CITY OF LONGMONT
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TRANSPORTATION

200.00 GENERAL

1. CONFORMANCE

   a. All street, alley, sidewalk, and bike path systems will comply with these specifications, the State Specifications where applicable, and with the approved plans. Sidewalks, concrete side paths and curb ramps shall comply with accessibility standards as adopted by the State (CDOT).

   b. Street improvements within State (CDOT) right-of-way shall follow CDOT's Standard Plans and Specifications and details. In the event of conflicts between CDOT and City Standards, the more stringent standard will apply as determined by the City Engineer.

   c. The City of Longmont Standards and Specifications shall take precedence over conflicting provisions in the CDOT Standard Specifications, MGPEC Specifications and/or other referenced standards.

   d. For rehabilitation or re-development projects, the standards used for design speed, horizontal alignment, vertical alignment, widths of traveled way, and bike lanes may be the City Standards that were in effect at the time of original construction or inclusion into the City's street network.

   e. The City of Longmont will review variations to these criteria in accordance with Section 100 in these City Standards.

201.00 STREET DESIGN, ACCESS, AND LAYOUT CONSIDERATIONS

1. Street placement layout, alignment, and classification shall conform with Title 15 in the Code and the Envision Longmont Multi-modal and Comprehensive Plan (2016).

2. Consideration shall be given within the established framework of local streets to provide for proper alignment and conformity to existing street patterns. The street design should adequately accommodate the traffic needs and the adjacent land uses. Street design for Local and Collector streets in residential areas shall specifically focus on creating a pedestrian and bicycle friendly design avoiding excessively wide or long straight streets that encourage excess speed. Street design within such residential areas is intended to focus on developing a street system that can provide access to the adjacent properties, provide a safe transportation system for pedestrians, bicyclists, and vehicles, and minimize the impacts of traffic on adjacent residential property. Streets, intersections, driveways, and pedestrian facilities shall be designed to provide for the greatest safety for pedestrians, bicycles, and motorists.

3. All developments shall have access in accordance with the requirements of the Code. In all new and re-development projects, access consolidation including adjacent parcels shall be considered.

4. The street pattern in a subdivision shall be the most advantageous configuration to serve adjoining areas and the entire neighborhood or district. Where appropriate to the design, proposed streets shall be continuous and in alignment with existing, planned or platted streets.

5. Provisions for future construction:

   a. Future Connections: Proposed streets shall be extended to the property lines of the subdivision, except where prohibited by topography or other physical conditions, or where such extension is not necessary for connection to adjacent properties as determined by the City Engineer. Where

streets will be extended beyond the property line, sufficient engineering data shall be provided to establish feasibility of extension meeting City standards. Street and drainage design considerations should be provided for a minimum one-hundred (100) feet beyond the proposed terminus or as required by the City Engineer. Construction of the proposed streets may include but is not limited to grading and drainage transitions at the edge of the development.

b. In areas where the ultimate street section is not constructed, the future road construction shall be anticipated in the design. Ultimate landscaping improvements shall be designed following Section 601.02 item 12 in these Standards. In the interim condition, the space between the existing road edge and the ultimate curb line shall contain any necessary interim drainage improvements and shall be seeded.

c. Grading: Grades outside of the ultimate roadway are to be graded to anticipate future road improvements. Grades between the existing road edge and the ultimate curb line are to be graded to provide drainage and a safe shoulder for vehicles.

d. In situations where curb and gutter is not provided in the interim condition, road delineators spaced on a fifty (50) foot spacing are required.

202.00 TRANSPORTATION IMPACT STUDY

1. Transportation Impact Studies are required as indicated in Section 100 in these City Standards.

203.00 RIGHT OF WAYS AND CROSS-SECTIONS

203.01 GENERAL

1. Sufficient right-of-way will be provided as required for the traffic needs, cross-section and maintenance of the street including cut or fill slopes, auxiliary lanes, sidewalks, public landscaping, signing, utilities, and other aspects of the development. The right-of-way will extend to the back of the detached sidewalk. In areas with attached sidewalks (curbwalks), a sign easement will be required in situations where the right-of-way does not extend two (2) feet behind the attached sidewalk.
2. Additional right-of-way and roadway width may be required to accommodate traffic or other development needs such as turn lanes, acceleration/deceleration lanes, additional travel lanes, medians, pedestrian or bicycle facilities, landscaping, utilities, drainage requirements per Section 300 in these City Standards, or construction requirements such as cut or fill slopes. Streets of less than the minimum required right-of-way and pavement width are not permitted unless otherwise approved by the City Engineer through a design exception process.

3. All streets and alleys shall maintain a continuous, unobstructed with of twenty (20) feet, free of parking and obstructions, with turning vehicle radii having no less than a fifty (50) foot outside or a thirty (30) foot inside radius.

203.02 RIGHT OF WAY REQUIREMENTS

203.02.01 RIGHT OF WAY REQUIREMENTS PRINCIPAL ARTERIAL STREETS

1. The minimum right-of-way width for Principal Arterial streets shall be one-hundred and twenty three (123) feet. Principal Arterial streets shall include a minimum eight (8) foot wide detached concrete side path, a minimum twelve (12) foot wide planting strip or tree lawn between the curb and detached concrete side path, and the right-of-way shall extend a minimum distance of four (4) feet beyond the nearest edge of the concrete side path on each side of the street. The twelve (12) foot wide planting strip or tree lawn may be reduced at intersections where turn lanes and auxiliary lanes are required or as approved by the City Engineer. A five (5) foot bike lane with a two (2) buffer in each direction will be required on all new Principal Arterial streets.
2. See Table 2-3 for minimum lane widths.
3. Refer to the Details Section in these City Standards for street typical sections.

203.02.02 RIGHT OF WAY REQUIREMENTS MINOR ARTERIALS AND COLLECTORS

1. The minimum required right-of-way for Minor Arterials and Collector streets shall be ninety-four (94) feet. For Residential Collectors, the minimum required right-of-way shall be eighty six (86) feet. All new Minor Arterial and Collector streets shall be constructed with a minimum eight (8) foot planting strip or tree lawn on each side of the street and a detached five (5) foot wide sidewalk on each side. An eight (8) foot planting strip between the sidewalk and the edge of the curb and gutter is required. A five (5) foot bike lane with a two (2) foot buffer in each direction will be required on all new Minor Arterial and Collector streets including Residential Collectors. A minimum eight foot parking lane is required in Minor Arterial/ Commercial/ Industrial Collector streets and a minimum seven (7) foot parking lane is required on Residential Collector streets.
2. See Table 2-3 for minimum lane widths. Minor Arterials/Collectors and Residential Collectors may require wider travel lanes as determined by the City Engineer.
3. Enhanced Multi-Use Corridors (EMUCs):
    a. Additional right-of-way may be required due to land use or at locations where Enhanced Multi-Use Corridors are designated. The Enhanced Multi-Use Corridor Plan identifies a set of corridors falling under this category and desirable design features. Developments within and or adjacent to the EMUC's route framework will be required to meet the Longmont Enhanced Multi-Use Corridor Plan and these City Design Standards.
    b. The Longmont Enhanced Multi-Use Corridor Plan is available at the City of Longmont's website.
4. Refer to the Details Section in these City Standards for street typical sections.

203.02.03 RIGHT OF WAY REQUIREMENTS LOCAL STREETS

1. The minimum right of way for Local streets shall be sixty-three (63) feet for Non-residential Local streets and sixty five (65) feet for Residential Local Streets. All new Local streets shall be constructed with a minimum eight (8) foot planting strip or tree lawn and a detached five (5) foot wide sidewalk on both sides of the street. On-street parking shall be provided on both sides of all new Local streets, unless otherwise approved by the City Engineer. Local streets in Non-Residential areas might require additional ROW as determined by the City Engineer.
2. Refer to the Details Section in these City Standards for Local street typical sections.

203.02.04 RIGHT OF WAY REQUIREMENTS CUL-DE-SACS

1. Sufficient right-of-way will be provided as required to satisfy the traffic needs, street classification, cross-section and maintenance of the cul-de-sac including cut or fill slopes, sidewalks, landscaping, signing, utilities, and other aspects of the development.

203.02.05 RIGHT OF WAY REQUIREMENTS PUBLIC ALLEYS

1. All public alleys shall have a minimum twenty-two foot (22) right of way width and a twenty foot (20) minimum pavement width. Additional right of way and or easements may be required to accommodate wet and dry utility installation.

204.00 MINIMUM DESIGN CRITERIA

204.01 DESIGN SPEED

1. The minimum design speed for Principal Arterial, Minor Arterial/ Collector and Local streets is listed in Table 2-1 below. These design speeds are standard speeds. Design speeds may be evaluated and determined by the City Engineer on a case-by-case basis.

Table 2-1 Design Speeds per Street Classification

Street Classification	Minimum Design Speed (mph)
Principal Arterials	45
Minor Arterials / Collectors	35
Local and Other	25

204.02 DESIGN VEHICLE

1. The selection of the design vehicle will determine the geometric street design controls needed to accommodate a vehicle with similar weight, dimensions and operating characteristics. Design vehicles to be used for the designated street facility are listed in Table 2-2 below.

Table 2 -2 Design Vehicle per Street Classification

Facility Type	Design Vehicle	Symbol	Height, ft	Width, ft	Length, ft	Effective Vehicle Wheelbase, WB1, ft	Effective Vehicle Wheelbase, WB 2, ft
Local Residential / Other	Passenger Car	P	4.3	7	19	11	0
Minor Arterials, Collectors and Local Industrial	Intermediate Semitrailer	WB 40	13.5	8	45.5	12.5	25.5
Principal Arterials	Interstate Semi Trailer	WB 62	13.5	8.5	69	19.5	41

Source: AASHTO PGDHS, table 2-1 B Design Vehicle Dimensions

204.03 STOPPING SIGHT DISTANCE

1. Street design shall provide adequate Stopping Sight Distance. Stopping Sight Distance is the length of travel way that the driver must be able to see in order to be able to stop and avoid collisions with obstructions in the roadway. Stopping sight distance is the sum of the distance traveled during the perception-reaction time (brake reaction distance) and the distance traveled after the brakes are applied (braking distance). Stopping sight distance is measured from the driver's eyes three and a half (3.5) feet above the pavement to an object two (2) feet high on the road. Refer to the current version of AASHTO A Policy on Geometric Design of Highways and Streets (PGDHS) for Sight Distance Calculation methodology and appropriate design values for various design speeds and grade adjustments.

204.04 ROADSIDE CLEAR ZONE/ HORIZONTAL CLEARANCE TO OBSTRUCTIONS

1. Roadside clear zone is a term used to define the roadside area that is free of obstructions in order to allow errant vehicles to regain control and stop safely or re-incorporate into the traffic way. The clear zone distance criteria is dependent on the type of roadway facility (rural or urban) and is measured from the edge of the traveled way to a certain distance calculated as a function of design speed, AADT, and slope of the embankment.

2. Rural Street Sections in City ROW: refer to the Clear Zone criteria recommended in the current version of AASHTO's A Policy on Geometric Design of Highways and Streets (PGDHS), and the current version of the AASHTO Roadside Design Guide.

3. Urban Street Sections: In urban street sections, where space is limited, the minimum lateral offset distance to roadside obstructions shall be eighteen (18) inches (per AASTHTO's Roadside Design Guide recommendations), as measured from the face of the curb, for obstructions meeting requirements for breakaway supports in AASHTO's LRFD Specifications for breakaway Structural Supports for Highway Signs, Luminaries and Traffic Signals. In situations where ROW width is not a limiting factor or where obstructions do not meet AASHTO's specifications for structural supports, a minimum four (4) foot offset distance, as measured from the face of the vertical curb (or back of the mountable curb), is required. Additional lateral offset widths may be required based on speed, traffic volume, geometric factors, or existing hazards.

