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TRAFFIC

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CHAPTER 8
TRAFFIC

8.00.00 **INTRODUCTION**

8.01.00 **GENERAL**

The standards contained in this Chapter regulate all improvements and private work to be dedicated to the public and accepted by the City and all work within the RIGHT-OF-WAY. They are intended to provide for adequate, coordinated, modern development with required facilities to serve and protect the users of the community.

The standards in this chapter apply to new developments which are not constrained by already existing improvements. This chapter is not to be applied without qualification to in-fill development. In-fill development in an urban area is often constrained by existing improvements. In-fill developments shall be required to conform to these STANDARDS AND SPECIFICATIONS. Any modifications of these STANDARDS AND SPECIFICATIONS shall be approved by the CITY ENGINEER.

8.02.00 **GLOSSARY OF TERMS**

AASHTO -- American Association of State Highway and Transportation Officials

Access -- Driveway or other point of access such as a street, road, or highway that connects to the general street system. Where two public roadways intersect, the secondary roadway shall be the access.

Approach -- The portion of an intersection leg which is used by traffic approaching the intersection.

Average Daily Traffic (ADT) -- The total bi-directional volume of traffic passing through a given point during a given time period, divided by the number of days in that time period.

Band Width -- The time in seconds or the percent of cycle between a pair of parallel lines which delineate progressive movement on a time-space diagram. It is a quantitative measurement of through traffic capacity provided by signal progression.

Capacity -- The maximum number of vehicles that have a reasonable expectation of passing over a given roadway or section of roadway in one direction during a given time period under prevailing roadway and traffic conditions.

Critical Volume -- A volume (or combination of volumes) for a given street which produces the greatest utilization of capacity for that street in terms of passenger cars or mixed vehicles per hour.

Cycle Time -- The time period in seconds required for one complete sequence of signal indications.

Deceleration Lane -- A speed change lane, including tapered areas, for the purpose of enabling a vehicle that is to make an exit turn from a roadway to slow to a safe turning speed after it has left the main stream of faster-moving traffic.

Delay -- Stopped time per approach vehicle in seconds per vehicle.

Design Hour Volume (DHV) -- Hourly traffic volume used for street design and capacity analysis, usually one or more peak hours during a twenty-four (24) hour period.

Design Speed -- Five to ten miles per hour (5-10 mph) above the proposed or desired speed limit of the facility under design.

Design Vehicle -- Developments intended for public use must be designed for the following types of vehicles:

Residential (excluding single-family or duplex)	SU30
Commercial Uses	WB40
Industrial Uses	WB50

For public streets, the following design vehicles must be used:

Commercial/Multi-Family Locals & Minor Collectors	SU30
Major Collectors	WB40
Arterials	WB50

Definitions for the above vehicle types are found in AASHTO Geometric Highway Design Standards.

Divided Highway -- A highway with separated roadways for traffic in opposite directions, such separation being indicated by depressed dividing strips, raised curbs, traffic islands, other physical separations, or by standard pavement markings and other traffic control devices.

Fire Trucks -- Must be considered as a WB40 truck with a minimum forty-five-foot (45') radius for design purposes.

Flowline -- The transition point between the gutter and the face of the curb. For a cross or valley pan, it is the center of the pan.

Grade -- Rate or percent of slope, either ascending or descending from or along the highway. It is usually measured along the centerline of the highway or access.

Green Time -- The length of a green phase plus its change interval, in seconds.

Hourly Volume -- The number of (mixed) vehicles that pass over a given section of a lane or roadway during a time period of one (1) hour.

Level of Service (LOS) -- A measure of the mobility characteristics of an intersection as determined by vehicle delay and a secondary factor, the volume/capacity ratio.

MUTCD -- Manual on Uniform Traffic Control Devices and the Colorado Supplement.

Sight Distance -- The length of roadway ahead visible to the driver. The minimum sight distance available should be sufficiently long to enable a vehicle traveling at or near the design speed to stop before reaching a stationary object in its path.

Signal Progression -- Progressive movement of traffic at a planned rate of speed through adjacent signalized locations within a traffic control system without stopping.

Speed Change Lane -- A separate lane for the purpose of enabling a vehicle entering or leaving a roadway to increase (acceleration lane) or decrease (deceleration lane) its speed to a rate at which it can more safely merge or diverge with through traffic.

Stopping Sight Distance -- The distance traveled by the vehicle from the instant the driver of a vehicle sights an object necessitating a stop to the instant the brakes are applied and the distance required to stop the vehicle from the instant brake application begins.

Storage Lane -- Additional lane footage added to a deceleration lane to store the maximum number of vehicles likely to accumulate during a critical period without interfering with the through lanes.

Time Space Diagram -- A chart on which the distance between signals and signal timing is plotted against time. The chart, when completed, indicates signal progression band widths and speed of traffic.

8.10.00

DESIGN STANDARDS

8.10.01 Responsibilities for Traffic Studies

Traffic studies may be required by the CITY in order to adequately assess the impacts of a development proposal on the existing and/or planned street system. The primary responsibility for assessing the traffic impacts associated with a proposed development shall rest with the developer, with the CITY serving in a review capacity.

Unless waived by the TRAFFIC ENGINEER, a written study meeting the criteria contained in this chapter shall be required for a development proposal when trip generation during the AM or PM peak hour is expected to exceed one hundred (100) vehicles, as determined by the TRAFFIC ENGINEER. This study shall be the responsibility of the applicant and shall be prepared by a Professional Engineer registered in the State of Colorado, with adequate experience in transportation engineering. Upon submission of a draft traffic study, the TRAFFIC ENGINEER will review the study data sources, methods, and findings. Comments shall be provided in a written form. The developer and the project engineer will then have an opportunity to incorporate necessary revisions prior to submitting a final report. All studies shall be approved by the TRAFFIC ENGINEER before acceptance. The following submittals will require traffic studies:

- (A) A rezoning application or an application for annexation into the CITY.
- (B) A preliminary map or final plat if the property has already been rezoned for the proposed use and no traffic study was required for the rezoning, or the land use assumptions at the time of platting will result in trip generation increasing by more than fifteen percent (15%) compared to trip generation estimates made for the traffic study at the time of rezoning.
- (C) Prior to issuance of a building permit, if the property has already been zoned/platted and no previous traffic study less than two (2) years old exists.
- (D) The applicant shall be required to submit a new traffic study if, after submitting the original traffic study for any of the above submittals, the land use intensity is increased by

more than fifteen percent (15%), or the land use is changed so that trip generation is increased by more than fifteen percent (15%).

All previous traffic studies relating to the development that are more than two (2) years old shall be updated, unless the TRAFFIC ENGINEER determines that conditions have not changed significantly. Where access points are not defined or a site plan is not available at the time the traffic study is prepared, additional traffic analysis may be required when a site plan becomes available or the access points are defined.

The applicant will be notified at the pre-application stage if a traffic study will be required, provided sufficient information is available for the CITY to determine whether the trip generation criterion has been met. If insufficient information is available but the property appears to involve a sufficiently intense land use, the applicant will be informed that a traffic study is required.

Transportation consultants are required to discuss projects with the TRAFFIC ENGINEER prior to starting the study. As a minimum, topics for possible discussion at such meeting shall include trip generation, directional distribution of traffic, trip assignment, definition of the study area, intersections requiring capacity/level of service analysis, and methods for projecting build-out volume. This will provide a firm base of cooperation and communication between the CITY, the owner or developer, and the project's consultants in forecasting future traffic characteristics which realistically define traffic movement associated with the proposed development. Specific requirements will vary depending on the site location.

8.10.02 Traffic Study Format

In order to provide consistency and to facilitate staff review of traffic studies, the following format shall be followed in the preparation of such studies by transportation consultants.

(A) Introduction:

The introduction portion of the report must contain the following:

1. A note stating the following: "We acknowledge that the City of Westminster's review of this study is only for general conformance with submittal requirements, current design criteria and standard engineering principles and practices. We are also aware of the provisions of section 11-6-5(B)3 of the Westminster Municipal Code."
2. A brief description of the size of the land parcel, general terrain features, the location within the jurisdiction and the region shall be included in this section. In addition, the roadways that afford access to the site and are included in the study area shall be identified. The exact limits of the study area should be based on engineering judgment and an understanding of existing traffic conditions surrounding the site. In all instances, however, the study area limits shall be mutually agreed upon by the developer, his engineer, and the TRAFFIC ENGINEER. A vicinity map that shows the site and the study area boundaries in relation to the surrounding transportation system shall be included.
3. The existing and proposed uses of the site shall be identified in terms of the various zoning categories of the CITY. In addition, the specific use for which the request is being made shall be identified, if known, since a number of uses may

be permitted under the existing ordinances. It shall be the intent of the traffic study to evaluate the worst case traffic impacts for the proposed development allowed by the zoning. If several different uses are permitted by the zoning, the highest trip generation shall be assumed for the study.

4. A complete description (including a map) of the existing land uses in the study area, as well as their current zoning and use, shall be included. In addition, all vacant land within the study area and its assumed future uses shall be identified. This latter item is especially important where large tracts of undeveloped land are in the vicinity of the site and within the prescribed study area. Generally, much of this information can be obtained from the CITY's Planning Division staff.
5. Within the study area, the applicant shall describe and provide volumes for existing roadways and intersections, including geometrics and traffic signal control, as well as improvements contemplated by all affected government agencies. This would include the nature of the improvement project, its extent, implementation schedule, and the agency or funding source responsible. A map shall be provided showing the location of such facilities.

(B) Trip Generation and Design Hour Volumes:

A summary table listing each type of land use, the size involved, the average trip generation rates used (total daily traffic and a.m./p.m. peaks) and the resultant total trips generated shall be provided. Trip generation shall be calculated for the maximum uses allowed under the existing and proposed zoning based on the latest data contained within the Institute of Transportation Engineers (ITE) Trip Generation Manual; or other applicable sources. In the event that data is not available for the proposed land use, the CITY must approve estimated rates prior to acceptance. The calculation of design hour volumes used to determine study area impacts shall be based on:

1. Peak hour trip generation rates as published in the ITE Trip Generation Summary or other applicable sources.
2. Traffic volume counts for similar existing uses if no published rates are available.
3. Additional sources from other jurisdictions, if acceptable to the TRAFFIC ENGINEER.

Use of reduction factors to account for passerby traffic may be considered upon approval of the TRAFFIC ENGINEER. Internal trip reductions and modal split assumptions will require analytical support to demonstrate how the figures were derived and will require approval by the TRAFFIC ENGINEER.

(C) Trip Distribution:

The estimates of percentage distribution of trips from the proposed development to destinations in the metro region shall be clearly stated in the report using the north, south, east, and west compass points. Market studies and information concerning origin of trip attractions to the proposed development may be used to support these assumptions where available. A map showing the percentage of site traffic on each street shall be provided as part of the traffic study graphic material.

(D) Trip Assignment:

The direction of approach of site-generated traffic via the area's street system shall be presented in this section. The technical analysis steps, basic methods, and assumptions used in this work shall be clearly stated and agreed to by the TRAFFIC ENGINEER. The assumed trip distribution and assignment shall represent the most logically traveled routes for drivers accessing the proposed development. These routes can be determined by observation of travel patterns to existing land uses in the study area.

(E) Existing and Project Traffic Volumes:

Graphics shall be provided which show the following traffic impacts for private access points, public intersections, and public streets.

1. A.M. peak-hour site traffic (in and out), including turning movements.
2. P.M. peak-hour site traffic (in and out), including turning movements.
3. A.M. peak-hour total traffic (in and out), including site-generated traffic. These volumes must include through and turning movement volumes for current conditions and separate set of numbers that also include twenty (20) year projections or build-out, whichever is specified by the TRAFFIC ENGINEER.
4. P.M. peak-hour total traffic (in and out), including site-generated traffic. These volumes shall include through and turning movement volumes for current conditions and a separate set of numbers that also include twenty (20) year projections or build-out, whichever is specified by the TRAFFIC ENGINEER.
5. Any other peak hour which may be critical to site traffic and the street system in the study area should be included in the graphics and show the same information as is provided for the a.m./p.m. peak hours.
6. Actual counts of existing total daily traffic for the street system in the study area at the time the study is being prepared.
7. Projected total daily traffic for the street system in the study area based on traffic from the proposed development and counts of existing daily traffic obtained in Item 6 above. The component of the existing daily traffic attributable to the existing uses shall be identified and the increase in total daily traffic from the proposed uses.
8. Projected total daily traffic for the street system in the study area based on traffic from the proposed development, counts of existing daily traffic obtained in Item 6 above, traffic projections based on build-out of land use within the study area, or a twenty (20) year projection, whichever is specified by the TRAFFIC ENGINEER.

All raw traffic count data, including average daily volumes and peak-hour turning movements, and analysis worksheets shall be provided in the appendices of the report. Computer techniques and the associated printouts may be used as part of the report. Volume projections for background traffic growth will be provided by the TRAFFIC

ENGINEER or, alternatively, a method for determining these volumes will be recommended by the TRAFFIC ENGINEER. All total daily traffic counts shall be actual machine counts and not based on factored peak-hour sampling. Latest available machine counts from the CDOT, the CITY, and other agencies may be acceptable if not more than two (2) years old.

(F) Level of Service:

Level of Service "C" shall be the design objective for all movements, and under no circumstances will less than level of Service "D" be accepted for site and non-site traffic, including existing traffic at build-out of the study area. The design year will be approximately twenty (20) years following construction and include volumes generated by build-out of the study area or a twenty (20) year projection in background traffic, whichever is specified by the TRAFFIC ENGINEER. The following interpretations of "Level of Service" have been provided:

Level of Service A. A condition of free flow with low-traffic density where no vehicle waits longer than one (1) signal cycle.

Level of Service B. A stable flow of traffic where only on a rare occasion do drivers wait through more than one (1) signal cycle.

Level of Service C. Still in the zone of stable flow but intermittently, drivers must wait through more than one (1) signal cycle and back-ups may develop behind left-turning vehicles.

Level of Service D. Approaching instability, drivers are restricted in their freedom to change lanes and delays for approaching vehicles may be substantial during peak hours.

Level of Service E. Traffic volumes are near or at the capacity of the arterial and long queues of vehicles may create lengthy delays, especially for left-turning vehicles.

Level of Service F. Congested condition of forced traffic flow where queued back-ups from locations downstream restrict or prevent movement of vehicles out of the approach creating a storage area during part or all of the peak hour.

(G) Capacity Analysis:

A capacity analysis shall be conducted for all public street intersections impacted by the proposed development and for all private property access points to streets adjacent to the proposed development and within the limits of the previously defined study area. The a.m., p.m., and any other possible peak period shall be tested to determine which peak hours need to be analyzed. Capacity calculations should also include an analysis for the twenty- (20) year projections or study area build-out conditions. The capacity analysis calculations should be based on the latest approved techniques as published in the latest update of TRB Special Report 209. All capacity analysis worksheets shall be included in the appendices of the report.

