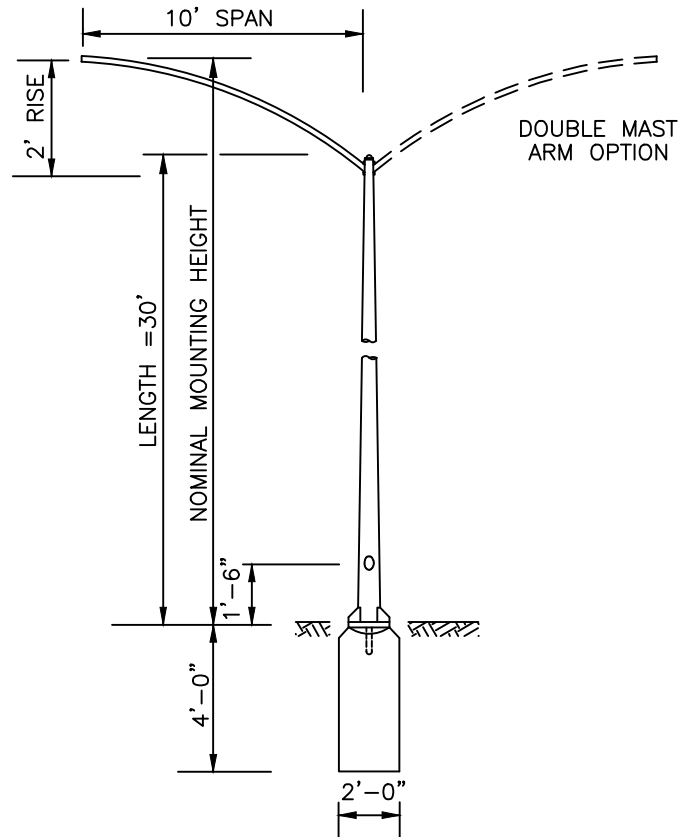
LOCATIONS	HPS EQUIVALENT WATTAGE
LOCAL	100
COLLECTORS	250
ARTERIALS *	250
INTERSECTIONS	400

STREET LIGHT SPACING SHALL BE INSTALLED AS INDICATED ON CONSTRUCTION PLANS.

* USE LED, 400W HIGH PRESSURE SODIUM EQUIVALENT, ALONG ARTERIALS NEXT TO COMMERCIAL AREAS WITH CITY APPROVAL

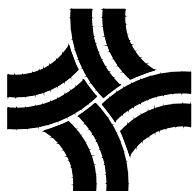


POLE, FIBERGLASS
DIRECT BURIED



STEEL MAST ARM POLE

N.T.S.



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STREET LIGHTS DETAIL

ISSUED:
MAY 1993
REVISED:
APRIL 2010

DRAWING NO.
700-21

POLE

SMOOTH, STRAIGHT, STEEL 38' PAINTED POLE, 5.6" DIAMETER SHAFT, 4" x 8" HAND HOLE 48" FROM 13" POLE BASE PLATE, AND 11" TO 13" BOLT CIRCLE. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE
MOUNTAIN STATES LIGHTING PART NO. 28SRS-5.6/258 XX