204.05 CROSS SECTIONAL ELEMENTS

204.05.01 LANE WIDTHS

1. The cross-section of streets shall be designed based on the specific needs of the street, taking into consideration the design vehicle and the need for travel lanes (exclusive of gutter pans), turn lanes, bicycle lanes, parking and pedestrian facilities. For design purposes the following lane width standards shall be used:

Table 2-3 Required Lane Widths per Road Classification

Lane Type	Principal Arterials **	Minor Arterials / Collectors	Local
Travel Lanes	12'**	12'**	12'**
Auxiliary Lanes	12'**	10'	10'
Parking Lane	-	8'	8'
Bicycle Lane	5'*	5'*	

*Width exclusive of buffer

** Narrower lane widths may be considered based on land use at the City Engineer's discretion.

204.06 SIDEWALKS AND SIDEPATHS

1. Detached sidewalks in Minor Arterials/ Collectors and Local Streets shall be installed at the edge of the right of way line. All sidewalks installed in Minor Arterials/ Collectors and Local Streets shall be detached and a minimum of five (5) feet in width. There shall be a minimum two (2) foot buffer distance between the edge of sidewalk and fences, light poles, and any other side obstruction or permanent objects.

2. Attached Sidewalk (curbwalks) details in the Detail Section in these City Standards are to be used in infill developments or re-development projects, City rehabilitation projects, and or to match existing conditions only. These details shall not be used for new construction unless otherwise directed by the City Engineer.
3. All new Principal Arterial, Minor Arterial and Collector streets shall include on-street bicycle facilities. Bicycle facilities should be designed for a low-stress user experience and should conform to AASHTO's Guide for the Development of Bicycle Facilities, latest edition. In case of conflict between City and AASHTO design standards, these City Standards shall govern.
4. Detached concrete side paths in Principal Arterials shall be eight foot (8) wide (min.) and shall be designed and constructed as per the concrete side path detail in these City Standards.

204.07 BICYCLE FACILITIES

1. Bicycle lane widths and use of other treatments (i.e. buffered or separated bike lanes) can vary depending on the functional classification and context of the street.
2. Buffered bicycle lanes are required on new Principal Arterial, Minor Arterial and Collector streets. Buffered bike lanes are conventional bicycle lanes paired with additional street striping that creates a designated buffer space (minimum width = 2 feet) that separates the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. In rehab or retrofit situations, the buffer width may be reduced based on the available street width at the City Engineer's discretion.
3. Higher speed, higher volume streets (e.g. Principal Arterials and Minor Arterials with speeds greater than 40 MPH and or ADT exceeding 10,000 VPD) may warrant the use of vertical separation (e.g. flexible posts, bollards, concrete barriers, curbs, raised medians, or other approved vertical element) in combination with a buffered area to provide additional separation between the bicycle lane and vehicle travel lane(s). Separated bike lanes will be approved at the City Engineer's discretion on a case-by-case basis as additional bicycle lane width will be required to accommodate snow removal and other maintenance operations.
4. Green pavement markings in bicycle/vehicle conflict areas (e.g. intersections, commercial driveways, etc.) is encouraged. Use of colored pavement markings shall be in accordance with the current version of the Manual on Uniform Traffic Control Devices (MUTCD).

204.07.02 MEDIANS

1. Landscaping requirements in medians: Landscaping is not allowed in medians with a width less than six (6) feet. In such instances, colored concrete material shall be installed. Landscaping can be installed in medians with a minimum width of six (6) feet provided that such installation will meet clearzone requirements, will not impede sight distance, and will not constitute a maintenance encumbrance. For medians with landscaping areas, the installation of an underdrain system will be required.

204.08 DRAINAGE ELEMENTS

1. Requirements: The drainage of streets shall be designed to meet drainage requirements in Section 300 of these City Standards.

2. Minimum Pavement Cross Slope: The minimum pavement cross slope on all new Principal Arterial, Minor Arterial/Collector, and Local street classifications shall be 2%. In infill, re-development, or rehabilitation situations, the maximum pavement cross slope shall not exceed 5%.
3. Curb and Gutter: Curb and gutter shall be installed in all urban street applications following the typical curb details in these City Standards. The use of mountable curb and gutter is limited to residential areas and medians.
4. Five (5) foot curb transitions are required from urban to rural section installations. Newly installed curb and gutter intersections shall extend the curb and gutter around the returns and shall be transitioned back into the connecting rural section.
5. The minimum gutter profile grade at the flowline for all urban sections is 0.7% with a construction tolerance of +/- 0.2%.
6. In new construction, at the time of Construction Acceptance or Final Acceptance, replacement of damaged curb and gutter shall be done in ten (10) foot sections. In rehabilitation projects, replacement of curb and gutter shall be done in five (5) foot sections.
7. Cross Pans:
    a. Cross pans on Principal Arterial and Minor Arterial/ Collector Streets are not allowed.
    b. Cross pans on Local streets with an average daily traffic volume greater than five hundred (500) vehicles per day will be assessed on a case-by-case basis.
    c. Local Street Intersections with Cross Pans: At intersections with cross pans, in cases where the intersecting street profile grade is less than 2%, the transition of the connecting roadway crown into the cross pan shall occur in thirty-five (35) feet. On roadways where the intersecting street profile grade is between 2% and 5%, the transition of the connecting roadway crown into the cross pan shall occur in fifty (50) feet.
8. Shoulders and Roadside Swales in Rural or Interim Sections:
    d. Rural sections or interim street sections without curbs shall include paved or stabilized shoulders adjacent to the edge of pavement. The width of shoulder shall be a minimum of four (4) feet with a minimum cross slope of 2%. Additional shoulder width might be required based on roadway classification and or traffic conditions.
    e. Roadside swales shall be designed to meet the drainage requirements for the street while taking into account clear zone requirements as indicated in the current version of AASHTO's Roadside Design Guide.

205.00 HORIZONTAL ALIGNMENT

1. Horizontal alignment shall provide for the safety of pedestrians, bicyclists, and motorists. On Minor Arterial/ Collector and Local streets in residential areas, particular care shall be given to avoid design that encourages excessive speed.
2. AASHTO recommended Stopping Sight Distances must be maintained at all times. The horizontal curve standards presented in these City Standards are for situations where there will be adequate stopping sight distance on the curve. In areas where obstructions limit sight distance, curve lengths may need to be greater than listed.

205.02 MINIMUM CENTERLINE RADIUS

1. For new construction, the minimum allowable centerline radius for various street classifications is indicated in Table 2-4 below. All proposed streets shall conform with the horizontal curve standards outlined as follows:

Table 2-4 Minimum Centerline Radius per Street Classification

STREET TYPE, DESIGN SPEED	MINIMUM CENTERLINE RADIUS (FT)*, **	MINIMUM TANGENT BETWEEN REVERSE CURVES (FT.)
45 mph	711	300
35 mph	454	100
25 mph	181	100

*Source CDOT 2018 Roadway Design Guide Table 3 – 2 (Table 3 – 13b of the PGDHS (1)) Minimum Radii and Superelevation for Low Speed Urban Streets. **Arterial: PGDHS Table 3 – 7 Minimum Radius Using Limiting Values of e and f, e = 4%, f=0.15

a) Note: The horizontal curve standards in Table 2-4 above are for the design speeds shown in table 2-1 for the distinct road classifications and assume 4% maximum superelevation for Principal Arterial streets and no superelevation on Minor Arterials/ Collector or Local streets. The City Engineer may require more stringent design parameters as land use and conditions require.

205.03 MINIMUM TANGENT LENGTH AT INTERSECTION APPROACHES

1. There shall be a minimum tangent where a curvilinear street is approaching an intersection. This distance shall be a minimum of one hundred fifty (150) feet for Principal Arterial street to Arterial street approaches and Collector streets approaching an Arterial street unless otherwise determined by the City Engineer. The minimum tangent distance for a Local street approaching a Local street or a Local street approaching a Collector street shall be one hundred (100) feet.

205.04 SUPERELEVATION

1. Where curves are designed with superelevation, the superelevation shall be in accordance with the recommendations of the current version of the AASHTO (PGDHS) criteria and approved by the City Engineer. The rate of superelevation, the superelevation runoff length, the crown runoff length, and the point at which the full superelevation is reached shall be clearly shown on the construction plans. Superelevation is not permitted on Minor Arterial/ Collector or Local streets.

205.05 TRAFFIC CALMING / SLOW POINTS

1. On Collector and Local streets in residential areas, the horizontal design shall include “slow points” at no more than five hundred (500) foot spacing. Examples of slow points can include curves,

medians, neckdowns/curb extensions, speed tables, traffic circles, stop condition intersections (based on approved traffic conditions and meeting the latest criteria of the MUTCD), and other approved traffic calming techniques as approved by the City Engineer.

206.00 VERTICAL ALIGNMENT

206.01 GENERAL

1. Vertical alignment and grades shall take into consideration the existing topography, and drainage needs, while providing for the safety of pedestrians and motorists. Unless modified in these Standards, vertical alignment shall be designed in accordance with the latest version of the AASHTO (PGDHS) criteria.
2. Continuous changing of grades that create a "rollercoaster" effect shall not be permitted.

206.02 MINIMUM AND MAXIMUM ALLOWABLE PROFILE GRADES

1. All proposed streets shall conform to the minimum and maximum allowable grade standards shown in table 2-5.

Table 2-5 Minimum and Maximum Allowable Profile Grade

Street Classification	Minimum Profile Grade, %	Maximum Profile Grade, %
Principal Arterial	0.7	4.0
Minor Arterials / Collectors	0.7	5.0
Local Streets	0.7	5.0
Cul-de-sacs	0.7	5.0
Alleys	0.7	5.0
Emergency Access	0.7	6.0

206.03 VERTICAL CURVES

1. Vertical curves are required when the algebraic difference between two profile grades exceeds 0.99%.
2. Vertical geometry shall ensure adequate stopping and passing sight distances. The lengths of vertical curves shall be compliant with the criteria for vertical curves in the current version of the AASHTO (PGDHS) Chapter 3.

206.03.02 CREST VERTICAL CURVES

1. Length of Crest Vertical Curves – Stopping Sight Distance Design Control.

   The vertical curve lengths in Table 2-6 below correspond to the indicated design speeds shown for stopping sight distance design control. The City Engineer may require curves designed for different design speeds as conditions require.

Table 2-6 Minimum Length for Crest Vertical Curves Based on Stopping Sight Distance

Rounded K Values for Crest vertical Curves per Design Speeds (Source AASHTO (PGDHS), Table 3-34) Based on stopping sight distance with a height eye of three and a half (3.5) ft. and headlight height of two (2) ft. per the AASHTO (PGDHS) criteria

Design Speed, mph	**45**	**35**	**25**
K Values	61	29	12
Stopping Sight Distance, ft.	360	250	155

Minimum Length of Sag Vertical Curve

L = K A

Where:
L = Length of Vertical Curve, ft.
A = Grade Algebraic Difference, %
K= Rate of Vertical Curvature

Notes:

Maximum Change in grade (A) without the need for a vertical curve is from 0% to 1%.

The length of vertical curves shall not be less than 3 X the design speed.

The values in this table are minimum. Longer vertical curves should be provided as conditions require.

Large curve length values may need to be checked for adequate drainage.