(H) Traffic Signals:

The need for new traffic signals shall be based on warrants contained in the MUTCD and any additional warrants established by the National Committee on Uniform Traffic Control Devices. In determining the location of a new signal, traffic progression is important. Generally, a spacing of one-half (1/2) mile for all signalized intersections should be maintained. This spacing is desirable to achieve good speed, capacity, and optimum signal progression. Pedestrian movements shall be considered in the evaluation and adequate pedestrian clearance provided in the signal cycle split assumptions.

To provide flexibility for existing conditions and ensure optimum two-way signal progression, an approved traffic engineering analysis shall be made to properly locate all proposed accesses that may require signalization. The section of roadway to be analyzed for signal progression will be determined by the CITY and will include all existing and possible future signalized intersections.

The progression pattern calculations shall use a cycle consistent with current signal-timing policies of the CITY. A desirable band width of fifty percent (50%) of the signal cycle shall be used where existing conditions allow. Where intersections have no signals presently but are expected to have signals, typically a sixty percent (60%) mainline, forty percent (40%) cross-street cycle split should be assumed. Cycle split assumptions shall relate to volume assumptions in the capacity analysis of individual intersections, and where computerized progression analysis techniques are used they shall be the type which utilize turning-movement volume data and pedestrian clearance times in the development of time/space diagrams. The green time allocated to the cross street shall be considered no less than the time which is required for a pedestrian to clear the main street using the MUTCD standards. Those intersections which would reduce the optimum band width if a traffic signal were installed may be required by the CITY to remain unsignalized and have turning movements limited by access design or median islands.

(I) Traffic Accidents:

Traffic accident data for affected street corridors may be required for the study. The study period will normally be three (3) years. Such locations will be specified by the TRAFFIC ENGINEER. Where this is necessary, estimates of increased or decreased accident potential shall be evaluated for the development, particularly if the proposed development might impact existing traffic safety problems in the study area, and safety improvements recommended where necessary.

(J) Noise Attenuation:

If a residential development is planned adjacent to a freeway or arterial roadway, the Developer may be required to comply with all noise mitigation measures per current regulations.

(K) Recommendations:

In the event that analysis indicates unsatisfactory levels of service on study area roadways, a description of proposed improvements to remedy deficiencies shall be included. These proposals would include projects by the CITY or CDOT for which funds have been appropriated and obligated. The assumptions regarding all future roads and

laneways in an analysis will require approval from the TRAFFIC ENGINEER. In general, the recommendation section should include:

1. Proposed Recommended Improvements. This section must describe the location, nature, and extent of proposed improvements to assure sufficient roadway capacity. A sketch of each improvement should be provided showing the length, width, and other pertinent geometric features of the proposed improvements.
2. Level of Service Capacity Analysis at Critical Points. Another iteration of the operational analysis shall be described which demonstrates the anticipated level of service as a result of making these improvements. This level of service must be "D" or better.
3. Traffic Volume Proportions. Percentages based on the traffic impact analysis may be required by the CITY to determine the proportion of traffic using various public improvements (both existing and proposed) from several developments within the study area.

(L) Conclusions:

This last section of the report must be a clear, concise description of the study findings explained in a manner that a citizen could understand as the language in this section will be inserted into the Planning Commission and City Council agenda memorandums. At minimum, the summary will include information pertaining to existing site generated traffic, impacts and mitigation measures and when they will be implemented.

(M) Revisions to Traffic Study:

Revisions to the traffic study shall be provided as required by the TRAFFIC ENGINEER. The need to require revisions will be based on the completeness of the traffic study, the thoroughness of the impact evaluation, and the compatibility of the study with the proposed access and development plan.

8.10.03 Summary of Typical Study Contents

(A) Introduction:

1. Land Use, Site, and Study Area Boundaries (provide map)
2. Existing and Proposed Site Uses
3. Existing and Proposed Uses in Vicinity of Site (provide map)
4. Existing and Proposed Roadway and Intersections (provide map), including but not limited to:
 - (a) Road geometry
 - (b) Number of lanes

- (c) Auxiliary turning lanes, including storage length and tapers
 - (d) Medians
- (B) Trip Generation and Design Hour Volumes (provide table)
- (C) Trip Distribution (provide figure)
- (D) Trip Assignment (provide figure)
- (E) Existing and Projected Traffic Volumes (provide figure for each item):
 - 1. A.M. Peak Hour Site Traffic (including turning movements)
 - 2. P.M. Peak Hour Site Traffic (including turning movements)
 - 3. A.M. Peak Hour Total Traffic (including site-generated traffic and projected traffic)
 - 4. P.M. Peak Hour Total Traffic (including site-generated traffic and projected traffic)
 - 5. Any Other Peak Hour Necessary for Complete Analysis
 - 6. Total Daily Existing Traffic for Street System in Study Area
 - 7. Total Daily Existing Traffic for Street System in Study Area and New Site Traffic
 - 8. Total Daily Existing Traffic for Street System in Study Area plus New Site Traffic and Projected Traffic from Build-Out of Study Area Land Uses
- (F) Level of Service
- (G) Capacity Analysis (provide analysis sheets in appendices)
- (H) Traffic Signals (provide analysis sheets in appendices)
- (I) Traffic Accidents (optional) (provide collision diagrams and accident rates)
- (J) Noise Attenuation
- (K) Conclusions
- (L) Recommendations:
 - 1. Proposed Recommended Improvements (provide sketches of improvements)
 - 2. Volume/Capacity Analysis at Critical Points (provide analysis sheets in appendices)

3. Traffic Volume Proportions

NOTE: Information required on figures may be combined provided that the information is clearly legible.

8.11.00 ACCESS REQUIREMENTS AND CRITERIA

8.11.01 Definition of Terms

For the purposes of this section the following definitions apply:

- (A) Width of Curb Opening (W) -- The width of curb opening measured at the curb line.
- (B) Edge Clearance (E) -- The distance measured along curb line from the nearest edge of the curb opening to a point where the property line extended intersects the curb line.
- (C) Corner Clearance (C) -- At an intersecting street, the distance measured along the curb line from the projection of the intersection street right-of-way line to the nearest edge of the curb opening.
- (D) Distance Between Double Drives (D) -- The distance measured along the curb line between the inside edges of two adjacent curb openings.
- (E) Setback (S) -- The lateral distance measured perpendicular to the street right-of-way line and extending from the right-of-way line to the closest point on a structure.
- (F) Frontage -- The distance along the street right-of-way line of a single property or development within the property lines. Corner property at an intersection would have a separate frontage along each street.
- (G) Residential -- Property used primarily for residential purposes such as single-family, two-family, and multi-family units.
 - Single-Family (SF) Residential: Single, detached family dwelling units, double bungalows, or duplexes.
 - Multi-Family (MF) Residential: Three or more attached dwelling units including townhouses, condominiums, and apartments.
- (H) Commercial -- Establishments where the buying and selling of commodities, entertainment, or services is carried on, excluding service stations. Included are such uses as office buildings, restaurants, hotels, motels, banks, grocery stores, theaters, parking lots, trailer courts, and public buildings.
- (I) Service Station -- Any property where flammable liquids such as motor vehicle fuel are used, stored, and/or dispensed from fixed equipment into fuel tanks of motor vehicles.
- (J) Industrial or Warehouse -- Any establishment that manufactures or stores an article or product.

8.11.02 General Requirements

(A) Number of Openings:

1. Single-Family Residential. In general, each single-family residential property shall be limited to one (1) access point.
2. Multi-Family Residential. In general, access shall be determined by information provided by the owner/developer in the traffic impact study and by comments generated during the TRAFFIC ENGINEER's review and acceptance of that study.
3. Commercial. In general, commercial property having less than one hundred and fifty feet (150') of frontage and located mid-block shall be limited to one (1) access point to the street. An exception to this rule may be where a building is constructed in the middle of a lot and parking is provided for on each side of the building. A second access point may be allowed for commercial property having more than one hundred fifty feet (150') of frontage. For commercial property located on a corner, one (1) access to each street may be permitted.
4. Service Stations. Where there is sufficient frontage to provide for minimum and maximum requirements, two (2) access points to a street may be permitted.
5. Industrial. Access shall be determined on a case-by-case basis. The City shall consider good traffic engineering practice and the information provided by the applicant in the traffic impact study accompanying the submittal.

(B) Amount of Curb Opening Permitted:

The total length of curb opening on a street for access to a commercial property or service station shall not exceed thirty-five feet (35'). This requirement does not apply to residential-type curb openings.

(C) Entrance Angle:

In general, the entrance angle for all driveway approaches shall be as near ninety degrees (90°) to the centerline of the street as possible. The minimum angle which will be permitted is sixty degrees (60°).

(D) Minimum Space Between Openings:

The minimum spacing between curb openings shall be thirty-five feet (35') measured at the curb line. This spacing shall apply to double drives that serve a single property, as well as the distance between drives serving adjoining properties. A fifty-foot (50') spacing applies to commercial openings.

(E) Joint Entrances:

Whenever possible and feasible, joint entrances shall be provided to serve two adjacent properties. Joint entrances are to be centered on the common property line.

8.11.03 General

New access to CITY streets and roadways is approved through one of the following mechanisms:

- (A) For new developments, access is granted through City Council approval of the Preliminary Development Plan; or
- (B) To obtain access to CITY streets from existing developed property, the mechanism is dependent upon zoning.
- (C) For Planned Unit Developments, new or altered access shall be obtained through the CITY Preliminary or Official Development Plan amendment process. This involves applying through the Planning Division for an amendment to the appropriate development plan. The application should be accompanied by appropriate plans for the proposed access and technical justification, including justification for the extent of the improvements proposed at the access point.
- (D) For property classified as a standard zoning district (other than Planned Unit Development), the application should be made to the Planning Division and accompanied by plans of the proposed access and technical justification for the access and associated public improvements.

The TRAFFIC ENGINEER may be available to provide advice on the extent of technical justification required for any access request. It is recommended that this advice be sought prior to submitting any application.

8.11.04 State Highways

- (A) Access to state highways is governed by the State Highway Access Code.
- (B) The CITY has delegated its authority to administer the State Highway Access Code to CDOT who is, therefore, responsible for the review of issuance of access permits to State Highways in the CITY.

8.11.05 Major Arterials

- (A) A Right-of-Way Permit shall be obtained from the CITY's Engineering Division for any public or private access constructed on a major arterial.
- (B) Private, direct access to major arterials shall be permitted only:
 - 1. When the property in question has no other reasonable access to the general street system; or
 - 2. When denial of direct access to the major arterial and alternative direct access to another roadway would cause unacceptable traffic operation and safety problems to the overall traffic flow of the general street system.

When direct private access must be provided, the following shall be considered:

1. Such access shall continue only until such time that some other reasonable access to a lower function category street is available and permitted. The Right-of-Way Permit should specify the future reasonable access location(s), if known, and under what circumstances what changes will be required.
 2. No more than one (1) access shall be provided to an individual parcel or to contiguous parcels under the same ownership unless it can be shown that allowing only one access conflicts with safety regulations (e.g.; fire access) or if additional access would significantly benefit safety and operation of the highway and is necessary to the safe and efficient use of the property.
 3. An access shall be limited to right turns only unless it has the potential for signalization, left turns would not create unreasonable congestion or safety problems and lower the level of service, or if alternatives to the left turns would not cause unacceptable traffic operation and safety problems to the general street system.
- (C) Public direct access to a major arterial where left turns are to be permitted shall meet the signal-spacing criteria under Section 8.11.05(D) of this chapter. Those that do not meet these requirements shall be limited to right turns only, unless they meet the requirements mentioned in Section 8.11.05(B) above. No local streets shall be permitted to intersect major arterials.
- (D) Spacing and Signalization:
1. In general terms, full access to major arterials shall be limited to one-half (1/2) mile intervals, plus or minus approximately two hundred feet (200'), in order to achieve good speed, capacity, and optional signal progression.
 2. To provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

8.11.06 Minor Arterials

- (A) A Right-of-Way Permit shall be obtained from the CITY's Engineering Division for any public or private access constructed to a minor arterial.
- (B) Private direct access onto a minor arterial will be permitted if it does not have the potential for signalization; if it does have the potential for signalization; and it meets the signal-spacing requirements for intersecting public streets stated below and does not interfere with the location, planning, and operation of the general street system and access to nearby properties.
- (C) Public direct access to a minor arterial where left turns are to be permitted shall meet the following signal-spacing criteria. Those that do not meet these requirements shall be limited to right turns only, unless they meet the requirements of Section 8.11.05(B) above. No local streets shall be permitted to intersect minor arterials.

- (D) Spacing and Signalization:
 - 1. In general terms, full access to minor arterials shall be limited to one-half (1/2) mile intervals, plus or minus approximately one hundred feet (100'), in order to achieve good speed, capacity, and optional signal progression.
 - 2. To provide flexibility for both existing and future conditions, an approved engineering analysis of signal progression shall be made to properly locate any proposed access that may require signalization.

8.11.07 Major and Minor Collectors

- (A) Private access to collectors shall be governed by the curb opening and driveway criteria in Sections 8.11.09 and 8.11.10. Single-family residence access to collectors is not permitted.
- (B) Public streets shall not intersect collectors closer than three hundred and thirty feet (330') (centerline to centerline).

8.11.08 Local Streets

- (A) Private access to local streets shall be governed by the following curb opening and driveway criteria.
- (B) Public streets should not intersect local roadways closer than one hundred and fifty feet (150') from each other (centerline to centerline).

8.11.09 Basic Principles for Curb Openings and Driveways

- (A) Certain control values for curb openings and driveways require minimum dimensions in some instances and maximum values for other dimensions. The design of curb openings and driveways within the range of these dimensions will provide for good service on the part of the motorist using the driveway while at the same time minimizing the interference to the traffic using the street. By controlling the location and width of openings of driveways along the street, it will be possible to avoid or eliminate long, open stretches where motorists can indiscriminately drive onto the street. The width of opening established in these STANDARDS AND SPECIFICATIONS are based on studies which indicate that the various width openings will accommodate vehicles of maximum size authorized on CITY streets.
- (B) The opening or driveway width should be adequate to handle properly the anticipated traffic volume and character of traffic, as well as being within the limits specified for the type of property development. The controls established for curb openings and driveways shall apply to existing streets as well as new streets that may be developed in the future.
- (C) To the greatest extent possible, all openings for driveways shall be located at the point of optimum sight distance along the street. For openings and driveways to commercial establishments and service stations, there shall be sufficient space reasonably cleared of any obstructions such that drivers entering the property will have sufficient sight distance to enable them to make proper and safe movements. The profile of a driveway approach and the grading of the adjacent area shall be such that when a vehicle is located on the

driveway outside the traveled portion of street the driver can see a sufficient distance in both directions to enable him to enter the street without creating a hazardous traffic situation.