ARM

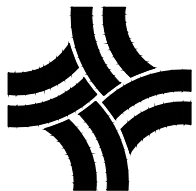
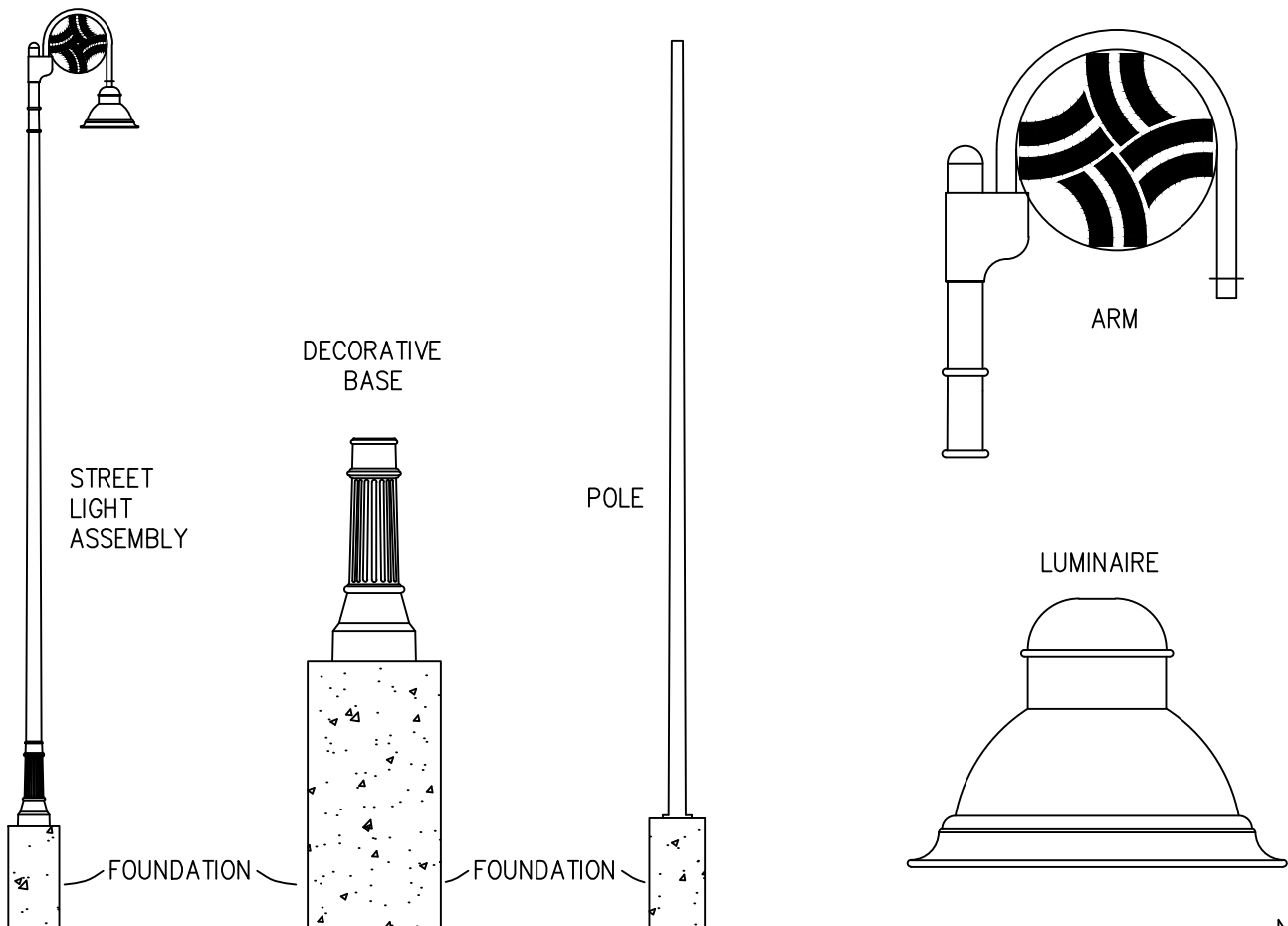
LUMINAIRE ARM, ALUMINUM, PAINTED, SLIP-OVER POLE FOR 9" WITH 5.6" OD, WITH BRACKET CAP SECURED WITH (3x) 1/4-20 STAINLESS STEEL SET SCREWS @ 120°. ARM IS ORDERED WITH BENT ALUMINUM DECORATIVE SCROLL. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE
LUMEC PART NO. LM1ACOLTXLMS (MODIFIED TO 30")
CITY LOGO SHALL BE REMOVABLE AND ANCHORED TO ARM USING STAINLESS STEEL BOLTS

LUMINAIRE

LED LIGHT, 250 WATT HIGH PRESSURE SODIUM EQUIVALENT, DOMUS FLAT LENS, 120/208/240/277 VOLT, MOGUL SOCKET, MULTI-TAP BALLAST, PENDANT MOUNT CLEAR GLASS TYPE III DISTRIBUTION. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE

DECORATIVE BASE

BASE, POLE, SPLIT ORNAMENTAL STANDARD, 16-1/2" DIAMETER x 40" HEIGHT, HIGH DENSITY ELASTOMER. FRANKLIN STYLE 16.5. FEDERAL COLOR # 20227 (SEMI-GLOSS) BEIGE
MOUNTAIN STATES LIGHTING PART NO. 16.5"W x 40"H-HDEB-XX



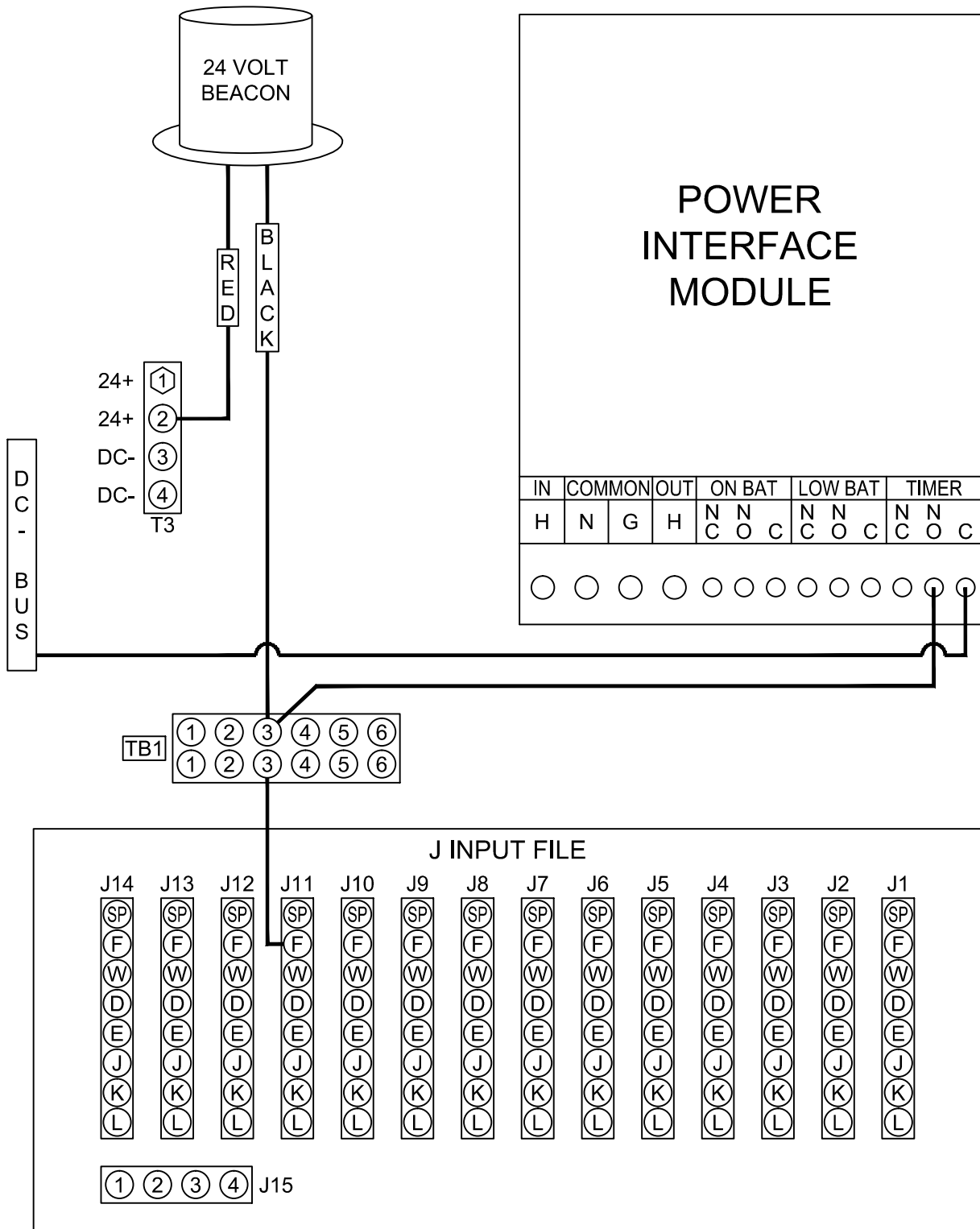
CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

STREET LIGHTS FOR WASHINGTON
STREET CORRIDOR

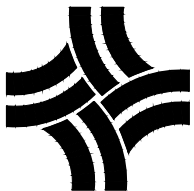
ISSUED:
JANUARY 2005

REVISED:
APRIL 2010

DRAWING NO.
700-22



N.T.S.