2. Length of Crest Vertical Curves – Passing Sight Distance Design Control

Crest vertical curve lengths in Table 2.6 above do not allow passing on the crest of vertical curves. If the design warrants a passing move on Minor Arterials/ Collectors or Arterials, the length of vertical curves should be calculated to take into account passing sight distance. The required lengths of curve for passing sight distance design control shall follow the criteria in Chapter 3 in the current version of AASHTO PGDHS.

206.03.03 SAG VERTICAL CURVES

1. The minimum vertical curve lengths in table 2-7 below correspond to the indicated design speeds as shown for headlight sight distance design control as per Chapter 3 in AASHTO's PGDHS. The City Engineer may require curves designed for different design speeds as conditions require.
2. The Design of sag vertical curves shall comply with criteria in Table 2-7:

Table 2-7 Minimum Length for Sag Vertical Curves

Rounded K Values for Sag vertical Curves per Design Speeds (Source AASHTO (PGDHS), Table 3-36)

Based on headlight sight distance with a headlight height of two (2) f.t and one degree divergence angle per AASHTO (PGDHS) criteria

Design Speed, mph	**45**	**35**	**25**
K Values	79	49	26
Stopping Sight Distance, ft.	360	250	155

Minimum Length of Sag Vertical Curve

L = K A

Where:
L = Length of Vertical Curve, ft.
A = Grade Algebraic Difference, %
K= Rate of Vertical Curvature

Notes:

Maximum Change in grade (A) without the need for a vertical curve is from 0% to 1%.

The length of vertical curves shall not be less than 3 X the design speed.

The values in this table are minimum. Longer vertical curves should be provided as conditions require.

Large curve length values may need to be checked to for adequate drainage.

207.00 INTERSECTION DESIGN CRITERIA

207.01 GENERAL

1. Intersections (which shall include all street access points - both public and private) shall be designed to provide for the safety of pedestrians, bicyclists and motorists.
2. At street intersections, property lines shall be truncated as shown the Standard Details to provide adequate right-of-way for curb ramps and utilities.
3. Intersection design shall take into consideration auxiliary turn lanes as required by the approved Transportation Impact Study or as required for site specific conditions.
4. The design criteria for all street intersections shall conform with the Horizontal Alignment Design Criteria outlined in these City Standards.
5. Pedestrian Mobility/ Pedestrian Connectivity Features/ Curb ramps**:** All intersections shall be designed and constructed with pedestrian curb ramp access on all corners of the intersection in accordance with current PROWAG standards.
6. All new intersections shall intersect at right angles. Skewed intersections between 75 degrees and 90 degrees will be considered on a case-by-case basis if existing topography and other limiting factors preclude a 90 degree angle. The skewed intersection angle shall be no less than 75 degrees. Special design considerations will be taken into account with the design of skewed intersections such as the use of larger curb radii, curb ramp alignment and additional sight distance. Intersection angles other than 90 degrees shall be identified in all construction plans submitted to the City.

207.02 STREET CONNECTIONS

1. Connections with existing streets shall be made in a way that will create a smooth transition. The higher volume street at an intersection shall govern the through grade and cross-sections.
2. The maximum allowable approach grade at the intersection of two Principal Arterials shall be 2%. The maximum allowable approach grade at the intersection of any other two street classifications shall be 4%. The above approach grades shall be maintained for the distance designated by Table 2-8 below:

Table 2-8 Maximum Allowable Approach Grade

APPROACHING STREET CLASSIFICATION	LOCAL	MINOR ARTERIALS/ COLLECTORS	PRINCIPAL ARTERIALS
Local and other	50 feet	50 feet	75 feet

Minor Arterials/ Collectors	----	75 feet	150 feet
Principal Arterials	----	----	200 feet (1)

Note: Distances shown are measured from the flowline at intersections.

207.03 INTERSECTION SIGHT DISTANCE

207.03.01 INTERSECTION SIGHT DISTANCE CONSIDERATIONS - EXISTING INTERSECTIONS

1. In existing intersections, all efforts shall be made to meet AASHTO sight distance criteria. In situations where the AASHTO minimum criteria cannot be met due to existing conditions, site constraints, or where it is not practical, as a minimum, the following criteria shall apply:

    a. At the intersection of any two streets, or where a street intersects with an alley: A triangle measuring thirty (30) feet along each curb or edge of roadway from their point of intersection, the third side being a diagonal line connecting the first two. The City Engineer may require a greater distance in certain high volume or high speed traffic intersections.

    b. At the intersection of a private access point and street: A triangle measuring fifteen (15) feet in length along the edge of the driveway and along the curb or edge of roadway from their point of intersection, the third side being a diagonal line connecting the first two (2).

207.03.02 INTERSECTION SIGHT DISTANCE CRITERIA AND DESIGN CONSIDERATIONS - NEW INTERSECTIONS

1. The minimum required sight distance at intersections shall be determined using the criteria in the current version of the AASHTO (PGDHS), Chapter 9. All intersections shall meet the intersection sight distance requirements as per the current version of the AASHTO (PGDHS). For new developments, and in situations where specific safety concerns exist, or on higher speed or volume streets, the City Engineer may require additional sight distance requirements and an increase in the obstruction free areas outlined in this section. The Design Engineer or Design Professional shall add to the construction plan set a sight distance plan sheet that indicates all criteria, assumptions, and calculations for the proposed sight distance triangles showing compliance to AASHTO sight distance criteria.
2. Traffic control methods, design speed, approach grade, time gap, and design vehicle will determine the sight distance required at each intersection.
3. Design Vehicle: The use of Passenger Vehicles to determine sight distance requirements is adequate for most residential street intersections. Heavy truck facilities or areas with heavy truck traffic volumes may require more stringent design parameters as determined by the City Engineer.
4. Methodology:

    a. Intersection sight distance shall be measured at a height of three and one half (3½) feet for the entering vehicle to a height of 4.35 feet for the oncoming vehicle. The entering driver's eyes shall be assumed to be at a point 15 feet back from the edge of the traveled way.

b. The area necessary for intersection sight distance shall be determined based on the methodology presented in the current version of AASHTO PGDHS, Chapter 9.

207.03.03 CLEAR SIGHT TRIANGLE AREAS (CLEAR SIGHT WINDOW)

1. In order to preserve sight distance and the safety of pedestrians and vehicles, an unobstructed area (clear sight triangle) shall be maintained within the sight distance triangular areas described above. The required clear sight window areas shall be free from shrubs, ground covers, berms, fences, signs, structures, parking, or other material or objects greater than three and one half (3.5) feet in height as measured from the grade of the roadway, which would block the intersection sight distance. Fences shall be exempted from the three and one half (3.5) foot height limitation provided that the fence does not exceed three and one half (3.5) feet in height, and is at least 50% open such that sight distance is not impaired.

207.03.04 LANDSCAPING WITHIN THE CLEAR SIGHT TRIANGLE AREAS

1. Trees, shrubs, and ground covers shall not be allowed within the clear sight window area unless they meet height requirement stated above**.**
2. Trees shall be installed such that the mature caliper of the tree shall not encroach into the clear sight window. Tree limbs that encroach into the clear sight window shall be pruned to a minimum height of eight (8) feet as measured from the finished grade.
3. Evergreen and ornamental treets shall be planted a minimum of six (6) feet from the edge of the clear sight window.

207.03.05 SIGHT DISTANCE EASEMENT

1. The City Engineer may require an additional sight distance easement if site conditions so require.

207.04 TRAFFIC CONTROL DEVICES

1. Determination of need for traffic control devices, including stop signs and traffic signals shall be made by the City Engineer in accordance with the current version of the MUTCD and other applicable City regulations.

207.05 INTERSECTION CURB RADII

1. Intersection Curb radii at the flowline shall conform with the standards in Table 2-9 below:

Table 2-9 Minimum and Maximum Intersection Curb Radii

Return Radius per Intersection Type	Minimum Return Radii (ft)	Maximum Return Radii (ft)
Arterial/ Any Street	35	50
Collector/ Collector	35	50
Collector / Local	25	35
Industrial / Any Street	35	50
Commercial/ Any Street	35	50
Local/ Local	15	25
Alley	20	-
Emergency Access	20	-
Truck Route/ Any Street	35	35

207.06 SPACING CRITERIA

207.06.01 SPACING FOR UN-SIGNALIZED INTERSECTIONS

1. All Intersections and private drives/entrances that generate 20 vehicles trips per day or more with no potential for signalization (as determined by the City Engineer) will be spaced centerline to centerline in accordance with Table 2-10 below:

Table 2-10 Intersection Spacing at Unsignalized Intersections

ROADWAY	OFFSET
Arterial	660 feet
Collector	330 feet
Local	135 feet *

* Non – Typical width Streets: 100’ minimum separation from flow line to nearest flowline is required for non-typical width streets.

207.06.02 SPACING FOR SIGNALIZED INTERSECTIONS

1. Intersections with the potential for signalization (as determined by the City Engineer) shall be spaced no less than one half (½) mile from the nearest existing or planned signalized intersection. If an intersection that will potentially need a signal cannot meet this spacing requirement, it may be limited to right turns.

207.07 AUXILLARY LANES

207.07.01 GENERAL

1. Intersection design shall take into consideration auxiliary lanes as required by the approved Transportation Impact Study, or as required by the City Traffic Engineer due to site specific conditions.

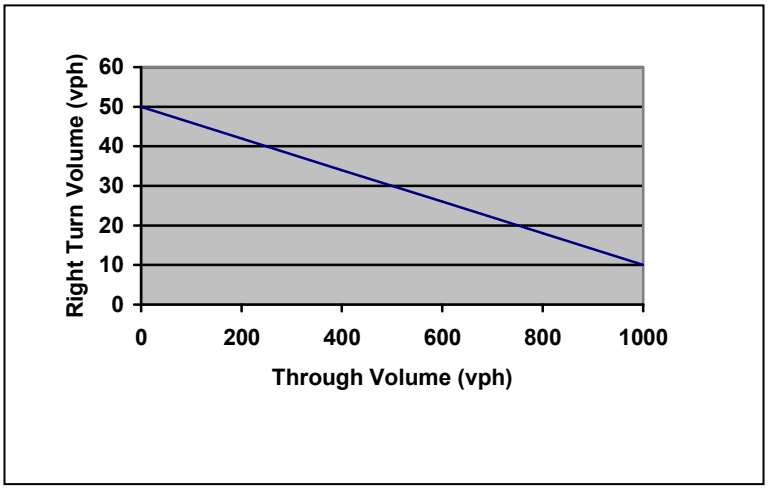
207.07.02 LEFT TURN LANES

1. Left turn lanes may be installed on intersection approaches (where left turns are not prohibited) when any of the following criteria are met:
   a. The approach is at an intersection that is signalized or is planned to be signalized in the future.
   b. On an uncontrolled approach on a Principal Arterial street.
   c. On an uncontrolled approach on a Principal Arterial/ Collector street that is striped as a three lane street (with a continuous center turn lane.)
   d. At a four-legged intersection when the opposing approach requires a left turn lane.
   e. On a STOP sign controlled approach on a collector or arterial street with adequate width for more than one approach lane when an exclusive left turn lane minimizes the approach delay (as determined using the latest Highway Capacity Manual analysis techniques.)
   f. At an existing intersection where the accident history identifies an accident pattern that is susceptible to improvement by installing a left turn lane as determined by the City Traffic Engineer.
   g. As warranted by the Traffic Impact Study.