- (D) Any adjustments which must be made to utility poles, street light standards, fire hydrants, catch basins or intakes, traffic signs and signals, or other public improvements or installations which are necessary as the result of the curb openings or driveways shall be accomplished without any cost to the CITY. Also, any curb opening or driveway which has been abandoned shall be restored by the property owner except where such abandonment has been made at the request of or for the convenience of the CITY.
- (E) Driveway approaches, whereby the driveway is to serve as an entrance only or as an exit only, shall be appropriately signed by and at the expense of the property owner. The property owner will be required to provide some means of ensuring that the motorists will use the driveway either as an entrance only or an exit only, but not both.

8.11.10 Control Dimensions

To accomplish the objectives of the basic principles stated earlier, certain control dimensions are necessary. There are many variables which affect these control dimensions. Some of the variables are as follows: type of street classification, type of private property development, volume and type of traffic, and width of right-of-way.

- (A) Width of Curb Opening (W):

The total width of curb opening for properties on various function street classifications shall be in conformance with the detail drawings in Chapter 6 of these STANDARDS AND SPECIFICATIONS.

- (B) Curb openings of thirty-five feet (35') or more shall be constructed as radius curb returns.

- 1. Residential. No edge clearance is required for residential access. However, the drive shall not extend beyond the property line extended.

- 2. Commercial.

- Access onto an Arterial -- 75 Feet Minimum Edge Clearance
 - Access onto a Local -- 75 Feet Minimum Edge Clearance

NOTE: Joint access with adjoining property is encouraged. Joint access shall be the only justification for reducing the minimum edge clearance dimension.

- 3. Service Stations.

- Access onto an Arterial -- 5 Feet Minimum Edge Clearance
 - Access onto a Local -- 5 Feet Minimum Edge Clearance

- (C) Corner Clearance:

It is important to locate driveways away from major intersections. This constraint is as much for the ability to enter and leave the property as for the benefit of intersection safety

and operations. Exiting a driveway during peak-hour conditions at traffic signals is difficult where the queue of standing or slow-moving vehicles never allows a sufficient gap for entry from the driveway. Corner clearness shall be in accordance with the Urban System Transportation Manual, Figure 7-12.

(D) Sight Distance:

Sight distance for curb openings to private property shall be in accordance with Chapter 6 of these STANDARDS AND SPECIFICATIONS.

8.12.00 PARKING

8.12.01 Regular Parking

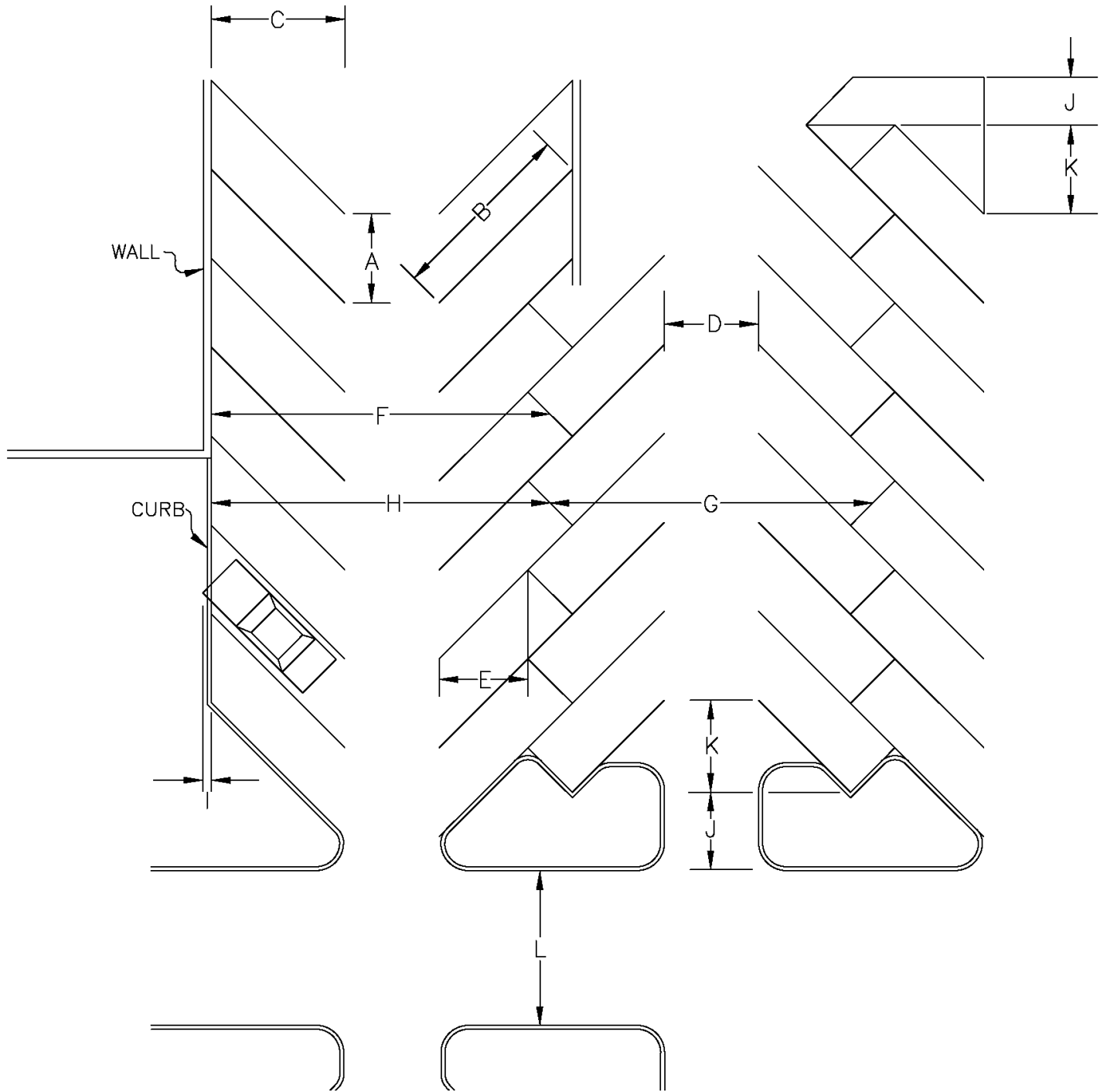
Conventional parking layout dimensions are provided in Table 8.12.01 and correspond to Figure 8.12.01. Other angled parking layouts meeting the approval of the TRAFFIC ENGINEER will be permitted where possible.

TABLE 8.12.01

Minimum Parking Layout Dimensions (In Feet) for 9-Foot Regular Parking Stalls at Various Angles

<u>Dimension</u>	<u>On Diagram</u>	<u>Angle</u>				
		<u>0</u>	<u>45</u>	<u>60</u>	<u>75</u>	<u>90</u>
Stall Width, Parallel to Aisle	A	9.0	12.5	10.5	9.5	9.0
Stall Length of Line	B	24.0	24.5	21.5	19.5	19.0
Stall Depth to Wall	C	9.0	17.0	18.5	19.0	19.0
Aisle Width Between Stall Lines	D	12.0	12.0	16.0	22.0	24.0
Stall Depth, Interlock	E	9.0	15.0	17.0	18.5	18.0
Module, Wall to Interlock	F	30.0	44.0	51.5	59.5	60.0
Module, Interlocking	G	30.0	41.5	50.0	58.5	60.0
Module, Interlock to Curb Face	H	30.0	42.0	49.5	57.0	58.0
Bumper Overhang (Typical)	I	0.0	1.5	2.0	2.0	2.0
Offset	J	--	6.5	2.5	0.5	0.0
Setback	K	24.0	11.0	8.5	5.0	0.0
Cross Aisle, One-Way	L	18.0	18.0	18.0	18.0	18.0
Cross Aisle, Two-Way	-	24.0	24.0	24.0	24.0	24.0

FIGURE 8.12.01
Parking Lot Layout



8.12.02 Compact Parking

Stall Layout. For ninety-degree (90°) compact parking, the minimum stall width shall be eight feet (8') and the minimum stall length at least sixteen feet (16'). Layout dimensions are provided in Table 8.12.02 and correspond to Figure 8.12.01. There shall be no bumper overhang for compact parking.

TABLE 8.12.02
Minimum Parking Layout Dimensions (In Feet) for 8-Foot Regular Parking Stalls
at Various Angles

<u>Dimension</u>	<u>On Diagram</u>	<u>Angle</u>				
		<u>0</u>	<u>45</u>	<u>60</u>	<u>75</u>	<u>90</u>
Stall Width, Parallel to Aisle	A	8.0	11.5	9.0	8.5	8.0
Stall Length of Line	B	22.0	24.0	20.5	18.0	16.0
Stall Depth to Wall	C	8.0	17.0	18.0	17.5	16.0
Aisle Width Between Stall Lines	D	12.0	12.0	16.0	22.0	24.0
Stall Depth, Interlock	E	8.0	11.5	14.5	16.0	16.0
Module, Wall to Interlock	F	28.0	43.0	48.0	53.5	56.0
Module, Interlocking	G	28.0	35.5	44.5	54.0	56.0
Module, Interlock to Curb Face	H	28.0	43.0	48.0	53.5	56.0
Bumper Overhang (Typical)	I	0.0	0.0	0.0	0.0	0.0
Offset	J	0.0	5.5	2.5	0.5	0.0
Setback	K	22.0	11.5	8.0	4.0	0.0
Cross Aisle, One-Way	L	18.0	18.0	18.0	18.0	18.0
Cross Aisle, Two-Way	-	24.0	24.0	24.0	24.0	24.0

8.12.03 Signing

Compact parking spaces shall be designated as being for the exclusive use of compact cars with a raised identification sign. The sign for compact car stalls must comply with the following:

- (A) The legend shall read "Compact Cars Only" in green lettering on a white background.
- (B) The minimum size of the sign shall be twelve inches by eighteen inches (12" x 18").
- (C) Height of the sign must be a minimum of seven feet (7'). A height of four feet (4') will be permitted in non-pedestrian areas.
- (D) Signs shall be reflectorized.

8.12.04 Maximum Allowable Grades Permitted in Parking Lots

Maximum grades permitted in parking lots must not exceed eight percent (8%).

8.12.05 Accessible Parking Posting

Each accessible parking stall should be between twelve feet (12') and fourteen feet (14') in width, must have a stall depth of at least nineteen feet (19'), and be located near buildings and accessible ramps. Dimensions of stalls shall meet the latest ADA guidelines referenced in Chapter 1. An accessible parking space will be required to be identified by an official "Disabled Reserved Parking" (MUTCD, R7-8) sign with the wheelchair logo.

In order for accessible parking spaces to function as intended, they will be required to be designed and signed in a uniform manner to allow for a clear understanding of the parking zone and to make enforcement possible. Signing of one, two, or three spaces for accessible parking spaces must be done by using one sign for each space placed at the center of each stall.

8.12.06 Parking Structures

The CITY will evaluate designs for such structures on an individual case basis.

8.13.00 BICYCLE LANES

8.13.01 General Requirements

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is located adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, street edge or parking lane.

8.13.02 Bike Lane Widths and Markings

The desired bike lane width is five feet (5') wide. Minimum dimensions vary with curbface conditions:

- Four foot (4') minimum width when adjacent to curb and gutter.
- Five foot (5') minimum for all other conditions.
- Additional bike lane or buffer width may be required at the CITY ENGINEER's discretion.

Bike lanes shall be delineated with a solid white line. Bike lane markings shall be placed at the beginning of every major driveway and/or intersection and at a minimum frequency of every three hundred feet (300').

Bike lane signage shall be in conformance with MUTCD.

8.13.03 Buffered Bike Lanes

Buffered bike lanes are conventional bicycle lanes paired with a designated horizontal buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

Minimum buffer dimensions are:

- Adjacent to travel lane: Two feet (2')
- Adjacent to parking lane: Three feet (3')
- Additional bike lane or buffer width may be required at the CITY ENGINEER's discretion.

The buffer should be marked with two (2) solid white lines with interior diagonal cross hatching spaced at a distance equal to the roadway's speed limit. For clarity at driveways or minor street crossings, consider a dotted line for the buffer boundary where cars are expected to cross.

8.13.04 Shared Bike Lanes

A shared bike lane is a shared environment with the vehicle travel lane and alerts motor vehicle drivers to the potential presence of bicyclists. The "Sharrow" bicycle symbol shall be used to provide positioning guidance for bicyclists outside of the door zone.

The "Sharrow" shall be placed in the center of the travel lane. Place the pavement marking symbol every two hundred feet (200') along the facility as well as after every intersection.

8.13.05 Bike Lanes and Right Turn Lanes

Where a separate right turn lane is provided on a facility with a bike lane, the right turn lane shall be designed with the bike separated by striping between the turn lane and through travel lanes. Refer to the standard drawings and the MUTCD for striping and signing treatments.

8.13.06 Shared Bike and Parking Lanes

Shared bike and parking lanes may be considered with the approval of the CITY ENGINEER in certain residential areas of low parking demand, typically on a residential collector roadway.

The shared bike and parking lane shall be delineated with a solid white line. The minimum width shall be ten feet (10') from the curb face, with a desirable width of twelve feet (12'). Required pavement symbols will be evaluated by the CITY on a case by case basis.

8.13.07 Bike Racks

Bike racks may be required to be installed adjacent to identified high user locations as directed by the CITY including, but not limited to, the following:

- Public transit facilities
- Schools
- Commercial destinations
- Transit Oriented Developments

Refer to the standard drawings for details of bike racks.

8.14.00 CROSSWALKS

8.14.01 General Requirements

Crosswalks are areas of roadway that are delineated to indicate where pedestrians are recommended to cross. Standard crosswalks shall be delineated with rectangular white crosswalk bars. In certain instances, crosswalks may have patterns or be constructed from materials that further increase their visibility.

8.14.02 School Crosswalks

Higher-visibility ladder-style crosswalk markings shall be placed in a roadway crosswalk contiguous to a school building or grounds.

8.14.03 Raised Crosswalks

A raised crosswalk is a marked pedestrian crosswalk at an intersection or a mid-block location constructed at a higher elevation than the adjacent roadway. A raised crosswalk is similar to a speed table, with the full width of the crosswalk contained within the flat portion of the table, typically ten feet (10') wide.

Raised crosswalk locations shall be approved by the CITY ENGINEER. Drainage must be accommodated by the developer with inlets or chase drains and approved by the CITY.