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

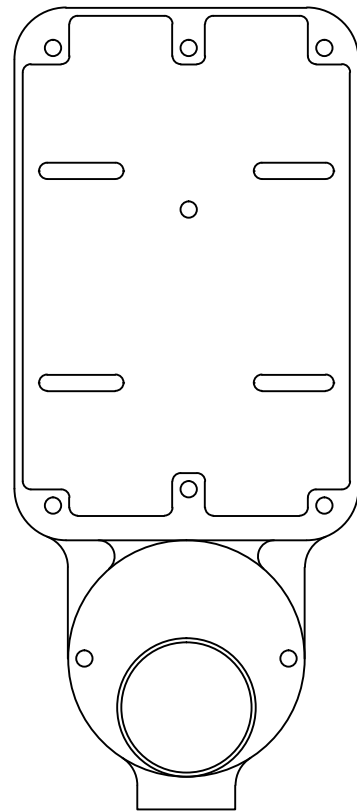
CONTROL CABINET
BEACON WIRING DETAIL

ISSUED:
SEPT 2012
REVISED:

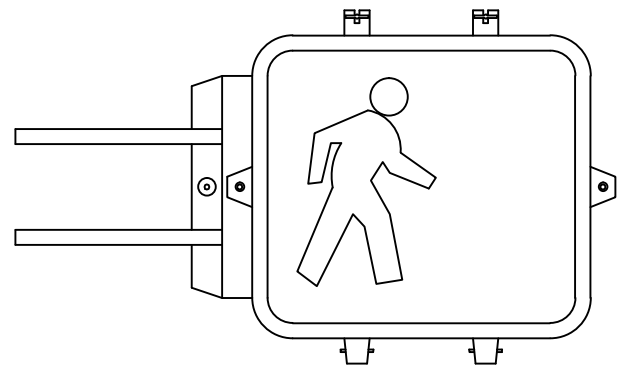
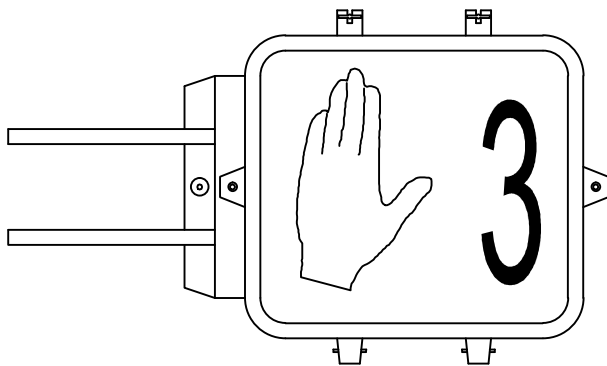
DRAWING NO.
700-23



PUSH BUTTON SIGN PLATE
(5" x 7-3/4")

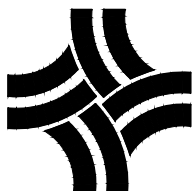


2" PUSH BUTTON &
PUSH BUTTON SIGN MOUNTING ASSEMBLY
(POLARA BULLDOG PUSHBUTTON)



ALL PEDESTRIAN
SIGNAL HEADS
(COUNTDOWN TYPE)

N.T.S.



CITY OF THORNTON, COLORADO
STANDARDS & SPECIFICATIONS

PEDESTRIAN TRAFFIC SIGNAL,
SIGN AND PUSH BUTTON

ISSUED:
SEPT 2012
REVISED:

DRAWING NO.
700-24