207.07.03 RIGHT TURN LANES

1. Right turn lanes may be installed on intersection approaches when any of the following criteria are met:
   a. The intersection is signalized or is planned to be signalized in the future.
   b. At an existing intersection where the accident history identifies an accident pattern that is susceptible to improvement by installing a right turn lane.
   c. On a STOP sign controlled approach on a Minor Arterial/ Collector or Principal Arterial street with adequate width for more than one approach lane when an exclusive right turn lane minimizes the approach delay (as determined using the latest Highway Capacity Manual analysis techniques.)
   d. The approach is uncontrolled and the traffic volumes estimated in the approved traffic impact study, when applied to the following graph, require a right turn lane. In the graph, when the plotted point representing the through traffic (or the through traffic in the outside through lane when more than one through lane exists) on the approach and the corresponding right turn volume on the approach fall above the line a right turn lane is warranted.

Figure 2-1



e. Right turn lanes may be required for new accesses on Principal Arterials and Minor Arterials/ Collectors as determined by the City Traffic Engineer.

207.07.04 TURN LANE LENGTH

1. On Principal Arterial streets, when conditions allow, the total length of left and right turn lanes will be the sum of the taper length plus the deceleration length plus the storage length. Where intersection spacing or other space constraints do not allow this lane length the taper length may be considered as part of the deceleration length. If further reduction is necessary the desirable deceleration length may be reduced to fit the turn lane in the available space at the discretion of the City Traffic Engineer.
2. On uncontrolled approaches on Minor Arterials/ Collector streets the total length of left and right turn lanes will be the deceleration length plus storage length. The taper length will be considered as part of the deceleration length. If intersection spacing or other space constraints do not allow this lane length the desirable deceleration length may be reduced to fit the turn lane in the available space at the discretion of the City Traffic Engineer.
3. On controlled approaches on Minor Arterials/ Collector streets the total length of left and right turn lanes will be the taper length plus storage length. If there is not adequate space to allow this lane length, the storage length may be reduced to fit the turn lane in the available space at the discretion of the City Traffic Engineer.
4. **Deceleration and taper lengths**
   a. Deceleration and taper lengths for turn lane lengths should be based on Table 2-10:

Table 2-11 Design Criteria Acceleration and Deceleration Lanes

Posted Speed Limit in MPH	25	30	35	40	45	50	55
Deceleration Length in Feet	180	250	310	370	435	500	600
Transition Taper Ratio	7.5:1	8:1	10:1	12:1	13.5:1	15:1	18.5:1

Source: Table 4-6 Design Criteria Acceleration and Deceleration Lanes - CDOT State Highway Access Code 2002

Note 1: The length of transition tapers shall be calculated by multiplying the transition taper ratio for the selected design speed in table 2-10 above with the width of the proposed auxiliary lane.

Note 2: The deceleration lengths above are valid for grades less than 3%. For grades 3% and higher, deceleration lengths in table 2-11 need to be adjusted per the factors in the table below:

Table 2-12 Grade Adjustment factors

3% to 4.9% Upgrade, Use 0.9	3% to 4.9% Downgrade, Use 1.2
5% to 7% Upgrade, Use 0.8	5% to 7% Downgrade, Use 1.35

Source: CDOT State Access Code 2002 Stopping and Deceleration Adjustment Factors for Highway Grade CDOT Table 4-4

b. Storage Length.

(i) For left turn lanes, the desirable storage length (in feet) at signalized intersections is 1.1 times the left turn volume projected for the approach in the approved Traffic Impact Study. For left turn lanes at un-signalized intersections, the desirable storage length is to be determined based on the results of the capacity analysis conducted as part of the approved Traffic Impact Study. The 95th percentile queue calculated using the latest procedures in the Highway Capacity Manual will be used to determine the appropriate storage length assuming twenty five (25) foot per car in queue.

(ii) For right turn lanes, the desirable storage length (in feet) at signalized intersections is 0.6 times the highest peak hour right turn volume projected for the approach in the approved traffic impact study. On controlled approaches at un-signalized intersections, the desirable storage length for right turn lanes shall be based on the results of the capacity analysis conducted as part of the approved Traffic Impact Study. The 95th percentile queue, calculated using the latest procedures in the Highway Capacity Manual, will be used to determine the appropriate storage length assuming twenty five (25) feet per car in queue. On uncontrolled approaches at un-signalized intersections, no storage length is required for right turn lanes.

(iii) The minimum allowable storage length shall be twenty-five (25) feet.

208.00 CUL-DE-SACS

208.01 GENERAL

1. Permanent dead-end streets shall be in the form of a cul-de-sac. Dead-end streets without a cul-de-sac shall not be allowed unless designed to connect with a future street. If the temporary dead-end street is longer than eight hundred (800) feet, or serves as primary access to any lot, a paved temporary turnaround or a paved temporary connection to another street shall be provided.

208.02 DESIGN CRITERIA

1. Permanent dead-end streets in the form of a cul-de-sac shall have a maximum length of two hundred and fifty (250) feet, measured along the centerline, from the center of the intersection to the center of the bulb. All cul-de-sacs shall have a minimum flowline radius of fifty (50) feet.
2. Medians or landscape islands within cul-de-sacs shall be subject to review and approval by the City Engineer. Proposed islands within cul-de-sacs are generally not permitted unless sufficient right of way is provided to allow for installation of the island, the proposed Islands do not preclude the functionality of the street and accesses, and there are no conflicts with any other provision in these City Standards as they relate to other design considerations. If allowed, there shall be no parking within these circulation aisles.
3. Where cul-de-sacs have been approved with medians or landscape islands with irrigated landscaping, underdrain systems or other approved drainage measures shall be installed to avoid damage to the adjacent pavement.
4. All other design criteria including pedestrian and bicycle considerations shall be the based on the design criteria for the particular street classification in these City Standards and Title 15 in the Code.

209.00 OTHER ROAD CLASSIFICATIONS

209.01 EMERGENCY ACCESS ROADS

Where required by the Fire Marshall and/ or Fire Code Official, all emergency access roads shall meet the following minimum criteria:

1. All emergency access paths shall be installed in a minimum twenty foot (20) easement and shall be a minimum twenty (20) foot wide with a minimum vertical clearance of thirteen point six (13.6) feet. Emergency access paths shall be designed to withstand a minimum loading of seventy five thousand (75,000) lbs.
2. Slope – The minimum allowable profile grade for emergency access roads shall be 0.7% and the maximum grade slope shall be 6%. See Section 503.2.7 of the International Fire Code.
3. Angles of approach and departure shall be within the limits established by the Fire Code Official based on the Fire Department's apparatus as per Section 503.2.8 in the International Fire Code.
4. Materials - Acceptable materials that provide all-weather driving capabilities per Section 503.2.3 in the International Fire Code include but are not limited to concrete, grass-crete, and asphalt as approved by the Fire Marshall and/or Fire code Official.
5. Straight dead-end roads shall be a minimum of one-hundred and fifty (150) feet long, including autocourts, in order to meet Fire Code requirements.

209.02 ALLEYS

1. Alleys should be designated as Public only if they are serving a public function and are maintained by the City.
2. All new alleys shall be paved to a full width and shall provide paved access to a paved street at both ends. Concrete alleys may be allowed on a case-by-case basis. In situations where redevelopment

occurs along an existing unpaved alley, and utilizes the alley as a primary access, the Developer shall be responsible for paving the alley along the frontage of the property, and for extending the paving to the closest intersection of the alley with a public street.

3. In City rehabilitation projects affecting existing paved or unpaved alleys, the alleys shall be restored to existing conditions or better, as determined by the City Engineer.

209.03 MAINTENANCE ACCESS PATHS

1. Maintenance access path for maintenance of public infrastructure shall be ten-foot (10) wide all-weather access paths designed to withstand loads of sixty thousand (60,000) lbs. as a minimum. Easement provisions for access path installations are to be provided, as needed.
2. If the infrastructure to be maintained is located at a distance greater than four (4) feet from the edge of the maintenance path, a bulb-out or turn-around area to allow the maintenance vehicles to turn-around is required.

209.04 PRIVATE DRIVES

Private drives are defined in these City Standards as driveways serving a private development. Private drives are owned and maintained by private entities and are not eligible to be maintained nor be turned over to the City in the future. Private drives shall not be wider than twenty-five (25) feet and shall serve as common access to multi-family developments.

210.00 CONCRETE SIDE PATHS, PEDESTRIAN BRIDGES, AND UNDERPASSES

210.01 GENERAL CRITERIA

1. Concrete side paths in Principal Arterials, rights-of-way, primary greenways, parks and other areas owned or maintained by the City, shall comply with all sections of these City Standards. Where those standards or specifications may conflict, the most stringent City Standard shall be followed, or as directed by the City Engineer.
2. Pedestrian Bridges or street underpasses may be required where crossings of a primary greenway, waterways, or Principal Arterial streets are necessary to allow for logical trail routes. Pedestrian Bridges are to comply with this section of these Standards and Specifications. Street underpasses shall also follow drainage requirements in Section 300 of these Standards and Specifications.
3. All Sections as applicable shall also apply to all City capital design and construction projects that reference these City Standards. References to “the Developer” in Section 210 of these City Standards shall be considered references to the Consultant or Contractor. In the event of any conflict between these Standards and the project specifications, the more stringent of the two shall apply.

210.02 MINIMUM DESIGN CRITERIA

A minimum eight (8) foot wide six (6) inch thick concrete path is to be provided along all Principal Arterial right of way, primary greenways, secondary greenways and other areas as determined by the City Engineer. There is to be a two (2) foot minimum clear zone adjacent to all concrete paths from any vertical object. Since there is a likelihood of crashes occurring on curves, the minimum clearance that should be used for line of sight obstructions should be determined following AAHSTO criteria in the ASSHTO Development of Bicycle Facilities (2012).

1. A minimum two (2) foot tool jointed concrete rumble strip may be used between the path and the vertical object where narrow nuisance strips may result.
2. A ten (10) foot wide inside clear dimension is to be provided for all pedestrian bridges in City-owned areas. Two (2) feet of clearance on each side of the path should be provided. For underpasses with a two (2) foot width on each side, the minimum inside width shall be 14 feet. For underpasses longer than 100 feet, increased width may be required.
3. Current Americans with Disabilities Act (ADA) and AASHTO recommendations should be followed in the design of all concrete side paths. A grade of not more than 1:20 shall be provided for all concrete side paths, sidewalks, and connections to public paths except where provisions are made to meet ADA.
    a. ADA guidelines allow for increased design grades for outdoor recreation trails. These requirements could apply to Primary Greenway concrete trails in some situations. It is the responsibility of the Developer to verify current ADA requirements and coordinate with the City Engineer to clarify where 'outdoor recreation trail' standards may be applied.
4. Concrete paths adjacent to slopes steeper than 4:1 shall include a six (6) foot shoulder with a 2% slope on the downhill side of the path and one (1) foot shoulder on the uphill side. Where the slope is 4:1 or less, include a one (1) foot shoulder on both sides at 2%.
5. Barrier railing to be provided at bridge abutment areas and other drop offs. Refer to AASHTO Bicycle Facilities for additional information regarding the use of barrier and rail.
6. Horizontal curves shall have a fifty (50) foot centerline minimum radius (fifty (50) foot minimum tangent sections between curves for all concrete paths. One hundred (100) foot radius curves are encouraged. An overly curvilinear concrete path is not permitted.
7. Curvilinear concrete paths may not be closer than six (6) feet from the back of curb.
8. Trail intersections to have fifteen (15) feet (min.) radius for maintenance vehicle turning movements.
9. Vertical curves shall take into consideration the topography, drainage and ADA requirements, shall be minimized where possible and shall provide for safety of pedestrians and recreationalists.
10. The concrete path shall be offset from the property line in such a manner as to provide a detached concrete path, except at street intersections where the path is to be curb attached for a minimum of fifty (50) lineal feet from the intersection.
11. Additional concrete flatwork is required where a detached concrete path becomes curb attached and where the detachment is two (2) feet or less in separation. This area may be placed in decorative concrete flatwork (colored/ textured).