8.20.00 **CONSTRUCTION STANDARDS**

8.21.00 **TRAFFIC SIGNALS**

8.21.01 **General Requirements**

The work specified in this section describes the installation of necessary material and equipment to complete traffic signals and/or other electrical systems as specified on the drawings, in the special contract provisions, or herein.

8.21.02 **Traffic Control and Street Closure**

The CONTRACTOR will be required to maintain access to all private drives throughout the period of construction for this project. The CONTRACTOR shall be required to erect and maintain all barricades, traffic control signs, cones, and other traffic control items necessary to provide proper traffic control during construction. The CONTRACTOR shall submit the traffic control plan to the TRAFFIC ENGINEER for approval 72 hours prior to beginning construction. At the completion of the project the CONTRACTOR shall remove all barricades, traffic control signs, cones and other necessary construction traffic control items and return all areas or permanent traffic control devices damaged during construction to their original condition at no cost to the CITY. Traffic control signs and devices shall be in accordance with Part VI of the MUTCD, latest edition, published by the Federal Highway Administration, and as directed by the TRAFFIC ENGINEER.

8.21.03 **Intersection Power**

The CONTRACTOR shall be responsible to contact Xcel Energy for requesting the power connection. Installation of an electric meter will require a CITY Building Permit. The CONTRACTOR is responsible for requesting a meter address from the TRAFFIC ENGINEER.

8.21.04 **Equipment Salvage**

Unless otherwise noted, all traffic signal equipment which is removed shall remain the property of the CITY. Such property is to be removed from the work site and returned by the CONTRACTOR to the CITY, as directed by the TRAFFIC ENGINEER. All delivery costs shall be the responsibility of the CONTRACTOR.

8.21.05 **Existing Traffic Signals**

When existing traffic signal installations are modified or completely rebuilt, the CONTRACTOR shall avoid disturbing existing traffic signal equipment until the new or modified traffic signal system has been installed and put into operation. If the existing traffic signal equipment must be removed to accommodate the new construction, the CONTRACTOR shall, with the TRAFFIC ENGINEER's approval and at no cost to the CITY, install temporary overhead traffic signal equipment. The CONTRACTOR shall at all times maintain a minimum of two (2) three-section (red, yellow, and green) traffic signal heads for each roadway approach.

8.21.06 Signal Heads

Signal heads installed on standards or poles at new signal locations which are not ready for actual electrical operation shall be bagged orange or turned away from traffic.

8.21.07 Field Location

All loops, poles, control cabinets, pull box locations, and pole foundations shall be field located by the TRAFFIC ENGINEER.

8.21.08 Utilities

All utilities shall be shown on the maps to the extent that they can, based upon utility records, surface field indications and proposed installations. During the progress of the work, all utility locations and elevations will necessarily require field verification in cooperation with the affected companies and public agencies. The CONTRACTOR shall be responsible for locating all valve boxes, manholes, etc., and insuring that they are properly protected and/or adjusted.

8.22.00 REGULATIONS AND CODE

All electrical equipment and material shall conform to the standards of the National Electrical Manufacturers Association (NEMA). In addition to requirements of these specifications, the plans, the special contract provisions, all material, and work shall conform to the requirements of the National Electrical Code (hereinafter referred to as the "NEC"), the Rules for Overhead Electrical Line Construction of the Public Utilities Commission, the Standards of the American Society for Testing Materials (ASTM), and any local ordinance which may apply. Wherever reference is made in these specifications or in the special contract provisions to the code, rules, or the standards mentioned above, the reference shall be construed to mean the code, rule, or standard that is in effect at the date of bidding.

8.23.00 SUBMITTAL REQUIREMENTS

The submittal shall include all equipment and material as identified on the plans or in the specifications by the manufacturer's name which is necessary or customary in the trade to identify such equipment and material. The list shall be complete as to name of manufacturer, unit size, material composition and shall be supplemented by such other data as may be required by the TRAFFIC ENGINEER.

Inspection or sampling of any materials, other than those already approved, according to the material specifications must be made by the TRAFFIC ENGINEER prior to installation. If the CONTRACTOR proposes a substitution of equipment called for in the plans or specifications, he shall provide additional information to prove the substitution item is of equal or superior quality. Any material and/or equipment installed by the CONTRACTOR that is not in conformance with these STANDARDS AND SPECIFICATIONS will be removed or changed at the CONTRACTOR's expense. Upon completion of the work, the CONTRACTOR shall submit an "as-built" plan showing, in detail, all construction changes including, but not limited to, wiring, cable, and location and depth of conduit.

8.24.00 BORING, EXCAVATING AND BACKFILLING

Excavations for the installation of conduit, foundations, and other traffic signal items shall be performed in such a manner as to cause the least possible injury to the streets, sidewalks, and other improvements. The

trenches shall not be excavated wider than necessary for the proper installation of the electrical appliances and foundations. Excavating shall not be performed until immediately before installation of conduit and other appliances. The material from the excavation shall be removed as the trenching progresses.

All conduit to be installed under existing roadways shall be bored. Trenches in proposed roadways shall be backfilled according to Chapter 9. After backfilling all trenches shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs are made.

Excavations in existing streets for conduit shall require CITY ENGINEER approval. All lane closures shall be approved by the TRAFFIC ENGINEER prior to closure. At the end of each day's work and any other time construction operations are suspended, all construction equipment and other obstructions shall be removed from that portion of the roadway open for use by public traffic. When excavations must remain open overnight, they shall be properly marked to warn motorists and/or pedestrians according to guidelines established in the MUTCD.

8.25.00 REMOVING AND REPLACING IMPROVEMENTS

If the CONTRACTOR removes material beyond the limits of disturbance in the plans, the material shall be repaired or replaced at the CONTRACTOR's expense. Whenever a part of a square or slab of existing concrete, sidewalk, or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed according to these STANDARDS AND SPECIFICATIONS.

The outline of all areas to be removed in concrete sidewalks and in pavements shall be a full depth cut to a neat vertical line, with no shatter outside the removal area, with an abrasive type saw prior to removing the sidewalk and pavement material.

8.26.00 UNDERGROUND FACILITIES

8.26.01 Foundations

- (A) All foundations shall be CDOT Class BZ concrete conforming to the applicable requirements of these STANDARDS AND SPECIFICATIONS, except as herein provided.
- (B) The bottom of concrete foundations shall rest on firm ground. Cast-in-place foundations shall be poured monolithically where practicable. The exposed portions shall be formed to present a neat appearance.
- (C) Forms shall be true to line and grade. Tops of foundations, except as noted on plans, shall be finished to curb or sidewalk grade or as ordered by the engineer. Forms shall be rigid and securely braced in place and inspected prior to the pouring of concrete. Conduit ends and anchor bolts shall be placed in proper position and in a template until the concrete sets.
- (D) Anchor bolts shall conform to the specifications and each individual bolt shall have two (2) flat washers, one (1) lock washer, and two (2) nuts. Shims or other similar devices for plumbing or raking will not be permitted.
- (E) Both forms and ground which will be in contact with the concrete shall be moistened before placing concrete. Forms shall not be removed until the concrete has thoroughly set.

- (F) All abandoned foundations shall be removed to a minimum 2' below finished grade and disposed of by the CONTRACTOR. The CITY ENGINEER may require a full depth removal on a case-by-case basis. All conduit runs associated with an abandoned foundation shall be extended or abandoned as called for on the plans. When a foundation is removed, the hole shall be backfilled in accordance with CDOT and these STANDARDS AND SPECIFICATIONS.

8.26.02 Conduit

- (A) All conduit shall be PVC Schedule 80 or greater. All cables and conductors not shown on the plans as aerial cable shall be installed in conduit unless installed in poles, pedestals, or mast arms.
- (B) All trenches excavated in new construction areas shall be backfilled with in accordance with these STANDARDS AND SPECIFICATIONS. Conduit to be installed under existing roadways shall be bored.
- (C) Following conduit schedule is in effect unless otherwise specified in the plans:

<u>Run Type</u>	<u>Quan.</u>	<u>Size</u>	<u>Use</u>
Street Crossings	1	3"	120 voltage
Street Crossings	2	2"	Low voltage
Street Crossings	1	2"	Xcel use
Signal Pole	1	3"	Signal cables
Signal Pole	1	2"	Xcel use
Controller Cabinet	2	3"	120 voltage
Controller Cabinet	2	2"	Low voltage
Interconnect	1	2"	Interconnect
Service Point	1	2"	Xcel use

- (D) The CONTRACTOR, at their sole expense, may use larger conduit if desired. Where larger conduit is used, it shall be for the entire length of the run from outlet. No reducing couplings will be permitted underground.
- (E) The end of all metal conduit, existing or new, shall be well reamed to remove burrs and rough edges. Field cuts of existing or new conduit shall be made square and true, and the ends shall butt together for the full circumference thereof. Slip joints of running thread will not be permitted for coupling metal conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used. All couplings shall be screwed up until the ends of the metal conduits are brought together.
- (F) Bored conduit bends shall have a radius of not less than six (6) times the inside diameter of the conduit.
- (G) Conduit shall be laid at a depth of not less than twenty-four inches (24") below the top of curb grade in sidewalk or grass areas and to a depth of not less than thirty inches (30") below the finished grade in all other areas. Conduit under railroad tracks shall meet applicable railroad requirements.

- (H) Conduit shall always enter a foundation, pull box, or any other type structure from the direction of the run only.
- (I) Conduits terminating in a pole shall extend approximately three inches (3") vertically above the foundation.
- (J) All conduit runs that exceed ten feet (10') in length shall have a continuous nylon line pulled into the conduit along with the specified electrical cables. The line shall be firmly secured at each end of the conduit run with a minimum slack of three feet (3'). The purpose of this line is to be able to pull future electrical cable through the existing conduit runs.
- (K) Existing underground conduit to be incorporated into a new system shall be cleaned with a mandrel or blown out with compressed air.
- (L) All empty conduit shall have a 14-gauge stranded copper tracer wire installed.

8.26.03 Pull Boxes

- (A) A pull box shall always be installed in combination with a traffic signal pole and at all other locations shown on the plans and at such additional points as ordered by the engineer.
- (B) Special pull boxes which are required shall be fabricated and installed in general conformance with the size and details shown on standard drawings.
- (C) Pull boxes installed in concrete or similar finished areas shall be designed for such installations and shall be stackable and manufactured of a pre-cast polymer concrete material or an approved equal, with minimum 20,000 lb load rating. Unless otherwise noted, pull box lids shall have the word "Traffic" cast into them. Pull boxes shall be installed so that the covers are level with curb or sidewalk grade or level with the surrounding ground when no grade is established. The bottoms of all pull boxes shall be bedded in minimum $\frac{3}{4}$ " pea gravel or crushed rock to a minimum depth of two inches (2"). Conduit ends shall extend three inches (3") above the gravel or rock bed.
- (D) When a new conduit run enters an existing pull box, the CONTRACTOR shall remove the pull box or tunnel under the side at no less than eighteen inches (18") below grade and enter from the direction of the run. No new conduit will be allowed to enter a new or existing pull box in any other manner than that shown on standard drawings.
- (E) Loop detector pull boxes installed in the street shall be placed according to the plans or as directed by the engineer. The lids shall have the word "Traffic" cast into them.

8.26.04 Detector Loop Wire Installation

- (A) Each individual detector loop is to be terminated within a water valve housing as specified on the construction drawing, and each loop shall consist of one continuous wire, without splicing, to this termination point. Any required series or parallel connections are to be at the termination point.

- (B) All loops shall have a tag attached to the leading clockwise lead of the loop. This tag shall be marked to indicate the relative location of the loop. This marking shall correspond directly to the loop designations on the intersection drawing provided in the contract.
- (C) Detector loop roadway slots shall be cut in asphalt that has a 6 inch minimum depth and sealed one-fourth inch (1/4") below the surface level of the roadway with 3M or approved equal. This sealer is to be used whether or not the roadway is to be overlaid.
- (D) The CONTRACTOR shall include cost for loop wire, saw cutting, sealant, splice and test for a complete installation of the loop to the termination point for the pay item price.

8.26.05 Conductor and Cable

- (A) Wiring shall conform to appropriate articles of the NEC. Wiring within cabinets, junction boxes, etc., shall be neatly arranged.
- (B) Powdered soap stone, talc, or other approved lubricant shall be used in placing conductors in conduit.
- (C) A common neutral conductor, separate from the signal light circuit neutral, shall be used for all low-voltage circuits, including the detectors and pedestrian push-button circuits.
- (D) Splicing of cable will not be permitted in conduit or pull boxes or outside of signal heads, standards or foundations.
- (E) In no case shall any shellac compounds be used. Buchanan or approved equal type connectors shall be used on all splices made above ground level. Detector loop lead-in splices in underground systems shall be waterproofed with 3M splice kits or CITY approved equivalent. A minimum of twelve inches (12") of slack shall be left at each splice except within hand-holes where twenty-four inches (24") shall be left.
- (F) When conductors and cables are pulled into the conduit, all ends of 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 and marked.
- (G) Cable shall be stranded. For span wire type installations, cable shall be installed where specified on the plans and secured to messenger cable with cable rings in accordance with standard practices. Aerial cable shall be supported by strand vices of proper size and strength as well as insulators used where necessary.
- (H) A small permanent tag on which the direction and phase is printed, in the order named, using the codes given in "**Cable Schedule**," shall be securely attached near the end of each conductor at each controller, standard, or pull box where conductors are separated. Where direction and phase are not clearly indicated by conductor insulation, additional tags shall be used.

TABLE 8-26-05
Cable Schedule

<u>Phase/Tag</u>	<u>Tape Color</u>
1. NBLT	Red/White
2. NB	Red
3. SBLT	Green/White
4. SB	Green
5. EBLT	Orange/White
6. EB	Orange
7. WBLT	Blue/White
8. WB	Blue
9. Pedestrian	Yellow

NOTE: This is a typical cable schedule and shall be used for the wiring of all signal installations. A new cable schedule will be noted on the plans at each intersection where different phasing and/or special equipment is required. It should be noted that a band of white is used to indicate a left turn and yellow for a pedestrian movement. This is in addition to directional tape for the phase. For cable size and number of conductors see traffic signal material specifications and/or standard drawings.

- (I) Inboard and outboard heads, mounted on mast arms, are to be wired separately from head to base of pole.

8.26.06 Bonding and Grounding

- (A) Metallic cable sheaths, metal poles, and foundations shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire, No. 8 AWG, for all systems. Beldon cable sheath for loop detectors to be grounded in control cabinet only. The other end of the sheath to be left ungrounded.
- (B) Bonding of standards shall be by means of a bonding wire attached to a bolt or a three-sixteenths inch (3/16") or larger bolt installed in the lower portion of the shaft.
- (C) At each pull box the ground electrode shall be a one-piece copper ground rod of five-eighths inch (5/8") diameter and eight feet (8') in length, driven into the ground so that the top is four inches (4") above the bottom of the pull box. The ground rod connector will be placed so that the bare copper wire, No. 8, can be pulled into a pole, foundation, or attached to the control cabinet ground buss.