12. Concrete trail design may be required to accommodate access for utility maintenance vehicles. In such cases, trails shall be required to be wider or thicker to accommodate wider or heavier maintenance equipment. Additional easements may be required over sections of these trails to allow for said maintenance

13. Where greenway concrete paths or ramps intersect with streets a stop sign shall be located at the intersection of the two traffic routes (facing the greenway route). An advance warning sign shall be placed one hundred (100) feet from the intersection along the greenway.

14. Concrete paths are to be located out of the low flow channel and associated areas that contain 10% of the 100-year flow rate in large drainage basins, and out of low flow channel and associated areas that contain 5% of the 100-year flow rate in small drainage basins, as determined by the City Engineer. Exceptions to this provision to be specifically requested with reason for non -compliance given.

15. Pedestrian bridges shall meet the requirements set forth in the AASHTO LRFD Bridge Specifications, as modified by the AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges. Minimum pedestrian bridge width shall be ten (10) feet inside clear dimension between railings Railing height shall be 42”-54” above deck height. Railings shall be designed to meet AASHTO requirements. Bridges shall be designed for the uniform pedestrian live load in accordance with the Guide Specifications. Pedestrian bridges shall be designed for a minimum vehicular load in accordance with the Guide Specifications. If maintenance vehicles, jet trucks or other large vehicles exceeding the design vehicular load require access, the specific width of those larger vehicles will be the minimum live load requirements. See bridge signage requirements in Section 607 to include weight capacity, year built and manufacturer signage. The design wind load shall be computed using a basic wind speed of 142 miles per hour (3 second gust), as if enclosed. Shop drawings shall be submitted to the City Engineer for approval a minimum of thirty (30) days prior to bridge manufacture schedule.

    a. Pedestrian bridges shall include additional railing to eliminate drop off areas at abutment or along approach pathways where needed. Railing to match bridge rails and accommodate turning movement of maintenance/emergency vehicles

    b. Pedestrian bridges in City-owned areas shall be located above 10% of the 100-year floodplain elevation with a minimum one (1) foot of freeboard unless larger flows are required by the City Engineer.

    c. See section 600 in these City Standards for signage requirements.

    d. A steel safety plate is to be mounted on the pedestrian bridge deck as needed to fill gaps over one half (½) inch at abutment. Plate is to be mounted to bridge only with a continuous weld, and constructed to slide over abutment with expansion movement of bridge. Plate is to run entire width of decking and extend onto abutment sufficiently to cover the gap completely. Plate edges to be beveled to lessen trip hazard or bump.

    e. Riprap or other engineered abutment protection is required as designed by the Design Engineer.

    f. Approaches to the bridge abutment shall be engineered to eliminate settling of the grade behind the abutment.

    g. Pedestrian bridge decking design shall allow for easy replacement of boards.

16. Principal Arterial street underpass of primary greenway concrete paths shall be sized to accommodate a minimum ten (10) foot wide concrete path plus a minimum two (2) foot wide

concrete warning strip on each side of the path, while maintaining an eight and one half (8.5) foot minimum head clearance (unless maintenance vehicles require greater vertical clearance) from finish grade of concrete path. Head clearance is to be calculated from the lowest part of the structure or attachments to that structure. Additional head clearance (up to ten (10) foot) is preferred where possible. A concrete thickened edge or other structural component is to be engineered for the concrete path within the low flow channel and associated areas. Riprap path edge protection to prevent undercutting path during flood conditions is required. Rip rap shall be hand placed to be flush with top of adjacent trail. Elevation of the concrete path should allow normal flow conditions without flooding. Separator walls and/or sump pumps are not allowed without specific exception granted. Alternate concrete trail route during flooding is to be provided at underpasses, using a concrete ramp meeting ADA requirements to the street grade.

a. Flood gates to be provided at both sides of underpass out of normal high water elevation or as per direction from the City Engineer. See Detail 601.02. Gate width shall include a minimum of two (2) feet between posts and trail edge.

b. Lighting of underpasses is required to be activated by photocell; see Approved Materials List. Number of fixtures shall provide consistent pedestrian lighting level. A building permit is required for this work.

c. Striping shall be required in all underpasses and where there is restricted visibility. Stripes shall be continuous yellow, four (4) inches wide. Lines shall be painted along the center of the trail. The striping shall extend through the underpass or low visibility zone for a minimum of fifty (50) feet outside of each end of the underpass up to the intersection with the trail connecting to surface grade.

17. Trail and underpass bridge signage – refer to Section 607 Trail Signage: Graphics for signs shall be provided by the City when available. Graphics and text for signs shall follow Park & Trail sign standards and must be approved by the City Engineer.

210.03 MATERIALS

1. For a specific list of materials accepted by the City, please see the Approved Materials List.
2. Concrete mix design: see Concrete Construction Section in these City Standards.
   a. Control joints: zip strips or saw cut (soft cut) to one third (1/3) the total slab thickness. Demo saw will not be allowed to cut joints.
   b. Curing compound: for all concrete trail surfaces - white pigmented sealant.
3. Pedestrian Bridge steel to be CorTen self-weathering steel or approved equal. Concrete reinforced bridges are acceptable. Concrete decking or ironwood decking with three (3) inch minimum thickness planks is acceptable. See Approved Materials List for pre-approved decking. Approach railing shall match bridge steel (if applicable). Safety plate at abutment expansions joint where applicable to be one and three eight (1-3/8) inch minimum textured, galvanized steel plate with both edges beveled. Welding and bolting along the entire length of the plate is required. Submit to the City Engineer for review.
4. Barrier railings shall meet ADA and be constructed with a minimum of two (2) inch round tubing with one-quarter (1/4) inch walls. All welds shall be ground smooth and railings shall be painted

gloss black (or other color with City approval) with zinc enamel paint. All railing designs shall be per these City Standards and current AASHTO standards.

5. Flood gates shall be welded from four (4) inch minimum galvanized pipe support posts and two and one-half (2-1/2) inch pipe for gate with ample cross members for structural integrity. Posts for locking into open and closed positions are required using heavy-duty chain and steel encased padlock (lock provided by City). Gates are to have reflector tape on both sides.
6. Lighting: Install recessed light fixtures between bridge beams or at corner of underpass structures if possible. Mount photocell in concealed location, yet open to natural light conditions. Vandal resistant, lexan lens fixtures with metal guard shall be used. Wiring to be enclosed in conduit and installed per National Electric Code. See Approved Materials List for pre-approved fixtures.
7. Root Barrier: See Approved Materials List for pre-approved barriers.

210.04 EXECUTION/ CONSTRUCTION

1. Locate all utilities prior to grading and trenching and protect from damage per these City Standards.
2. Submit concrete mix design to the City Engineer for approval.
3. Alignment shall be per the approved plans. Field modifications in alignment must be approved by the City Engineer prior to formwork.
4. Coordinate with irrigation or electrical installation so necessary sleeves are placed beneath concrete path as needed. Sleeves shall be set at standard trench depth per CDOT standards.
5. Schedule proof roll prior to forms being set per these specifications. Obtain testing of density and moisture and re-compact as needed in order to obtain minimum compaction requirements prior to pour.
6. No tooled joints are allowed on concrete trail construction. Place expansion joints at maximum spacing of four hundred (400) lineal feet or three thousand, two hundred (3,200) square feet, whichever is less. Install expansion material at sufficient depth to allow for sealant and remain flush with finish surface elevation. Expansion joints shall be installed where flatwork intersects vertical concrete, manholes, valve boxes, inlets, or other structures.
7. Dowel per these specifications between all cold joints and between concrete path and bridge abutment or design to prevent settling.
8. Control joints shall be zip-strip or saw-cut. Control joints on eight (8) or ten (10) foot centers, not exceeding trail width shall be straight and perpendicular to the edge of the concrete path.t Control joints shall be placed at intersections, radius points and elsewhere as needed to prevent cracking.
9. Saw-cut joints shall be timed properly with the setting of the concrete. Cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates from being dislodged by the saw, and shall be completed before shrinkage cracks have developed.
10. Testing shall be done by an independent testing lab per these City Standards.
11. Concrete finish shall be consistent light broom finish. Heavy broom finish will not be permitted. Irregularities, poor finish and other deficiencies of workmanship or vandalism will require concrete work to be removed and replaced. Weather damage to finish will also be cause for removal and replacement. Contractor has option to provide sample panel of finish prior to work for City approval.

12. No concrete wash is to be dumped onto landscape areas. Concrete wash out areas to be identified per these City Standards. Any concrete water or spillage shall be contained and completely removed from the site prior to landscaping.
13. Protect concrete with curing compound and other means to prevent premature drying, frost and rain. Provide watchmen as needed to protect from vandalism until reasonable cure is obtained.
14. Remove forms twenty four (24) hours after pour unless otherwise approved. Avoid damage to edges of pavement.
15. Backfill edges of concrete path prior to opening to public use, per these City Standards.

211.00 PUBLIC TRANSIT FACILITIES

1. On Arterial and Collector roadway classifications, public transit provisions shall be provided, where feasible. All transit facilities installed in City right of way shall meet PROWAG standards.
2. Contact the Regional Transportation District (RTD) for Bus Bay/ bus stop requirements and details.

212.00 BRIDGES

212.01 DEFINITIONS

Major Structure: For the purposes of these specifications, a "major structure" is defined as a bridge or culvert(s) with a total length greater than 20 ft. measured along the centerline of the roadway between the inside face of abutments, inside faces of the outermost walls of culverts, or spring lines of arches. Major Structures also include culverts with multiple pipes where the clear distance between the centerlines of the exterior pipes, plus the radius of each of the exterior pipes, is greater than 20 ft.

Minor Structure: For the purposes of these specifications, a "minor structure" is defined as a bridge, culvert, or a group of culverts that have a length greater than or equal to 4 ft. and less than or equal to 20 ft. measured along the centerline of the roadway between the inside face of abutments, inside faces of the outermost walls of culverts, or spring lines of arches.

Pedestrian Bridge: A structure designed and constructed to provide means for pedestrian and light vehicle traffic only to cross an obstacle such as a river, stream, ditch, road, railway, etc. The minimum span width over the obstacle shall measure at least 5 feet.

212.02 DESIGN SPECIFICATIONS

1. Bridge structures shall be designed in accordance with CDOT's Bridge Design Manual and AASHTO's LRFD Bridge Design Specifications. All major structures, minor structures and pedestrian bridges shall be designed by a Colorado licensed professional engineer who specializes in Structural engineering.
2. A Structure Selection Report shall be prepared for all major structures or as determined by the City Engineer. The Structure Selection Report presents the results of the preliminary design process. All

feasible solutions shall be evaluated and compared. The Structure Selection Report shall document, justify, and explain the Project Structural Engineers' structure layout and type selection.

3. Bridge railing test levels and crash criteria shall be in accordance with AASHTO. The minimum test level shall be TL-4 for all new bridges on arterial roadways.

213.00 STRUCTURAL CROSS SECTION PAVEMENT DESIGN

213.01 GENERAL

1. The design of the pavement cross-section shall be performed by a Professional Engineer registered in the State of Colorado, whose expertise is geotechnical engineering.
2. For Development projects: The Engineer's report for the pavement thickness design and the soils report upon which it is based will be submitted for review and approval after the overlot grading has been completed or after installation of wet utilities, if applicable, and at least three weeks prior to the pre-paving conference.
3. If a single pavement design is used for all Local streets within a development, that pavement design shall be based on the worst soil encountered from the standpoint of subgrade support.