8.26.07 Maintenance

The CONTRACTOR shall have full maintenance responsibility of the traffic signal from the date of the written notification by the TRAFFIC ENGINEER to the final inspection and date of written approval of the work performed. Continuous maintenance and emergency service shall be provided by the CONTRACTOR 24 hours each day during the time frame outlined above.

The CONTRACTOR shall provide and maintain a 24-hour a day continuous one number telephone answering service. All malfunctions of a controller and its accessory equipment shall be considered an emergency unless otherwise identified by the City. Equipment malfunctions and/or damage, which in the opinion of Westminster's TRAFFIC ENGINEER or other authorized person, constitutes a serious hazard or inconvenience to the public shall be considered an emergency. Such malfunctions or damage may include, but not necessarily be limited to, situations where:

- (A) all indications are out including bulbs and lenses, for any one traffic movement;
- (B) signal heads give conflicting indications to any intersection approach;
- (C) a signal has been knocked down;
- (D) an overhead red indication is out

CONTRACTOR shall undertake each such emergency repair no later than one hour after Westminster notifies CONTRACTOR of the emergency.

Should the CONTRACTOR fail to perform any maintenance responsibilities within the prescribed time periods, the TRAFFIC ENGINEER or other authorized person shall employ the services of the CITY's designated Traffic Signal Maintenance Contractor to perform said maintenance work. The CONTRACTOR shall reimburse the CITY for labor and equipment charges associated with the utilization of the CITY's designated Traffic Signal Maintenance Contractor plus a fifteen percent (15%) administration fee.

8.26.08 Field Testing

Prior to completion of the work, the CONTRACTOR shall cause the following tests to be made on all traffic signals in the presence of the engineer or his designee.

- (A) Each circuit shall be tested for continuity.
- (B) Each circuit shall be tested for grounds.
- (C) A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended herein. The functional test for each traffic signal system shall consist of not less than fourteen (14) days of continuous, satisfactory operation commencing with full operation of all electrical facilities. During the fourteen-day period, the CONTRACTOR will maintain the system or systems. The cost of any maintenance necessary, except electrical energy and maintenance due to damage by public traffic, shall be borne by the CONTRACTOR and will be considered as included in the price paid for the contract item involved, and no additional compensation will be allowed.

8.27.00 TRAFFIC SIGNING AND PAVEMENT MARKINGS

8.27.01 General

The installation of all traffic control devices shall conform to the MUTCD, latest edition, and the CDOT Standard Specifications for Road and Bridge Construction, latest edition.

8.27.02 Traffic Control Devices on Public Property

All permanently fixed traffic control devices will generally be installed by the DEVELOPER at no cost to the CITY. Traffic control devices shall be placed to conform to the drawing details. Unless otherwise noted, street name signs will be installed by the CITY at the DEVELOPER's expense.

8.27.03 Traffic Control Devices on Private Property

- (A) **Responsibility:** All traffic control devices on private property; e.g., pavement markings, regulatory signs, stop signs for private drives entering public roads, fire lane signs, and accessible parking signs shall be installed and maintained by the property owner.
- (B) **Placement:** A signage and striping plan specifying the various types and combinations of traffic control devices shall be submitted to the TRAFFIC ENGINEER for approval.
- (C) **Damaged Private Signs:** If the CITY is aware of a private sign that is damaged and requires corrective action, the CITY will make best efforts to contact the responsible party. If the CITY does not receive a response within twenty-four (24) hours the CITY will conduct the corrective action and bill the property owner for the work required.

8.27.04 Pavement Markings

All lane line pavement markings required to be installed as a result of new construction or development shall be epoxy. Alternative materials for lane lines may be required in certain cases by the TRAFFIC ENGINEER. Preformed tape may be required on concrete pavement for lane lines.

Pavement marking symbols such as turn arrows and bike lanes shall be preformed thermoplastic. The use of the "ONLY" word marking in turn lanes is discouraged and should be replaced with an additional arrow. Stop bars, yield lines and crosswalk bars shall be thermoplastic. Alternative materials may be required in specific cases by the TRAFFIC ENGINEER.

Temporary pavement markings necessary to facilitate construction (i.e. detours) may be installed using paint.

The CONTRACTOR shall submit a plan for all pavement markings to the TRAFFIC ENGINEER for approval prior to the beginning of the work. The pavement marking plan shall meet the requirements for such work as outlined in the Manual on Uniform Traffic Control Devices. All pavement marking materials must be approved by the TRAFFIC ENGINEER.

8.28.00 TRAFFIC CONTROL IN CONSTRUCTION AREAS

8.28.01 General

The requirements of this chapter shall apply to any person, corporation, municipality, quasi-municipality agencies, mutual companies, electric, gas or communication utility (including

telecommunications) who for any reason cuts, disturbs or otherwise defaces any City road for the purposes of installing or repairing or for any reason pertaining to the presence of an underground utility or structure.

For any construction done on, in or to an existing CITY roadway and/or right-of-way or for the construction of a new CITY roadway, appropriate traffic control during construction shall be provided. For any such construction, a TRAFFIC CONTROL PLAN shall be prepared by the CONTRACTOR and/or DEVELOPER and shall be approved by the TRAFFIC ENGINEER prior to issuance of a PERMIT.

Where a roadway does not currently exist, it is presumed that there is no motorist expectation of a travel route. Therefore, a TRAFFIC CONTROL PLAN for construction of a new roadway should strive to do two things: alert the motorist that this is a construction area, and alert the motorist that the road is not open to traffic. TRAFFIC CONTROL PLANS shall also be prepared for construction occurring on existing CITY roadways where the motorist has an expectation of accessibility and shall be warned, advised, guided or regulated through any construction activity.

8.28.02 Time of Submittal

A TRAFFIC CONTROL PLAN shall be submitted to the TRAFFIC ENGINEER at the earliest with the submittal of final construction plans and at the latest with the application for a right-of-way or public improvement construction permit(s). All final construction plans submitted to the CITY that entail construction on an existing CITY roadway or construction of a new CITY roadway must either:

- (A) Be accompanied by a TRAFFIC CONTROL PLAN.
- (B) Include a note stating a TRAFFIC CONTROL PLAN shall be submitted to the CITY for approval before any permit for construction is issued. No PERMIT shall be issued without the approved TRAFFIC CONTROL PLAN.

8.28.03 Scope of Construction Traffic Control Plan

For construction of new roadways, traffic control during construction should strive to keep all modes of mobility from entering the facility. The primary means to accomplish this are by use of temporary barricades located in advance of the point where new construction joins old and appropriate signing. New roadways shall not be opened to general traffic and the construction traffic controls shall not be removed, without the approval of the CITY INSPECTOR and the TRAFFIC ENGINEER. One precondition of such an opening is that permanent signage and striping be in place.

8.28.04 Elements of Construction Traffic Control Plan

- (A) All TRAFFIC CONTROL PLANS shall contain the following information:
 - 1. Name of contracting firm and, if different, the name of the firm responsible for traffic control devices.

2. Name and phone number(s) of 24-hour contact person responsible for traffic control devices.
 3. Description of location of activity (roadway names, north arrow, etc.)
- (B) Projects identified as minor TRAFFIC CONTROL PLANs as determined by the TRAFFIC ENGINEER shall include, in addition to items listed in (A) above, either one of the following:
1. A detailed MHT of the roadways and the proposed traffic control devices; or
 2. A copy of a typical drawing of traffic device layout from an accepted source approved by the TRAFFIC ENGINEER.
- (C) Projects identified as major TRAFFIC CONTROL PLANs as determined by the TRAFFIC ENGINEER shall include, in addition to items in (A) above, the following: The proposed traffic control devices specifically identified as to type and explicitly noted and dimensioned on construction plan drawings or other detailed drawings. Major projects shall require TRAFFIC CONTROL PLANs prepared by a certified Traffic Control Supervisor.

8.28.05 Basis for Construction Traffic Control Plan

The MUTCD, latest edition, shall be the basis upon which the TRAFFIC CONTROL PLAN is designed in concert with proper, prudent and safe engineering practice. All necessary signing, striping, coning, barricading, flagging, etc. shall be shown on the plan.

8.28.06 Restriction, Regulations and Opportunities

In concept, CITY streets shall not be closed overnight and work shall not force road or lane closures before 8:30 a.m. or after 3:30 p.m. If exceptions to this are required, this shall be noted on the TRAFFIC CONTROL PLAN and shall be approved by the TRAFFIC ENGINEER. Travelway width may be restricted. Minimum travel lane width in construction areas shall be ten feet (10'), but proper controls, including flagging, shall be indicated. Prohibition of on-street parking should be considered and noted where applicable.

All traffic control devices necessary to provide for public safety at the work site shall be furnished and maintained by the CONTRACTOR at his own expense.

8.28.07 Approval

The TRAFFIC ENGINEER shall approve all TRAFFIC CONTROL PLANs. All complete road closures and all partial road closures (removing one or more travel lanes) that are proposed for overnight shall be approved by the TRAFFIC ENGINEER. One (1) copy of the approved plan shall remain with the CITY INSPECTOR for their verification that the TRAFFIC CONTROL PLAN has been adhered to in the field. One (1) copy shall be placed in the engineering project file. The CONTRACTOR shall have one (1) approved copy of the TRAFFIC CONTROL PLAN on site at all times.

8.28.08 Modifications

Actual conditions in the field may necessitate modifications to the TRAFFIC CONTROL PLAN. Provided that the general intent of the original plan is satisfied, these modifications may occur without revision to the plan. The CITY INSPECTOR shall be notified of any substantial changes.

8.30.00 MATERIAL SPECIFICATIONS

8.31.00 SIGNAL HEADS

8.31.01 Traffic Signal Unit Specifications

- (A) All signal units shall be of the individual section, adjustable type, black polycarbonate or approved equivalent. Unless otherwise noted on the plans, all signal and pedestrian displays shall be ITE approved LED and conform to the appropriate sections below. One southbound overhead red and green indication shall be SnowMelt LED type and conform to sections B through C below.
- (B) Visors shall be detachable, of the twelve-inch (12") tunnel type, open at the bottom; be black in color on the outside and flat black on the inside.
- (C) Doors on the signal heads for the installation of lamps and lens replacement or other maintenance shall not require use of any tool whatsoever to be opened. Doors and lenses shall be equipped with neoprene weatherproof gaskets to insure against infiltration of moisture, road film, and dust. Each three-color signal unit shall have the socket leads from all signal sections connected to a terminal board stamped with identifiable terminals. There shall be a terminal for color indication plus a common terminal where one lead from each socket shall terminate. The terminal board shall be mounted in the middle section and be properly insulated. All openings, top and bottom, shall be for one-half-inch (1/2") pipe or pipe mounting brackets. Gaskets shall be supplied for top and bottom openings.

8.31.02 Pedestrian Signal Units

Sixteen-inch (16"), one-way, ICC or equal pedestrian signal head as specified on the plans. "Walk/Don't Walk" indications shall be symbolized with countdown indication..

8.31.03 Backplates

- (A) Where shown on the plans, black back plates shall be furnished and installed on signal faces. No background light shall show between the back plates and the signal face or between sections. All back plates are to be of aluminum construction and shall be the louvered type. Back plates shall provide a five-inch (5") border with a two-inch (2") yellow outline for all twelve-inch (12") signal heads.
- (B) Traffic signal heads requiring backboards shall be drilled for three-sixteenths-inch diameter by one-half-inch (3/16" x 1/2") pan head bolt with nut and lock washer. If the

manufacturer fails to supply as described, it will then be the CONTRACTOR's responsibility to do so. When installing backboards on the traffic signal head, the CONTRACTOR will furnish three-sixteenths-inch (3/16") fender washers between bolt head and backboard

- (C) The manufacturer will fabricate all backboards with a three-sixteenths-inch (3/16") washer on both sides of each rivet which is used to hold each section of backboard together.

8.32.00 ELECTRICAL CABLE

8.32.01 Signal Cable

14 AWG multi-conductor, stranded, copper wire manufactured to meet IMSA 25-1 specifications or approved equivalent. Each conductor in the cable will be individually insulated and rated at 600 volts. There shall be a minimum of four (4) and a maximum of nine (9) strands per conductor. There shall be a separate 25-conductor cable installed from the controller cabinet to the bottom handhold of each signal pole. From that point, a separate 5 or 7-conductor cable for each overhead signal and 7-conductor to outside signal head shall be spliced to the 25-conductor cable.

8.32.02 Interconnect Cable

Unless otherwise noted, all traffic signal interconnect communications shall be accomplished through a single-mode fiber optic cable system. Provisions for the fiber optic system shall be annotated on the plans or described by supplemental specifications. As a minimum the fiber optic cable shall be an outdoor rated single-mode cable, 96 fiber strands grouped into 8 buffer tubes of 12 each with wavelengths of 1300/1310 nm.

8.32.03 Loop Wire

Detect-A-Duct Cable consisting of single conductor No. 14, stranded THHN with an outer protective sleeve. No splices allowed in traffic valve box with loop wires pulled through to the closest pull box behind the curb for splice termination to loop lead-in cable.

8.32.04 Pedestrian Push-Button Cable

Two (2) conductor No. 14, seven (7) strands, tinned, soft-drawn copper wire, one-sixteenth-inch (1/16") neoprene insulation. Conductors to be twisted. Color coded one (1) white and one (1) black.

8.32.05 Loop Lead-In Cable

Detector loop lead-in cable shall be a four conductor .25 inch diameter, shielded and jacketed cable suitable for installation in a pavement sawslot, conduit or direct burial. Conductors shall be AWG No. 18 stranded copper with polypropylene insulation. The conductors shall be twisted at least six turns per foot. Color rotation shall be black, red, white, green. The interior of the cable shall be filled with an amorphous material which prevents water penetration. Aluminized polyester shielding shall be applied around the conductors to prevent electromagnetic interference. The Cable jacket shall consist of black high density polyethylene.

The jacket shall not be degraded by prolonged exposure to typical pavement runoff components. The cable shall be suitable for operation at temperatures of -60°C to +80°C. (Canoga 30003 43#18 AWG shielded loop detector lead-in cable or approved equal.)

8.32.06 Ground

Single conductor, AWG No. 8, soft-drawn bare copper wire.

8.32.07 Optical Detector Lead-In Cable

The lead-in cable for the Emergency Vehicle Optical Detectors shall be 3M Type 138 or approved equal.

8.33.00 VEHICLE DETECTORS

8.33.01 General

- (A) Unless otherwise noted, all traffic signal vehicle detection systems shall be accomplished through a video camera system. All camera systems shall be 100 percent compatible and identical in both operations and programming with the CITY's existing Econolite Vision Camera system or approved newer Econolite model. The remaining portions of this section reference roadway imbedded inductive loop systems and are applicable when specified. This specification defines the minimum design operational and performance requirements for multiple channel, digital self-tuning inductive loop detectors, detector units shall be card rack mounted plug-in type and operate from an external 24 VDC power supply. Detector units shall be in full compliance with the environmental and size requirements of NEMA standard TS1-Section 15 and meet the design, operation, electrical and functional performance requirements of both TS1 and TS2 specifications.
- (B) The front panel shall include an erasable, write-on channel identification area and clearly indicated switch operating position. I.D. area one centimeter square per channel minimum.
- (C) All component part and test points shall be clearly identified by permanent marking of circuit referenced on the P. C. Board. Integrated circuit devices having 16 or more leads shall be socket-mounted to facilitate repair and maintenance of units. Detectors supplied to this specification shall be warranted by the supplier to be free of defects in materials and workmanship for a period of five years from date of shipment from manufacturer.
- (D) Each detector unit shall include two or four complete detector channels. Each channel shall sequentially energize its loop inputs to eliminate crosstalk (mutual coupling) between large, very closely spaced adjacent loops connected to the same unit. The sequential time sharing and digital processing of loop inductance data shall be accomplished on a single LSI microcircuit per unit for maximum reliability. The method of measuring shall be crystal reference digital period counting, multi-channel scanning. Only one channel input per unit shall be active at any point in time.
 - 1. Sequential scanning shall fully prevent crosstalk between channels of a detector connected to closely spaced or overlapped loops for directional detection.

2. Sequential scanning shall allow two detection channels to operate with full performance using a common home-run cable.
 3. Sequential scanning shall allow two or more detection channels to be connected to a single detection amplifier with full operating performance, including separate mode and sensitivity selection capability on each channel.
- (E) Each channel of the sensor unit shall automatically self-tune to any loop and lead-in inductance from 20 to 2500 microhenries within 2 seconds with full sensitivity after application or interruption of supply voltage. Units shall also track changes in loop/lead-in electrical characteristics, as might reasonably be expected to occur in undamaged loops, properly installed in sound pavements, without producing false indications or changes in sensitivity.
- (F) Each detector unit shall be provided with a loop test switch position to verify loop system integrity and reduce maintenance costs. The "open loop test" position shall indicate a previous fault via the front panel indicator. The memory shall remain intact and can be queried repeatedly. Existing detections shall not be reset and the memory shall only be reset by power interruption as by removing and re-inserting the plug-in detector units.
- (G) Each channel shall include a 16-position Push type wheel switch to allow selection of 8 pulse sensitivities, 7 presence levels and a "Reset" and an "Off" position. Each detector unit shall include 8 sensitivity selections in 2:1 steps that can be correlated to the relationship of the number of turns of wire in a loop versus the sensitivity required to detect a specified vehicle. The selections shall be designed to allow detection of licensable vehicles in loops of two or more turns electrically in series, parallel or series/parallel configuration in non-reinforced or reinforced pavements with lead-in/homerun combinations from 50-feet to 1000-feet. The number of turns in a loop, electrical configuration of multiple loops and pavement type will dictate the sensitivity required for proper, predictable detection.
- (H) If specified, channel presence time shall be modified if delay or extension time is selected. The timing switch shall select delay or extension or "Off", if no timing is desired. Internal DIP switches shall provide for selection of "Delay" time of 0 to 31 seconds in 1.0 second increments and "Extension" time of 0 to 7-3/4 seconds in .25 second increments.
- (I) Presence indicators shall be wide angle, high brightness type LED's suitable for sunlight visibility. When timing is selected and a channel is active that channel's indicator shall flash at 4 Hz during Delay and at 16 Hz during Extension to indicate timing is in progress. Further, the timing shall be aborted when the vehicle is no longer present and/or the channel control input shall become inactive. The Delay timer shall be reset when a vehicle leaves the loop prior to time out and shall abort when the control input becomes inactive. The Extension timer shall operate and reset when a vehicle leaves the loop and be aborted when the control input becomes inactive. Each timer (Delay and Extension) shall be provided with buffer circuitry to enable or disable the timer based on an external input (green gate) signal. Circuit shall be designed for AC or DC input control on AC powered units and for DC control on DC powered units.

- (J) Each detector unit shall utilize a $\Delta L = (\text{Delta-L})$ thresholding technique to provide a more constant, predictable vehicle detection sensitivity with series added inductance, i.e., many loops connected in series and/or long lead-in/homeruns will generally require the same sensitivity setting as would be required for a single loop with short lead-in, to simplify setup.
- (K) Each channel shall automatically recover from intermittent opens or multiple shorts to ground. Each channel shall tolerate and continue to operate with no change with a single point short to ground on the loop or lead-in system. Each channel shall provide a continuous, non-resettable (fail-safe) output and indication in response to an open loop/open lead-in system. The open loop indication and output shall not be resettable as long as the open exists, except that they shall be defeated when the channel "Off" position is selected.
- (L) Extended features shall include: Two serial ports (front panel RS232 and Edge connector Xmit/Recve), TS1 and TS2 compatible from manual or software switch, microloop occupancy detection, Traffic counting capable to include long-loop presence count from 15 minute to infinite intervals all accessible from either serial interface, Dual Detect and Fault LED indicators per channel, External inputs to control Timing functions and enable Remote Reset, Extended diagnostics, programming and Live status available via serial interface utilizing windows compatible software.

8.34.00 EMERGENCY VEHICLE DETECTORS

OPTical COMmunication Detectors for emergency vehicle pre-emption shall be the GTT Model 711, 712 or 722 Optical Detector or approved equal as specified in the construction plan notes. Placement of the Detectors shall be determined by the Engineer. Optical phase selector modules for emergency vehicle pre-emption shall be GTT Model M762 or M764.

8.35.00 DETECTORS (PEDESTRIAN PUSH-BUTTON)

8.35.01 General

- (A) Pedestrian push-buttons shall be of the direct push-button contact type. They shall operate on a voltage not to exceed 18 volts AC. They shall be of tamper-proof design and equipped with a push-button instruction sign as shown in the Standard Details.
- (B) The assembly shall be weatherproof.
- (C) The housing shall be shaped to fit the curvature of the pole to which it is attached to provide a rigid installation. Saddles shall be provided to make a neat fit when required. Pedestrian signs shall be installed as shown on the Standard Details.
- (D) Pedestrian push buttons shall be accessible pedestrian signals meeting MUTCD and PROWAG requirements, and shall be Polara APS two-wire equipment or approved equal, and shall be supplied with a dongle.

8.36.00

TRAFFIC SIGNAL POLES, PEDESTALS AND MAST ARMS

8.36.01 Submittal Requirements

A Professional Engineer sealed and signed drawing or letter stating that the traffic signal structures meet the design criteria as stated in these STANDARDS AND SPECIFICATIONS will be required.

8.36.02 Traffic Signal Poles with Mast Arms

Traffic Signal poles are designed based on 4 pole sizes to accommodate the following grouping of mast arm lengths:

- (A) 20'-30'
- (B) 35'-45'
- (C) 50'-60'
- (D) 65'-70'

Traffic signal poles, lighting poles, pedestals, mast arms, luminaire arms shall be of the general configuration shown in the CITY's Standard Details. Pole should be designed to accommodate the standard loads as shown on the standard plan drawing. All traffic signal poles and mast arms shall be designed to meet the most current edition of the 2015 AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals, using the following design criteria:

- (A) Design shall use Typical Risk Category with an ADT > 10,000 (1700 year MRI) and 130mph per Colorado special wind region.
 - 1. Fatigue Category I (Traffic)
 - i. Design shall include Natural Wind Gust, Galloping and Truck-Induced Gust Fatigue Design Loads
 - 2. or Fatigue Category II (Traffic) must incorporate a CITY approved effective mitigation device.
 - i. Design shall include Natural Wind Gust Fatigue Load. No Galloping and Truck-Induced Gust Fatigue Design Loads are required, when a CITY approved effective mitigation device is used.
 - ii. Fatigue Category II traffic designs will only be accepted if the design includes a mitigation device that is deemed effective and has been given prior approval by the CITY. The mitigation device must be manufactured by the same manufacturer as the pole it is attached to and covered under the same warranty and liability terms. An acceptable mitigation device should be an active, non-aerodynamic vibration damper system to effectively mitigate the vertical movement under fatigue loads. Effectiveness must be proven through an analytical model and approved by the CITY ENGINEER prior to utilizing in a

design. The pole manufacturer will be required to submit all the necessary documentation and testing of the device being used on their pole. Documentation and testing must prove the device is effective for a range of loading and pole frequencies by incorporating a dampening system for large displacements and a secondary dampening system for small displacements. The multi-design system must be self-adapting and must not require structure-specific tuning. The device must provide and documentation must show an 85 percent or greater excitation reduction. The mitigation device shall be tested to withstand over 15 million large amplitude cycles with no deterioration of the dampening performance.

Currently pre-approved mitigation systems:

- Valmont Mitigator TR1 Vibration Damper on tested Valmont structure

- (B) Ice Loading is not required.
- (C) Ring-Stiffened Box Connection for Traffic Mast Arms will be used per AASHTO Section/Figure 5.6.7-2
- (D) Do not design structure following AASHTO width ratio and clear distance for unreinforced and reinforced holes as shown in section 5.14.6 and 11.9.2.
- (E) Welding shall meet requirements of AWS Latest Edition and AASHTO 2015 Section 5.14.
- (F) All poles shall be wrapped to provide maximum protection from damage prior to shipping.

8.36.03 Finishes

All items shall be hot-dipped galvanized to ASTM A123 for fabricated products and ASTM A153 for hardware items. All processing will be result in a debris free zinc coating. Galvanizing shall be abrasive blasted to a uniform dull appearance.

All items before being assembled into a completed product shall be cleaned in a manner that will remove all impurities and foreign matter. After welding, all flux shall be removed. The final assembly will be dried to ensure no moisture is trapped in the product.

8.36.04 Color Coating Specifications

- (A) An epoxy prime coat shall be applied with a minimum thickness of 5 mils on the lower eight feet of the pole and 3 mils minimum on the upper sections of pole and mast arms. Prior to finish coating, the prime coat shall have any imperfections such as sags or runs repaired by light sanding to obtain a uniform surface. Any voids shall have additional epoxy prime coat applied.
- (B) An electrostatically applied TGIC or polyester powder finish coat shall be applied to 3 mils minimum thickness. The electrostatically applied finish will be cured in a manner to provide a durable surface.
- (C) Traffic signal poles, pedestals and mast arms shall be finish coated according to the following color specifications or approved equal:

The color is Federal Standard 595C color FS 14056 (Federal Green). The CONTRACTOR shall provide a sample based on this color for approval if requested.

8.36.05 Final Steps

All poles shall be wrapped to provide maximum protection from damage prior to shipping. Following the installation of the poles and mast arms, the CONTRACTOR shall use factory-supplied paint to touch-up nicks and abrasions if necessary.

Traffic signal poles and mast arms shall not be ordered until the exact location of the pole foundations are verified and there are no underground conflicts. Potholing or foundation excavation to determine potential conflicts shall not be paid for separately, but shall be included in the unit bid costs.

8.37.00 CONTROLLER CABINET

8.37.01 General

This specification sets forth the minimum requirements for a TS2 Type 1 Traffic Control Plug-N-Go Cabinet Assembly. The cabinet assembly shall meet, as a minimum, all applicable sections of the NEMA TS2 Standard. The manufacturer shall be ISO 9001-2008 Registered and have been certified in the IPC "Class II" Electronics standard and training for all manufacturing staff to ensure manufacturing quality, documentation, and proper ongoing/continuing employee training for manufacturing processes by IPC Certified Trainers. The cabinet and controller supplied under this specification shall be by the same manufacturer to ensure matched component system testing. Where differences occur, this specification shall govern.

8.37.02 Cabinet Assembly Profile Detail

Each cabinet assembly provided to the CITY shall include the following as per outlined in the specification:

- 1 – P65 painted aluminum cabinet housing with rear door; painted white inside only
- 2 – Corbin #2 deadbolt locks
- 1 – Dual fan panel assembly
- 3 – LED light strips, 2 in top on fan panel and 1 under bottom shelf
- 2 – Full width cabinet shelves
- 2 – Battery shelves and covers mounted on the lower left side of cabinet
- 1 – Power auxiliary panel w/SHA-1210 surrestor, line filter, SSR, 1-40A CB, 2-15A CB, GFCI, extra neutral and GND bus
- 1 – 16 position vertical PNG main panel assembly
- 1 – Power buss assembly w/ 6 PNG power connectors
- 1 – 7-position SDLC hub assembly w/ 6 SDLC cables, screw down cables on hub end
- 1 – Aluminum washable cabinet air filter
- 1 – 16-channel detector rack and interface panel w/EVP interface cable
- 1 – Police/auxiliary switch assembly w/auto manual and police cord
- 1 – Generator transfer switch and confirmation light
- 1 – 6-position power strip wired to 4 position tb on left side, filtered power.
- 1 – 13" wide under shelf document drawer and laptop shelf

- 1 – 8 position load resistor panel assy
- 10 – Red jumpers for unused phases
- 1 – CCA2 controller power cable
- 1 – Flasher
- 6 – Flash transfer relays
- 16 – Load switches
- 1 – Model MMU2-16LEIP Malfunction Management Unit (MMU)
- 1 – Model EDI PS200 cabinet power supply
- 3 – Bus Interface Units (BIU)
- 1 – Hygrotherm humidity sensor and heater

8.37.03 Cabinet Design & Construction

- (A) The cabinet shall be constructed from type 5052-H32 aluminum with a minimum thickness of 0.125 inches.
- (B) The cabinet shall be designed and manufactured with materials that shall allow rigid mounting, whether intended for pole, base, or pedestal mounting. The cabinet shall not flex on its mount.
- (C) A rain channel shall be incorporated into the design of the main door opening to prevent liquids from entering the enclosure. The cabinet door opening shall be a minimum of 80 percent of the front surface of the cabinet. A stiffener plate shall be welded across the inside of the main door to prevent flexing.
- (D) The top of the cabinet shall incorporate a minimum of 1-inch slope toward the rear to prevent rain accumulation.
- (E) Unless otherwise specified, the cabinet shall be supplied with a natural aluminum finish. Sufficient care shall be taken in handling to ensure that scratches are minimized. All surfaces shall be free from weld flash. Welds shall be smooth, neatly formed, free from cracks, blowholes, and other irregularities. All sharp edges shall be ground smooth.
- (F) Where painted cabinets are specified, the exterior shall be degreased and primed with a spray applied iron phosphate coat – equivalent to a four-stage iron phosphate coat, prior to painting. The final coat shall consist of a powder-coat paint (TGIC or equivalent) applied with a minimum thickness of 2 mils. The cabinet shall be painted inside only – White.
- (G) All seams shall be continuous welded.
- (H) The lower section of the cabinet shall be equipped with a louvered air entrance. The air inlet shall be large enough to allow sufficient air flow per the rated fan capacity. Louvers shall satisfy the NEMA rod entry test for 3R ventilated enclosures. A non-corrosive, removable aluminum air filter shall be secured to the air entrance. The filter shall fit snugly against the cabinet door wall.
- (I) The roof of the cabinet shall incorporate an exhaust plenum with a vent screen. Perforations in the vent screen shall not exceed 0.125 inches in diameter.