213.02 DESIGN CRITERIA

1. The pavement design of streets shall be based on the design period of twenty (20) years for flexible pavement and thirty (30) years for rigid pavement unless otherwise approved by the City Engineer.
2. In State right of way, the design of pavements shall be based on the latest M-E Pavement Design Manual of the Colorado Department of Transportation as required by CDOT.
3. AASHTO's 1993 and 1998 Supplement Design Process is adequate for most City right of ways.
4. Pavement design and structural number calculations shall be included in the geotechnical report, as applicable.

Table 2-13 includes minimum standard design volumes, percent truck, and EDLA (Equivalent daily loaded axle) values. The listed EDLA values in Table 2-13 are minimum requirements to be used for checks or in the event a Traffic Impact Study is not associated with the project. Pavement structural sections (thickness) should reflect structural number values resulting from pavement design calculations and actual traffic data. If the calculated structural number falls below the minimum allowable limits, the minimum established values in Table 2-13 may be used.

Table 2-13 Pavement Design Minimum Criteria

STREET TYPE	ADT	% TRUCK	EDLA (MINIMUM)
Local Residential	2,500	1%	10
Local Commercial	2,500	7%	50
Local Industrial	2,500	20%	85 (2)
Residential Collector	9,000	(1)	50
Non-Residential Collector	9,000	(1)	100 (2)
Principal Arterial	9,000+	(1)	200 (2)

Note 1: For Minor Arterials/ Collectors and Principal Arterial streets, the percent truck usage shall be determined on a case by case basis.

Note 2: EDLA for Local Industrial, Non-residential Collector and Principal Arterial streets shall be based on values obtained from a Transportation Impact Study. The listed EDLA values are minimum requirements.

213.03 MINIMUM STRUCTURAL SECTIONS REQUIRED AT CONSTRUCTION ACCEPTANCE

1. Flexible Pavement: The minimum structural section shall be four and one half (4½) inches of asphalt pavement placed on eight (8) inches of class six (6) aggregate base course placed on twelve (12) inches of minimum compacted subgrade.
2. Full Depth Asphalt: The minimum full depth asphalt structural section thickness shall be six and one half (6½) inches of hot mixed asphalt pavement placed on twelve 12 inches of minimum compacted subgrade. As determined by the City engineer, any subgrade exhibiting swell potential shall require chemical stabilization for full depth asphalt sections.
3. Rigid Concrete Pavement: The minimum concrete structural section shall be six (6) inches of non-reinforced Portland cement concrete pavement placed on twelve (12) inches minimum compacted subgrade.
4. If the minimum pavement section is to be used, the report must demonstrate the adequacy of the structural section for the soil conditions encountered.

214.00 GENERAL STREET CONSTRUCTION

214.01.01 DEFINITIONS

1. "Streets" as used in this specification shall include the pavement section, right-of-way, sidewalks, driveways, concrete paths, alleys and alley approaches.
2. The term "State Specifications" and "CDOT" in these standards refers to the current version of the State Department of Transportation, Division of Highways, State of Colorado "Standard Specifications for Road and Bridge Construction". Sections 100 through 109 and measurement and payment provisions of the "State Specifications" shall not apply unless otherwise required. Reference in these specifications to the "Division" shall be understood to refer to the City of Longmont and its authorized personnel.
3. **Base Course:** The layer or layers of specified or selected material placed on a subbase or a subgrade to support a surface course.
4. **Roadbed:** The graded portion of a highway within top and side slopes, prepared as a foundation for the pavement structure and shoulders.

5. **Subbase:** The layer or layers of specified or selected material placed on a subgrade to support a base course, surface course, or both. Subgrade that has been treated with lime, fly ash, cement kiln dust, or combinations thereof for stabilization will be considered subbase.
6. **Subgrade:** The native soil beneath the subbase.
7. **Surface Course:** One or more layers of a pavement structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate. The top layer is sometimes called "wearing course."

214.02 SEQUENCE OF CONSTRUCTION

1. Prior to commencing paving operations, a pre-paving meeting shall be held.
2. Pavement Installation: For development projects, the top one and one-half inch (1-1/2) of asphalt pavement shall be constructed at the end of the warranty period in accordance with the Rotomill Detail in these Standards unless otherwise identified in the Public Improvement Agreement (PIA), or as agreed to by the City Engineer.
3. After the lower lift paving is installed, no cuts shall be made without the approval of the City Engineer. If utility installation is required after installation of curb, gutter, sidewalk, concrete path or pavement, boring, jacking, or other alternative means of construction will be utilized.
4. If a pavement cut is permitted after installation of the top lift of pavement, the City Engineer may require heater scarifying of patch joints, overlaying of the street, or other techniques approved by the City Engineer to avoid any reduction in the useful life of the pavement.
5. All installation and proper compaction of buried utilities shall be completed prior to the construction of the subgrade, base course, pavement, curb, gutter, crosspans, sidewalks, concrete paths and driveways. The Contractor shall adjust valve boxes and manholes to final grade after installation of the curb and gutter as described below. Electrical services and dry utility road crossing sleeves shall be installed prior to the installation of curb and gutter.

214.03 FIXTURE ADJUSTMENT

1. The Contractor shall adjust all manhole ring and covers, valve boxes and other fixtures encountered within the area to be paved to conform to the finished surface of the pavement to be built as per the street plans and details and in accordance with all requirements outlined in these City Standards . Clean the outside of the fixtures of loose, foreign material for the depth of the pavement prior to the paving. The Contractor shall adjust manhole castings, valve boxes and other fixtures outside the paved areas, but within the street right-of-way, to conform with the finished cross section after construction. Inspect valve boxes by placing a valve key on the operating nut to assure a proper alignment. All adjustments shall be to proper alignment and grade to the satisfaction of the City Engineer.
2. Manholes ring and covers, valve boxes, and other fixtures shall be adjusted to the interim street grade after the installation of the lower lift of pavement to produce a safe and rideable surface around the fixture. Prior to placing the final lift of asphalt, manholes, valve boxes, and other fixtures shall be adjusted to the final street grade.

214.04 PROTECTION AND CLEANING

1. The Contractor shall take proper precautions for the protection of all existing improvements which are to remain in place and all other identifiable installations that may be encountered during construction which are to remain and not be replaced.
2. The City Engineer shall be the sole judge as to whether items may be reset and reused. If, in the opinion of the City Engineer, items that were allowed to be reused and reset are damaged during construction, the items shall be replaced by the Contractor.
3. The Contractor is responsible for site cleaning during the entire construction period. After paving operations have been completed, the Contractor shall clean and remove all leftover and waste materials. All curbs shall be properly backfilled and the adjacent ground left in a neat and uniform condition, acceptable to the City Engineer.
4. Culverts designated to remain shall be cleaned at the end of construction by removing all sediment and debris from within the culvert and appurtenant structures.

215.00 CLEARING AND GRUBBING

1. This work shall consist of clearing, grubbing, removing and disposing of vegetation and debris within the limits of the right-of-way, easement areas, and such other areas as may be indicated on the drawings or required by the work, except such vegetation and objects designated to remain.
2. The Contractor shall remove and dispose of protruding obstructions, stumps, roots and matted roots over four (4) inches in diameter to two feet below the finished grade. Backfill all holes resulting from the removal of obstructions, stumps, and roots and compact the backfill to 95% of Standard Proctor, ASTM D698. Undisturbed stumps, roots, and nonperishable solid objects located two (2) feet or more below the subgrade may remain in place.
3. The Contractor shall clear and strip all surface vegetation, sod, and topsoil from subgrades for permanent construction, fills and embankments. Undisturbed stumps, roots, and nonperishable solid objects located two (2) feet or more below the subgrade may remain in place.
4. The Contractor shall trim or remove and dispose of branches of trees extending over the roadway to a clear height of fifteen (15) feet above the roadway surface. All removal and trimming shall be done by a licensed arborist.

216.00 REMOVAL OF STRUCTURES AND OBSTRUCTIONS

1. This work shall consist of the removal, wholly or in part, and the satisfactory disposal of buildings, foundations, fences, signs, structures, old pavements, abandoned pipelines, and other obstructions which are not designated on the approved plans to remain.
2. All culverts or sewers to be abandoned under City streets shall be flow-filled where they are located longitudinally within the public right-of-way. Unless otherwise approved by the City Engineer, the culverts or sewers that cross the public right-of-way under City streets shall be removed. The removal of culverts shall include the removal of headwalls and any other associated items that are necessary to accommodate the work as determined by the City Engineer
3. The Contractor shall not remove sidewalks, concrete paths, streets, driveways, culverts, or other drainage structures in use by traffic or pedestrians until satisfactory arrangements acceptable to the City Engineer have been made to accommodate traffic and drainage.

4. All structures designated to partially remain within the right-of-way shall be removed to a depth of two (2) feet below the proposed subgrade.
5. Where new construction ties into existing improvements, such as edges of pavement, sidewalks, curbs, etc., the Contractor shall line out and cut or saw the existing improvements to a true line and to an approved depth with a vertical face at the line of removal. Where the existing improvements are damaged, the Contractor shall remove the damaged improvements and shall tie-in to improvements which are in good condition as determined by the City Inspector.

217.00 EXCAVATION AND EMBANKMENT

217.01 GENERAL

1. This section covers excavation, hauling, disposal, placement, subgrade preparation, shaping, backfill, compaction, and embankments.
2. The Contractor shall complete all necessary clearing and grubbing and removal of obstructions prior to beginning grading operations.
3. The Contractor shall not begin site grading until the work has been properly staked. The Contractor shall not excavate beyond the dimensions and elevations established.
4. Completed or partially completed areas of work that are disturbed by subsequent construction operations or by adverse weather shall be scarified, reshaped, and re-compacted to the required density.

217.02 MATERIALS

1. Generally, soil materials for roadway construction shall be as recommended in the approved geotechnical report. Following are the minimum requirements for the materials to be used in the construction of roadways.
2. Embankment and fill material shall consist of soil, granular sand, gravel, cobble and boulder material, free from frozen material, organic material, trash, glass, and broken concrete, other corrosive or deleterious material. The Contractor shall import approved material as necessary. Prior to placement of any imported material, the Contractor shall submit test results to the City Engineer for review and approval indicating compliance with the requirements of the geotechnical report and these City Standards.
3. Approval of embankment and fill material is contingent on the material having a resistance value when tested by the Hveem Stabilometer, or equivalent resilient modulus value, of at least 25 and a maximum dry density of not less than 90 pounds per cubic foot. The material must be stable and have a liquid limit less than 40 and a plastic index less than 15 when tested in accordance with AASHTO T-89 and T-90, respectively. Size restrictions are as follow:
    a. No material shall have a dimension larger than six (6) inches. In the top eighteen inches of fill, no material shall have a dimension larger than four (4) inches.
    b. These size restrictions are contingent upon the material being evenly distributed in finer material such that uniform soil consolidation is achieved. If uniform soil consolidation is not being achieved, the City Engineer may reduce the size of materials allowed or change the embankment and fill material requirements.
4. Where unstable subgrade is encountered, the Contractor shall take steps necessary to stabilize the material by techniques such as over excavation and backfill with imported material, use of

geotextile/geogrid or other combinations. The contractor shall notify the City Engineer of the proposed solution to stabilize the subgrade. If required by the City Engineer, the Design Engineer or Geotechnical Engineer will make recommendations on stabilization techniques and materials.