- (J) The main door and the police door-in-door shall close against a weather-proof, dust-proof, closed-cell neoprene gasket seal. The gasket material for the main door shall be a minimum of 0.250 inches thick by 0.500 inches wide. The gaskets shall be permanently bonded to the cabinet.
- (K) The handle on the main door of the cabinet shall be manufactured from cast aluminum or stainless steel. The handle shall include a hasp for the attachment of an optional padlock. The cabinet door handle shall rotate counter-clockwise to open. The handle shall be positioned so that the handle shall not cause any interference with the key when opening the cabinet door.
- (L) The main door hinge shall be a one-piece, continuous piano hinge with a stainless steel pin running the entire length of the door. The hinge shall be attached in such a manner that no rivets or bolts are exposed.
- (M) The main door shall include a mechanism capable of holding the door open at approximately 90, 145, and 165 degrees under windy conditions. The cabinet shall be provided with two (2) doors (front door and a rear door).
- (N) The front and rear cabinet doors shall be equipped with a Corbin tumbler lock Model# 1548-1 or exact equivalent, with a minimum of two keys provided.
- (O) The police door-in-door shall be provided with a treasury type lock, Corbin No. R357SGS or exact equivalent, with a minimum of one key provided.
- (P) The main cabinet front door shall incorporate a shroud to cover the filtered louvered openings as appropriate for the design. The assembly is secured on the interior of the door over the filtered louvers. The shroud is louvered downward and matches the door louvers.
- (Q) A minimum of one set of vertical “C” channels shall be mounted on each interior wall of the cabinet for the purpose of mounting the cabinet components. The channels shall accommodate spring-mounted nuts or studs. All mounting rails shall extend to within three (3) inches of the top and bottom of the cabinet. Rear-wall rail spacing shall be 18.50 inches center-to-center.
- (R) For size 6 or larger cabinets, each sidewall shall have two (2) sets of equipment mounting rails. Each rail set shall be spaced 7.88 inches center-to-center. All channel nuts used to install equipment on the rails shall be the spring loaded type.
- (S) All cabinets shall be supplied with three (3) removable shelves manufactured from 5052-H32 aluminum. The shelf shall be a minimum of 10 inches deep.
- (T) The shelf shall have horizontal slots at the rear and vertical slots at the front of the turned down side flange. The shelf shall be installed by first inserting the rear edge of the shelf on the cabinet rear sidewall mounting studs, then lowering the shelf on the front sidewall mounting studs. The shelf shall be held in place by a nylon tie-wrap inserted through the holes on the front edge of the shelf and around the front sidewall mounting studs.

- (U) The front edge of the shelf shall have holes punched every 6 inches to accommodate tie-wrapping of cables/harnesses.
- (V) All base mounted cabinets require anchor bolts to properly secure the cabinet to its base. The cabinet flange for securing the anchor bolts shall not protrude outward from the bottom of the cabinet. Four (4) anchor bolts shall be required for proper installation.
- (W) The cabinet shall be of sufficient size to accommodate all equipment. The minimal cabinet size is 65" H x 44" W x 26" D.
- (X) All enclosures shall be constructed, approved and marked in accordance with the requirements for Type 1 Industrial Control Panel Enclosures contained in UL 508A, the Standard for Industrial Control Panels. The enclosure shall meet NEMA 3R rating requirements and be marked with a UL approval sticker.

8.37.04 Terminals & Facilities

- (A) The terminals & facilities shall be supplied as a minimum in the following NEMA configuration: NEMA Configuration #4 – Sixteen (16) load switch sockets; six (6) flash transfer relay sockets; one (1) flasher socket; two (2) BIU sockets; one (1) 16-channel detector rack with one (1) BIU; one (1) Type-16 MMU.
- (B) All terminals & facilities configurations shall be provided with BIU wiring assignments consistent with the current NEMA TS2 Standard.
- (C) All terminals & facilities configurations shall be provided with sufficient RS-485 Port 1 communication cables to allow for the intended operation of that cabinet. Each communication cable connector shall be a 15-pin meal shell D subminiature type. The cable shall be a shielded cable suitable for RS-485 communications.
- (D) The grounding system in the cabinet shall be divided into three (3) separate circuits: AC Neutral; Earth Ground; Logic Ground. These ground circuits shall be connected together at a single point as outlined in the current NEMA TS2 Standard.

8.37.05 Main Panel Design & Construction

- (A) The main panel shall be constructed from 5052-H32 brushed aluminum of 0.125 inches minimum thickness and installed so as to minimize flexing when plug-in components are installed.
- (B) The 16-position main panels are provided with a mounting mechanism which allows easy access to all wiring on the rear of the panel. Lowering of the main panel shall be accomplished without the use of hand tools. Complete removal shall be accomplished by the use of simple hand tools.
- (C) All load switch and flash transfer relay sockets reference designators shall be silkscreen labeled on the front and rear of the main panel to match drawing designations. Socket pins shall be marked for reference on the rear of the panel.

- (D) Main panel load switch sockets shall be positioned either vertically/stacked or in a horizontal row.
- (E) All load switches shall be supported by a bracket, extending at least half the length of the load switch.
- (F) The sixteen (16) load switch position main panels shall have all field wires contained on two (2) rows of horizontally mounted terminal blocks. The upper row shall be wired for the pedestrian and overlap field terminations.
- (G) The field output circuits shall be terminated on a non-fused barrier type terminal block with a minimum rating of 10 amps.
- (H) The field input/output (I/O) terminals shall be identified by permanent alphanumeric labels. All labels shall use standard nomenclature per the NEMA TS2 Standard.
- (I) It shall be possible to flash either the yellow or red indication on any vehicle movement and to change from one color indication to the other by use of a screwdriver.
- (J) Field terminal blocks shall be wired to use four (4) positions per vehicle or overlap phase (green; yellow; and red flash). It shall not be necessary to de-bus field terminal blocks for flash programming.
- (K) The main panel shall contain at least one (1) flasher socket (silkscreen labeled) capable of operating a 15-amp, 2-pole, NEMA solid state flasher. The flasher shall be supported by a bracket, extending at least half its length.
- (L) One (1) RC network shall be wired in parallel with each group of three flash transfer relays and any other relay coils.
- (M) All logic-level, NEMA controller and Malfunction Management Unit input and output terminations on the main panel shall be permanently labeled. Cabinet prints shall identify the function of each terminal position.
- (N) At a minimum, three (3) 20-position terminal blocks shall be provided at the top of the main panel to provide access to the controller unit's programmable and non-programmable I/O. Terminal blocks for DC signal interfacing shall have a number 6-32 x 7/32 inch screw as a minimum.
- (O) All main panel wiring shall conform to the following wire size and color:
 - Green/Walk load switch output – brown wire – 14 gauge
 - Yellow load switch output – yellow wire – 14 gauge
 - Red/Don't Walk load switch output – red wire – 14 gauge
 - MMU (other than AC power) – violet wire – 22 gauge
 - Controller I/O – blue wire – 22 gauge
 - AC Line (power panel to black wire main panel) – 8/10 gauge
 - AC Line (main panel) – black wire – 10 gauge
 - AC Neutral (power panel to white wire main panel) – 8/10 gauge
 - AC Neutral (main panel) – white wire – 10 gauge
 - Earth Ground (power panel) – green wire – 8 gauge
 - Logic Ground – gray wire – 22 gauge

- Flash Programming – Orange wire – various gauge sizes
 - Flasher Terminal – Black wire, red or yellow field terminal – 14 gauge
- (P) All wiring, 14 AWG and smaller, shall conform to MIL-W-16878/1, type B/N, 600V, 19-strand tinned copper. The wire shall have a minimum of 0.010 inches thick PVC insulation with clear nylon jacket and rated to 105 degrees Celsius. All 12 AWG and larger wire shall have UL listed THHN/THWN 90 degrees Celsius, 600V, 0.020 inches thick PVC insulation and a clear nylon jacket.
- (Q) Connecting cables shall be sleeved in a braided nylon mesh or poly-jacketed. The use of exposed tie-wraps or interwoven cables is not acceptable.
- (R) All main panels shall be pre-wired for a Type-16 Malfunction Management Unit.
- (S) All wiring shall be neat in appearance. All cabinet wiring shall be continuous from its point of origin to its termination point. Butt type connections/splices are not acceptable.
- (T) All connecting cables and wire runs shall be secured by mechanical clamps. Stick-on type clamps are not acceptable.
- (U) The main panel shall incorporate a relay, designated as K1, to remove +24 VDC from the common side of the load switches when the intersection is placed into mechanical flash. The relay shall have a momentary pushbutton to apply power to the load switch inputs for ease of troubleshooting.
- (V) All pedestrian pushbutton inputs from the field to the controller shall be opto-isolated through the BIU and operate at 12 VAC.
- (W) All wire (size 16 AWG or smaller) at solder joints shall be hooked or looped around the eyelet or terminal block post prior to soldering to ensure circuit integrity. Lap joint soldering is not acceptable.
- (X) The main panel connections for power and all cabinet switch interfacing shall be via a 37-pin plastic shell MS connector with an incorporated twist lock as part of the Plug N Go cabinet system wiring.

8.37.06 Power Panel Design & Construction

- (A) The power panel shall interface with the main panel and be located on the lower right portion of the cabinet. The power panel shall be wired to provide the necessary filtered power to the load switches, flasher(s), and power bus assembly. The technicians shall be protected from the power panel components with a removable Plexiglas front cover. The design shall allow a technician to access the main and auxiliary breakers without removing the protective front cover.
- (B) The power panel portion of the main panel shall include the following components:
- One (1) 40-amp main circuit breaker. This breaker shall supply power to the controller, MMU, signals, cabinet power supply and auxiliary panels. Breakers shall be at a minimum, a thermal magnetic type, UL listed for HACR service, with a minimum of 10,000 amp interrupting capacity.

- One (1) 15-amp auxiliary breaker shall supply power to the fan, light and GFI utility outlet.
- One (1) 15-amp circuit breaker shall supply filtered power to the power strip located elsewhere in the cabinet assembly. The circuit breaker shall be wired to the 4-position terminal block, located on the upper left side of the cabinet.
- An EDCO/HESCO model SHA-1210 or exact approved equivalent surge arrester.
- A 50-amp, 125 VAC radio interference line filter.
- A normally-open, 75-amp, solid state signal bus relay. The SSR shall be a Crydom Model# HA4875H or approved equivalent.
- A minimum of one (1) 8-position neutral bus bar capable of connecting three (3) #12 wires per position.
- A minimum of one (1) 6-position ground bus bar capable of connecting three (3) #12 wires per position.
- A minimum of one (1) NEMA type 5-15R GFI utility outlet.

8.37.07 Power Bus Assembly – SDLC Hub Assembly

- (A) The power bus assembly shall be manufactured from 0.090”, 5052-H32 aluminum. It shall provide filtered power for the controller, MMU, cabinet power supply, and all auxiliary equipment.
- (B) The power bus assembly shall house the following components:
 - A minimum of three (3) and a maximum of six (6) power connectors.
 - Two (2) terminal strips to hardwire the power connections.
- (C) All cabinet equipment requiring filtered power to operate shall be connected to the power bus assembly by a fourteen (14) pin plastic MS circular connector with a twist lock connection, or hardwired directly to the supplied terminal blocks.
- (D) SDLC connections shall be made via an eight (8) position SDLC Hub Assembly. The SDLC Hub assembly shall have provisions for the SDLC cable connectors to be tightened down the hub assembly by two screws. Six (6) SDLC cables shall be supplied with each cabinet.

8.37.08 Auxiliary Cabinet Equipment

- (A) The cabinet shall be provided with two (2) thermostatically controlled (adjustable between 55-160 degrees Fahrenheit) ventilation fans in the top of the cabinet plenum. The fan plate shall be removable with the use of simple hand tools for serviceability. A minimum of two (2) exhaust fans shall be provided. The fans shall be a ball-bearing type fan and shall be capable of drawing a minimum of 100 cubic feet of air per minute each. The Fan/Thermostat assembly shall be connected to the power panel by means of a 4-position plug-in cable.
- (B) An LED cabinet lighting system shall be used to illuminate the internal structure of the cabinet assembly. Two (2) LED cabinet lighting strips shall be mounted on the fan panel assembly in the top of the cabinet. The fan panel shall also incorporate the LED light power supply. The LED light strips shall be Califfa Model P3100-C-S. The lamp shall be wired to a door activated switch mounted near the top of the door. A third LED light strip shall be mounted under the bottom shelf to illuminate the lower portion of the cabinet, specifically the field terminals.

- (C) A document drawer shall be mounted to the underside of the bottom shelf to store the cabinet documents. The document drawer shall be a minimum of 13” wide.
- (D) A minimum of two (2) sets of complete and accurate cabinet drawings shall be supplied with each cabinet.

8.37.09 Vehicle Detection

- (A) One (1) loop detector rack shall be provided in each cabinet. The Detector rack shall be available in the following NEMA configuration: NEMA Configuration #2 – Shall support up to sixteen (16) channels of loop detection (either eight (8) 2-channel detectors or four (4) 4-channel detectors), two (2) preemption devices, and one (1) BIU. This configuration shall be included as a standard on the 12- or 16-position main panel assembly.
- (B) Detector rack BIU mounting shall be an integral part of the detector rack.
- (C) All BIU rack connectors shall have jumper address pins corresponding to the requirements of the NEMA TS2 Standard. The jumpers may be moved to change the address of any individual rack. The address pins shall control the BIU mode of operation. BIUs shall be capable of being interchanged with no additional programming.
- (D) Each cabinet shall contain detector interface panels for the purpose of connecting field loops and loop detector racks. The panels shall be manufactured from FR4 G10 fiberglass, 0.062 inches thick, with a minimum of 2 oz. of copper for all traces.
- (E) One (1) 16-position interface panel shall be provided for a 16-channel rack cabinet. The interface panel shall be secured to a mounting plate and attached to the left wall of the cabinet.
- (F) Each interface panel shall allow for the connection of sixteen (16) independent field loops. A ground bus terminal shall be provided between each loop pair terminal to provide a termination for the loop lead-in cable ground wire.
- (G) Each interface panel shall provide a 10-position terminal block to terminate the field wires for up to two (2) 2-channel preemption devices.
- (H) Lightning protection device mounting holes shall be provided to accommodate an EDCO SRA-16C or EDCO SRA-6 or EDCO LCA-6, or a varistor lightning protection device. Lightning protection devices shall not be provided unless specified.
- (I) A cable consisting of 20 AWG twisted pair wires shall be provided to enable connection to and from the panel to a detector rack. The twisted pair wires shall be color-coded red and white wire.
- (J) All termination points shall be identified by a unique number and silkscreened on the panel.

- (K) Each detector rack shall accommodate rack-mountable emergency vehicle preemption (EVP) devices such as Opticom.
- (L) Each detector rack shall be powered by the cabinet power supply and be connected to the power bus assembly by means of a 14-pin plastic MS circular connector with a twist lock connection.

8.37.10 Cabinet Test Switch Panel & Police Switch Panel

- (A) A test switch panel shall be mounted on the inside of the main door. The test switch panel shall provide as a minimum the following:
 - AUTO/FLASH SWITCH – In the FLASH position, power shall be maintained to the controller and the intersection shall be placed in flash. The controller shall not be stop-timed when in flash. Wired according to the current NEMA TS2 Standard, the MMU forces the controller to initiate the start-up sequence when exiting flash.
 - STOP-TIME SWITCH – In the STOP-TIME position, the controller shall be stop-timed in the current interval.
 - CONTROL EQUIPMENT POWER ON/OFF – This switch shall control the controller, MMU, and cabinet power supply AC power. Momentary test pushbuttons for all vehicle and pedestrian inputs to the controller are not required. The TS2 controller to be provided with the cabinet assembly shall provide vehicular and pedestrian call inputs from its keyboard while in the standard status display.
- (B) A police switch panel shall be mounted inside the police access compartment located on the exterior of the cabinet door. The police switch panel shall contain the following:
 - SIGNALS ON/OFF SWITCH – In the OFF position, power shall be removed from signal heads in the intersection. The controller shall continue to operate. When in the OFF position, the MMU shall not conflict or require reset.
 - AUTO/FLASH SWITCH – In the FLASH position, power shall be maintained to the controller, and the intersection shall be placed in flash. The controller shall be stop-timed when in flash. Wired according to the current NEMA TS2 Standard, the MMU forces the controller to initiate the start-up sequence when exiting flash.
 - AUTO/MANUAL SWITCH – Cabinet wiring shall include provisions for an AUTO/MANUAL switch and a momentary pushbutton or hand cord. The AUTO/MANUAL switch and pushbutton or hand cord shall be in each cabinet assembly.
- (C) All toggle switches shall be heavy duty and rated 15-amps minimum. Single- or double-pole switches may be provided, as required.
- (D) Any exposed terminals or switch solder points shall be covered with a non-flexible shield to prevent accidental contact.
- (E) All switch functions shall be permanently and clearly labeled.
- (F) All wire routed to the police door-in-door and test switch pushbutton panel shall be adequately protected against damage from repetitive opening and closing of the main door.
- (G) All test switch panel wiring shall be connected to the main panel via a 24-pin plastic MS circular connector with a twist lock connection.

- (H) All wiring from the main panel to the test switch panel shall be connected to the test switch panel via a 24-pin plastic MS circular connector with a twist lock connection.

8.37.11 Auxiliary Devices

- (A) Load switches shall be solid state and shall conform to the requirements of the NEMA TS2 Standard.
- (B) Signal load switches shall have a minimum rating of 10 amperes at 120 VAC for an incandescent lamp load.
- (C) The front of the load switch shall be provided with three indicators to show the input signal from the controller to the load switch.
- (D) Load switches shall be dedicated per phase. The use of load switches for other partial phases is not acceptable.
- (E) A full complement of load switches shall be supplied with each cabinet to allow for maximum phase utilization for which the cabinet is designed.
- (F) The flasher shall be solid state and shall conform to the requirements of the NEMA TS2 Standard.
- (G) Flashing of field circuits for the purpose of intersection flash shall be accomplished by a separate flasher.
- (H) The flasher shall be rated at 15 amperes, double-pole with a nominal flash rate of 60 FPM.
- (I) All flash transfer relays shall meet the requirements of the NEMA TS2 Standard.
- (J) The coil of the flash transfer relay shall be de-energized for flash operation.
- (K) A full complement of flash transfer relays shall be supplied with each cabinet to allow maximum phase utilization for which the cabinet is designed.
- (L) Each cabinet assembly shall be supplied with one (1) MMU as defined by the requirements of the NEMA TS2 Standard.
- (M) Malfunction Management Units shall be a Type-16. The MMU shall be Econolite Model 1133-128 (EDI Model MMU2-16LEip) or approved equivalent.
- (N) All BIUs shall meet the requirements of the NEMA TS2 Standard.
- (O) A full complement of Econolite Model 160-1003-501 Bus Interface Units shall be supplied with each cabinet to allow for maximum phase and function utilization for which the cabinet is designed.
- (P) Each BIU shall include power on, transmit and valid data LED-type indicators.

- (Q) The cabinet power supply shall meet the requirements of the NEMA TS2 Standard.
- (R) The cabinet power supply shall provide LED indicators for the line frequency, 12 VDC, 12 VAC, and 24 VDC outputs.
- (S) The cabinet power supply shall provide (on the front panel) jack plugs for access to the +24 VDC for test purposes.
- (T) One (1) Econolite Model 1084-003 cabinet power supply shall be supplied with each cabinet assembly and shall be wired directly to the Power Bus Assembly via a fourteen (14) pin plastic MS circular connector with a twist lock connection.

8.37.12 Auxiliary Cabinet Devices - To Be Provided Per Customer Request

- (A) Two (2) extra Ground and Neutral bus assemblies shall be mounted below the power auxiliary panel on the right lower side of the cabinet assembly.
- (B) A six (6) position power strip assembly shall be installed on the upper left hand rails in the cabinet assembly. This power strip shall receive filtered power from CB3 in the power auxiliary panel via a 4 position terminal block, located near the power strip on the left side of the cabinet.
- (C) An eight (8) position resistor panel assembly shall be installed on the right lower side of the cabinet and wired to the odd Vehicle phase red on the main panel.
- (D) Two (2) battery shelves and covers shall be provided and installed on the lower left side of the cabinet for housing three (3) batteries.
- (E) One (1) Hygrotherm unit and Humidity Control Heater shall be installed for monitoring and controlling condensation within the cabinet housing.
- (F) The inside of the cabinet housing shall be painted WHITE.
- (G) A Generator transfer switch assembly shall be installed and located on the lower right side of the cabinet.
- (H) A 30A Generator Plug shall be installed in the right side of the cabinet with outside access to the Generator plug.

8.37.13 Testing & Warranty

- (A) Each controller and cabinet assembly shall be tested as a complete entity under signal load for a minimum of 48 hours.
- (B) Each assembly shall be delivered with a signed document detailing the cabinet final tests performed.
- (C) The cabinet shall be assembled and tested by the controller manufacturer or an authorized local distributor to ensure proper component integration and operation.

- (D) The controller and Malfunction Management Unit shall be warranted by the manufacturer against mechanical and electrical defects for a period of two (2) years from date of shipment. The manufacturer's warranty shall be supplied in writing with each cabinet and controller. Second party extended warranties are not acceptable.
- (E) The cabinet assembly and all other components shall be warranted for a period of one (1) year from date of shipment.
- (F) Any defects shall be corrected by the manufacturer or supplier at no cost to the CITY.

8.38.00 ACTUATED CONTROLLERS

8.38.01 General

- (A) Compatibility - The local controller and cabinet shall be compatible with the CITY's existing computerized signal system which utilizes Econolite equipment, or necessary modifications of the software and hardware shall be included to make both systems fully compatible.
- (B) The controller shall conform to the latest NEMA specifications and shall provide for complete and full operation of eight phases from within either a TS1 or TS2 type 1 cabinet.
- (C) Every controller supplied shall be the manufacturer's latest, first line production model tested and delivered by a domestic manufacturer who is regularly engaged in the construction of such equipment.
- (D) Each controller shall be supplied with a complete set of operational and service manuals, wiring schematics and part's layout up to a maximum of ten sets per order. Any controller for which these documents are not available is not a production model within the meaning of these STANDARDS AND SPECIFICATIONS.
- (E) Each controller shall have a removable data module.
- (F) Pre-emption. All actuated controllers shall be equipped to accommodate four E.V.P. inputs and one railroad preemption input and include Transit Signal Priority control.
- (G) The coordination unit shall be an internal function within each local controller and shall meet, as a minimum, the following functional requirements.
- (H) The coordinator shall provide for at least four cycle lengths adjustable from 30 to 255 seconds, three offsets adjustable from 0 to 99 percent with offset correction by dwelling in coordinated phase or smooth transition, and four splits per cycle.
- (I) Standard NEMA functions shall be used to control the intersection timing.
- (J) The coordinator shall be capable of changing the controller's phase sequence upon command and telemetry failure.
- (K) The coordinator shall be capable of setting the intersection free by loss of system sync, cycle/offset false commands, free command and telemetry failure.

- (L) The coordinator shall be capable of setting the intersection into a flashing operation in accordance with the MUTCD, latest edition.
- (M) The coordinator shall be capable to operate with telemetry module without additional hardware or software.
- (N) Time-base coordination mode shall be provided as a backup with all standard coordination features available. At least two 7-day programs shall be available with 50 additional holiday programs in the event of a master controller or communications failure. Time-base standby mode shall be programmable for an entire year with automatic daylight savings and leap-year changes.

8.39.00 MISCELLANEOUS HARDWARE

8.39.01 General

- (A) Aluminum pedestal mounts shall be Pelco or approved equal..
- (B) Mast arm brackets shall be Sky brackets or CITY approved equivalent and shall be installed 90 degrees to the roadway.

8.40.00 INSTRUCTIONS AND WIRING DIAGRAMS

A manual for the controller, containing service instructions, wiring diagrams, trouble-shooting procedures, etc. shall be provided in the controller cabinet.

8.41.00 SIGN SPECIFICATIONS

8.41.01 Sign Face Materials

All sign faces shall be fabricated from reflective sheeting, high-intensity prismatic grade or approved equal, that meets current MUTCD reflectivity requirements.

8.41.02 Sign Post Materials

All sign posts shall be fabricated from 12-gauge galvanized, perforated Telespar tubing or approved equal. The sign post assembly shall consist of a three foot (3') deep two inch by two inch (2" x 2") anchor sleeve and a one and three-quarter inch by one and three-quarter inch (1 ¾" x 1 ¾") by ten foot (10') post. See detailed drawing in Appendix.

8.41.03 Fire Lane Sign Specifications

Fire Lane parking prohibition signs shall meet the requirements of parking sign criteria in the MUTCD (latest edition).

8.42.00

ILLUMINATED STREET NAME SIGNS

8.42.01 General

Sign panel layouts and fixture shop drawings for internally illuminated signs and proposed mounting brackets/extensions shall be submitted as part of the bid. Final approval of submittals must occur prior to bid award, fabrication and installation. A sample fixture shall be submitted to the CITY within ten (10) days of request. Submittal of the shop drawings and sample fixture shall be waived if the manufacturer has previously supplied approved signs to the CITY. All signs and fixtures shall conform to the concept designs as shown in the detail drawings. A source facility and manufacturing process inspection shall be allowed within five (5) days of the CITY's request.

8.42.02 Sign Material

All signs shall be fabricated with new materials. No used or reconditioned sign blanks or outdated sheeting and/or pre-cut letters or numbers shall be used.

Internally illuminated signs shall be "Naim-Series-Inter Mark II, single-faced" logo and guide or approved equal. These may be fabricated or of the general type manufactured by Nu-Art Lighting or McCain Traffic Supply or approved equal. All signs on any single project or at any specific location shall be from the same manufacturer or fabricator unless otherwise specified by the TRAFFIC ENGINEER.

The face of the panel shall be "Lexan" or an approved type of sufficient thickness to permit minimum deflection, as certified by the manufacturer. If vinyl materials are used, verses silk screen applications, the material shall be diamond grade. All faces shall be of the same material.

The illumination source shall be LED lamps, powered by a twelve (12) Volt power supply. The internal illumination shall provide a uniform lighting on the sign message and background. A photoelectric control unit is required and shall be of the "hail-resistant" type and of the load rating for the intended use as shown on "Wiring Schematic". The photoelectric control shall be a unit that plugs into an EEI-NEMA twist lock receptacle mounted on top of the housing or traffic signal pole. Only one photoelectric control per intersection will be allowed. The single source photoelectric control unit shall power all units at any particular intersection. A wired 'pig-tail' for the electrical service connection shall be supplied which extends three feet beyond the inboard side of the sign fixture.

The front sign panel of the case shall be hinged 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 fact 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.

8.42.03 Lettering

Street names and numbers shall be eight inch (8") Times Roman Bold in upper and lowercase display. The street prefix/suffix and hundred block designations shall be five inch (5") Times Roman Bold in upper and lowercase display.

8.42.04 Colors

Colors shall be as shown on the concept designs. The colors shall be white on teal for the street name and CITY logo areas, gray with a purple header above the street name with the CITY logo affixed to the top center.

8.42.05 Installation

The sign case shall be securely attached to the support structure using an Astro-Brac®, Sky Bracket® or an approved equal attachment device. Six foot (6') signs shall require a single bracket with eight foot (8') signs requiring two attachment devices. Close coordination is to be maintained between the sign fabricator and support fabricator to assure all attached devices are properly placed.

Illuminated street name signs shall be in lateral alignment in respect to the traffic signal mast arm for a true horizontal alignment in respect to the ground. The single faced signs shall mount in front of or in-line with the mast arm. All signs to be installed two feet (2') from the vertical pole as measured from the closest sign edge.

8.42.06 Wiring

Electrical service to the single source photo-electric control unit shall be connected to the luminaire circuit using a new cable of sufficient capacity to handle the number of fixtures required. Final Service connection to the electrical power source shall be independently fused at the source. Connections from the single photoelectric control unit to each sign fixture may utilize existing spare traffic signal wires/cables where available. Intersections that are controlled and maintained by CDOT shall include new wiring for all circuits and shall not use any spare traffic signal cables. A waterproofing cable grommet shall be installed at the cable exit port in the signal pole mast arm. No external wiring shall be visible for the approach of each respective sign.

8.42.07 Warranty

Both the sign fixture and the sign panel shall have a five (5)-year warranty against defects in material and workmanship.