217.03 SUBGRADE

1. The Contractor shall scarify the subgrade to the depth specified in the approved geotechnical report and compact to the density specified within the approved report. In no case shall the depth be less than twelve (12) inches, or the compaction less that specified in these City Standards.
2. The Contractor shall not place any embankment, fill, base course, pavement or other permanent improvements on frozen or muddy subgrade. Compact and consolidate subgrades such that they are free from mud and sufficiently stable to remain firm, dense and intact.
3. Wherever material is encountered that is wet or otherwise unstable and is incapable of supporting structures or the roadbed, the material shall be over excavated to a depth suitable for construction of a stable subgrade. The Contractor shall backfill over excavated areas with a stabilization material approved by the City Engineer. An approved geotextile/geogrid material shall be used where required by the City Engineer beneath the stabilization material and on the subgrade to stabilize the subgrade. The geotechnical report shall identify areas that in the Geotechnical Engineer's opinion need to be treated with the appropriate chemical stabilization for the soils type and shall conform to the CDOT Standard Specifications for Road and Bridge Construction.
4. Level and roll the subgrade so the materials will be uniformly compacted and bond well with the first layer of the base course, backfill, fill or embankment.
5. Shape the surface of the subgrade under areas of base course, and pavement surfaces so that they are not more than one quarter (¼) inch above or one half (½) inch below the required subgrade elevation. Shape the surface of the subgrade under structures such that they are not more than zero inches above or one and one quarter (1¼) inches below the required subgrade elevation. Fill areas of the subgrade that are low with the material to be placed upon the subgrade. Shape the subgrade to prevent the ponding of water from drainage and rain.
6. Where pipe will pass through backfill, embankment, or fill the Contractor shall place and compact the backfill, embankment or fill to an elevation at least one (1) foot above the top of the proposed pipe prior to beginning trenching.
7. Remove exposed cobbles, stones or boulders greater than four (4) inches in size that create an irregular surface at the subgrade under base course material. Backfill the resulting voids with base course material and compact to the specified density.

217.04 EXCAVATION

1. The Contractor shall remove and dispose of excess excavated materials and materials that are not suitable for use within the public right-of-way.
2. Foundations and the pavement structure shall be founded on original, undisturbed soil or on structural backfill extended to the undisturbed soil. Unless otherwise approved by the City Engineer and stipulated in the approved geotechnical report, foundations and the pavement structure shall not be founded on existing or imported material that does not meet the properties required in these specifications. If unsuitable material is encountered, the contractor shall take the necessary measures to provide a stabilized subgrade following the recommendations of the geotech/ soils report. The disposal of unsuitable soil material is the responsibility of the Contractor.

3. Excavate rock that is encountered at the site to a minimum depth of six (6) inches below subgrade within the limits of the roadbed.

4. The Contractor shall blend the intersection of cut slopes with the slopes of adjacent natural ground surfaces in a uniform manner. The tops of cut slopes shall be flattened and rounded in accordance with the approved plans. Slopes shall be graded as shown on the approved plans, shall not exceed a 4:1 slope unless otherwise approved by the City Engineer, and shall be graded to drain.

217.05 BACKFILL, FILL AND EMBANKMENT

1. The Contractor shall import approved material if compaction cannot be obtained with job excavated material, or if job excavated material does not meet the criteria in Section 217.02, or the requirements of the geotechnical report. Prior to importing approved material the Contractor shall process and rework the job excavated material and attempt to achieve compaction unless otherwise directed by the City Engineer. The Contractor shall provide the proper documentation showing that the existing and imported materials meet the appropriate criteria.

2. Place the backfill, fills and embankments on suitably prepared subgrades. Distribute material so as to preclude the formation of lenses of material differing from the surrounding materials. Lifts shall have uniform thickness prior to compaction and shall not exceed eight (8) inches in un-compacted thickness. Spread and level material that is deposited in piles or windrows prior to compaction. Continuously mix, level, and manipulate the material as compaction progresses to assure uniform moisture and density.

3. The Contractor shall insure that the methods of compaction shall not overturn or place excessive pressure against the structure (retaining walls, abutments, wing walls, or culvert head walls) until the concrete has reached 80% of its design strength. When backfill, fill or embankment is placed on all sides of a concrete structure, the embankment shall be brought up equally on all sides of the structure. The fill adjacent to the abutment of a bridge shall not be placed higher than the bottom of the back wall until the superstructure is in place.

4. Where embankments encroach on stream channels, ponds or lakes, the largest available rock from the excavation shall be placed along the toes of slopes to protect the embankments against erosion from water action. The City Engineer may require the use of riprap along channels, ponds and lakes. All environmental and grading permits shall be obtained from the US Army Corps of Engineers, Colorado Department of Public Health and Environment and the City of Longmont Public Works and Natural Resources Department prior to construction adjacent to stream channels, ponds or lakes.

5. Rock embankment, if allowed, shall not be constructed above an elevation two (2) feet below the finished subgrade. The balance of the embankment shall be placed in layers not to exceed eight (8) inches loose thickness and compacted as specified for embankments. When rock fill is placed over any structure, the structure shall be covered with a minimum of two (2) feet of compacted earth or other approved material before the rock is placed.

6. Cross hauling or other action as appropriate will be required by the City Engineer when necessary to insure that the best available material is placed in critical areas of embankments.

7. The Contractor shall use equipment suited to the soil being compacted. Compaction by use of water ponding or jetting or use of a hydro-hammer is strictly forbidden.

217.06 FINISH GRADING

1. After the pavement, permanent surface improvements, structures, backfills and fills have been completed, the Contractor shall grade non-paved areas to slopes, contours or elevations indicated on the approved plan. Finish grading shall ensure proper positive flow and drainage. Conduct final rolling operations to produce a stable, uniform and smooth cross-section. Provide effective drainage with slopes of at least 2% unless otherwise indicated.
2. Where topsoil is to be placed in the non-paved areas the Contractor shall provide adequate depth for the topsoil placement. Finish grade areas to receive topsoil to within not more than 0.1 feet above or below the required subgrade elevations. Compact areas to receive topsoil as specified and grade such that they are free from irregular surface changes.

218.00 MATERIAL COMPACTION AND TESTING

218.01 GENERAL

1. The requirements for compaction and testing, construction water, and compaction test failure are the same as those required under their respective sections for trenching as specified in the General Requirements section of these City Standards, except as modified herein.
2. Testing frequencies: The Contractor shall test the subgrades, fills, base course, backfills and embankments for compliance with the requirements for thickness and compaction density. Provide, as a minimum, one (1) density test for each one hundred fifty (150) lineal feet of roadway subgrade, one (1) density test for each 150 lineal feet of sidewalk or concrete path and one (1) density test for each five hundred (500) cubic yards of embankment, fill or backfill. The City Engineer may designate the locations for testing. The City Engineer may require more tests when in their opinion they are required. Remove and replace unacceptable materials and repair unacceptable areas of thickness or compaction as required by the City Engineer. Compaction tests do not relieve the Contractor of the requirement for a firm, stable surface.

218.02 COMPACTION TEST REQUIREMENTS PER MATERIAL COMPOSITION

218.02.01 SUBGRADE

1. All compaction within the public right-of-way shall be equal to 95% compaction at plus or minus 2% optimum moisture content or as recommended in the geotechnical report.
2. Do not compact topsoil.

218.02.02 AGGREGATE BASE COURSE

1. Aggregate base course shall be compacted to 95% minimum density, Modified Proctor, ASTM D1557 or AASHTO T180. All compacted aggregate base course shall be within 2% of the optimum moisture content as determined by ASTM D1557. The City Engineer may require more tests when in their opinion they are required due to visibly unstable areas. Remove and replace unacceptable materials and repair unacceptable areas of thickness or compaction as required by the City Engineer. Compaction tests do not relieve Contractor of the requirement for a firm, stable surface.
2. Proof-roll the subgrade and base course prior to the placement of the subsequent course after the specified compaction densities have been obtained. Proof rolling shall be done with an approved vehicle having an average minimum axle load of 18,000 pounds per axle. Use of graders or front-end loaders is not acceptable. Areas that show movement and unstable areas shall be corrected.

Proof rolling shall be done within twenty four (24) hours of the compaction density testing and within twenty four (24) hours of placement of any asphalt or concrete surface.

219.00 AGGREGATE BASE COURSE

1. The source of aggregate base course shall be approved by the City Engineer prior to incorporation of the material into the project. The Contractor shall furnish to the City Engineer test results from an AAASHTO accredited laboratory and signed and sealed by a Colorado licensed Professional Engineer certifying that the material meets the required specifications. Results from aggregate tests performed more than two years in the past will not be accepted. The Contractor shall furnish aggregate base course from a single source unless otherwise approved by the City Engineer. The Contractor shall provide certification that sufficient quantity of material is available from the proposed source to satisfy the requirements of the project.
2. Aggregate base course shall be crushed stone, crushed gravel, natural gravel or crushed reclaimed concrete conforming to Section 703.03 of the State Specifications with a minimum R value of 78.
3. The Contractor shall mix the aggregate by methods that ensure a thorough and homogenous mixture.
4. The subgrade, subbase, and base course shall be free from standing water during construction. Remove any water encountered during construction to the extent necessary to provide a firm and stable subgrade and base course. Divert surface runoff or use other means necessary to accomplish the above. Do not deposit, tamp, roll or otherwise mechanically compact the aggregate base course in water. Do not construct aggregate base course with frozen material or on frozen subgrade.
5. If the required compacted depth of the aggregate base course exceeds six (6) inches, it shall be constructed in two or more layers of approximately equal thickness. The maximum compacted thickness of any one layer of aggregate base course shall not exceed six (6) inches. The surface of each layer shall be maintained during the compaction operations so that a uniform texture is produced and the aggregates are firmly keyed. Water shall be uniformly applied during compaction in the quantity necessary for proper consolidation of the material, or the material shall be harrowed, disked, bladed, or otherwise worked to insure a uniform moisture content. Immediately prior to paving, proof roll the aggregate base course as described in these City Standards to verify the base course stability. Correct areas that are not stable.
6. Herbicides, conforming to the requirements of the current version of CDOT Standard Specifications for Road and Bridge Construction, shall be applied to the aggregate base course and/or subgrade no more than one (1) day prior to paving. The rate of application shall be as recommended by the herbicide manufacturer. Herbicides shall not be used where they may contaminate water.
7. The in-place compacted thickness of aggregate base course shall be no more than one quarter (¼) inches less than the thickness shown on the approved drawings.
8. Test the finished surface of the compacted aggregate base course for smoothness using ten foot straightedge applied parallel with, and at right angles to centerline of the paved area. Any deviation in excess of one quarter (¼) inches shall be corrected to the satisfaction of the City Engineer.
9. Final proof roll of the aggregate base course shall be completed prior to placement of the pavement layer.

220.00 ASPHALT PAVEMENT CONSTRUCTION

220.01 GENERAL

1. The job mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of asphalt material to be added to the aggregate and a single temperature for the mixture at the discharge point of the plant. The job mix formula shall also identify all additives, optimum asphalt content and the final gradation shown on 0.45 power graph. Where reclaimed asphalt is used in the job mix, the design report shall address the use of reclaimed asphalt and the percent of asphalt in the reclaimed asphalt. Submit the following with the job mix formula.
2. The proposed job mix gradation for each mixture which shall be wholly within the Gradation Range Table before the production (job mix) tolerances are applied.
3. When the City Engineer finds the materials or work furnished, work performed, or the finished product are not in conformity with the Contract and has resulted in an inferior or unsatisfactory product, the work or material shall be removed and replaced or otherwise corrected at the expense of the Contractor. Paving operations may be suspended by the City Engineer if the Contractor is performing work not in conformance with these City Standards. Whenever paving is suspended, corrective actions shall be proposed in writing by the Contractor. Paving will not be allowed to resume until the proposed corrective actions have been accepted by the City Engineer in writing.
4. Throughout this section WMA may refer to either Warm Mix Asphalt (as is typically referenced by CDOT) or as a Workability Mix Additive (as is typically referenced by MGPEC.) Both definitions are referring to the same product or process which is the potential production of asphalt at lower temperatures when compared to regular hot-mix asphalt.

220.02 MATERIALS

1. All asphalt paving materials and mixtures shall conform to Item 20 of the most recent version of the Metropolitan Government Pavement Engineers Council (MGPEC) specifications, except as modified herein, for all non-State Highways. On all State Highways the most recent version of the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction shall be utilized. On Capital Projects, CDOT, MGPEC or other applicable specifications may be used at the discretion of the City Engineer.
2. Workability Mix Additive/Warm Mix Asphalt (WMA) - WMA technologies must be used in compliance with Item 20 of the Metropolitan Governments Pavement Engineers Council (MGPEC) and the Colorado Department of Transportation's Colorado Procedure 59 (CP-59). WMA technologies shall be on the CDOT Approved List of WMA Technologies.
3. Asphalt mixture design and field control testing of dense graded asphalt mixes shall meet the requirements of Table 2-14 below.

Table 2-14 Superpave Mixture Properties

TABLE 2-13 - SUPERPAVE MIXTURE PROPERTIES				
Traffic Loading, Total 18,000 pound equivalent single axle loads (18K ESALs) over design life of 20 years	Non-Vehicular or Paths	Less than 300,000	300,000 to 3 Million	Greater than 3 Million
Recommended Performance Graded (PG) Binder (see Note 4 and 5)	PG 58-28	PG 58-28	PG 64-22	PG 64-22 (Top Lift) PG 64-28 (Bottom Lift)

Design gyrations, N_{design}	50	75	75	75
Air Voids (V_a) % at N_{design} (CP-L 5115 or AASHTO T-132) (see Note 1 and 2)	3.0 – 4.0	3.0 – 4.0	3.0 – 4.0	3.0 – 4.0
Hveem Stability Grading SX and S only (CP-L 5106 or AASHTO T-246)	N/A	28 Min.	28 Min.	30 Min.
Voids Filled with Asphalt, %, MS-2	70-80	65-80	65-80	65-75
Accelerated Moisture Susceptibility (Lottman), Tensile Strength Ratio, % retained (CP-L 5109 or AASHTO T-283 Method B)	80 Min.	80 Min.	80 Min.	80 Min.
Dry Tensile Strength, **psi** (CP-L 5109 or AASHTO T-283)	30 Min.	30 Min.	30 Min.	30 Min.
Voids in Mineral Aggregate (VMA) % (CP-48 or AASHTO PP-19) (see Notes 2 and 3)	All mixes shall meet the minimum VMA specified in the most recent version of Item 20 of the MGPEC Specifications or the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction, whichever is applicable.			

Note 1: Select the target Job Mix Optimum Binder Content for APM gradings as close to 3.5% air voids as possible.

Note 2: Maximum Theoretical Specific Gravity of mix by Colorado Procedure 51 (CP-51) or AASHTO T-209.

Note 3: VMA shall be based on tests of the Bulk Specific Gravity of the Compacted Mix (CP-L 5103 or AASHTO T- 166) and Aggregate (AASHTO T-84 & T-85), and calculated according to CP-48 or AASHTO PP-19.

Note 4: Asphalt cement binder shall meet all requirements of Item 20 of the MGPEC Specifications or CDOT Standard Specifications for Road and Bridge Construction, whichever is applicable.

Note 5: Variation from the recommended asphalt cement binder shall be approved by the City Engineer.

4. After the job mix formula is established, all mixtures furnished for the project shall conform to the approved job mix formula within the range of production tolerances in Table 2-15.

Table 2-15 Job Mix (Production) Formula Tolerances

TABLE 2-14- JOB MIX (PRODUCTION) FORMULA TOLERANCES	
Passing No. ¾" and Larger	6%
Passing No. 4 and No. 8	5%
Passing No. 30	4%
Passing No. 200	2%

220.03 CONSTRUCTION REQUIREMENTS

1. Construction of asphalt pavements shall conform to Item 20 of the most recent version of the Metropolitan Government Pavement Engineers Council (MGPEC), except as modified herein, for all non-State Highways. On all State Highways the most recent version of the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction shall be utilized. On Capital Projects, CDOT, MGPEC or other applicable specifications may be used at the discretion of the City Engineer.
2. Construction of APMs on all roadways shall be in accordance with Section 401.07 through 401.20 of the most recent version of the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction, except as modified herein. Pavement compaction test sections (CTS) shall not be required unless specifically stated in the project documents or as required by the State.
3. A pre-paving meeting shall be held at least seven days prior to commencing paving operations.
4. Before starting the paving, the Contractor shall ensure that utility lines, piping, general grading and heavy trucking are complete so such operations will not damage paving work. No less than one day prior to paving, the City Engineer must receive all test results certifying that the subgrade and/or aggregate base is adequate for paving. After lower lift paving is installed, no cuts shall be made without the approval of the City Engineer. If utility installation is required after installation of curb, gutter, sidewalk, concrete path or pavement, alternative means of utility installation will be required such as boring, or jacking
5. If a pavement cut is permitted after installation of the top lift of pavement, the City Engineer may require heater scarifying of patch joints, thing of the street, or other techniques approved by the City Engineer to avoid any reduction in the useful life of the pavement.
6. Manhole frames, valve boxes and other fixtures shall be adjusted prior to paving. All fixtures shall be adjusted to 1/8 to 3/8 inches below final pavement grade. Refer to manhole adjustment details in Section 400.
7. Surface temperatures shall primarily be used to determine placement of APM. APM produced with documented WMA will be allowed a reduction in minimum surface temperatures for placement as provided in Table 2-16. If ambient temperatures and other weather conditions are unfavorable for paving, the City Engineer may impose additional requirements beyond minimum surface temperatures.

Table 2-16 Minimum Surface Temperature Limitations for Mix Placement

TABLE 2-15 - MINIMUM SURFACE TEMPERATURE LIMITATIONS FOR MIX PLACEMENT (°F)				
Compacted Layer Thickness (in.)	Top Layer of Pavement		Layers Below the Top Layer	
	APM	with WMA	APM	with WMA
< 1 ½	60	50	50	40
1 ½ to < 3	50	45	40	35
3 or more	45	40	35	35

8. Minimum APM discharge and delivery temperatures are provided in Table 2-17 below.

Table 2-17 Minimum Discharge and Delivery Temperatures for APM

TABLE 2-16 – MINIMUM DISCHARGE AND DELIVERY TEMPERATURES FOR APM

Asphalt Grade	Minimum Mix Discharge Temperature, $^{o}F^{1,3}$	Minimum Delivered Mix Temperature, $^{o}F^{2,3}$
PG 58-28	275	235
PG 64-22	290	235
PG 64-28	320	280

Note 1: The maximum mix discharge temperature shall not exceed the minimum discharge temperature by more than 30°F.

Note 2: Discharge mix temperature shall be measured at the mixing plant and the delivered mix temperature shall be measured behind the paver screed.

Note 3: If a WMA technology (additive or foaming) is used, temperatures may be lowered per manufacturer's recommendations during production at the discretion of the Contractor provided all specifications are achieved.

9. Apply a tack coat, prior to placement of APM in accordance with Item 20 of the MGPEC Specifications or CDOT Standard Specifications for Road and Bridge Construction, whichever is applicable. Tack coat the surface of the previously constructed asphalt layer when more than eight hours passes between the paving of lifts.
10. Unless otherwise approved by the City Engineer, hot mixed asphalt pavement shall be placed in passes 12 feet wide or as approved on the joint layout plan. The Contractor shall arrange paving operations so there will be no exposed longitudinal joints between adjacent travel lanes at the end of a day's production for all local roadways. Longitudinal joints for Minor Arterials/ Collectors and Arterial streets shall be constructed in accordance with all applicable CDOT Specifications.
11. Lift thicknesses when placing APM shall be in accordance with Table 2-18 below. Additionally, the Contractor must select proper compaction equipment, thickness and techniques to achieve required compaction in all cases.

Table 2-18 Minimum and Maximum Lift Thickness by Grading Mix

TABLE 2-17 – MINIMUM AND MAXIMUM LIFT THICKNESS BY GRADING MIX			
Mix Grading (nominal size)	Minimum Lift Thickness (approximately 3 x nominal size)	Recommended Lift Thickness (4 x nominal size)	Maximum Lift Thickness
SX (½")	1.5"	2.0"	2.5"
S (¾")	2.5"	3.0"	4.0"
SG (1")	3.0"	4.0"	5.0"

12. Compact all hot mixed asphalt pavement to between 92-96% of Maximum Theoretical (Rice) Density (CP 51: Maximum Specific Gravity of Bituminous Paving Mixtures)
13. After final rolling, vehicular traffic is not permitted until the asphalt pavement has cooled to one hundred and sixty (160) degrees Fahrenheit or other minimum temperature as agreed upon by the City Engineer and Contractor based on site specific conditions such as asphalt mix, roadway classification, traffic loading and weather conditions.
14. Joint and crack sealant shall conform to Section 408 of the State Specifications.

220.04 TEST REQUIREMENTS/TOLERANCES

1. Testing, sampling and tolerances for asphalt pavements shall conform to Item 20 of the most recent version of the Metropolitan Government Pavement Engineers Council (MGPEC) specifications, except as modified herein, for all non-State Highways. On all State Highways the most recent version of the Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction shall be utilized. On Capital Projects, CDOT, MGPEC or other applicable specifications may be used at the discretion of the City Engineer.
2. Testing for asphalt pavement mixtures shall be performed in accordance with Table 2-19 below. The test results shall be signed by a Professional Engineer employed by an independent testing company. The City may order additional testing at the Contractor's expense if the City Engineer feels it is necessary to determine that the pavement is acceptable or to determine the extent of unacceptable pavement. Repair or remove and replace unacceptable pavement as required by the City Engineer.

Table 2-19 Minimum Asphalt Paving Materials Sampling and Testing

TABLE 2-18 – MINIMUM ASPHALT PAVING MATERIALS SAMPLING AND TESTING		
Test	**Standard**	**Minimum Frequency**
Sampling	AASHTO T-168, ASTM D 979 and ASTM D3665 or CP-30, CP-41 and CP-55	1/1000 tons or fraction thereof (not less than one test per day)
In-place Density	AASHTO T-166, T-238, T-230 or CP-44, CP-81, CP-82	One test for each 150 lineal feet/lane (Minimum of six per project)
Thickness (Core)	ASTM D 3549	One test for each 1,000 lineal feet/Lane
Air Voids and VMA	AASHTO T-166 & AASHTO PP 19 or CP-48	1/1000 tons or fraction thereof (not less than one test per day)
Gradation	AASHTO T 27, T 11 or CP-31A, CP-31B	1/1000 tons or fraction thereof (not less than one test per day)
Hveem Stability	CP-L 5106, T 245	1/1000 tons or fraction thereof (not less than one test per day)
Asphalt Binder Content (AC)	AASHTO T-164 or CP-L 5120 or other methods agreed upon between Agency and Contractor	1/1000 tons or fraction thereof (not less than one test per day)
Maximum Theoretical Specific Gravity (Rice)	AASHTO T-209 or CP-51	1/1000 tons or fraction thereof (not less than one test per day)
Lottman Stripping, TSR & Dry Density	CP-L 5109 or AASHTO T-283	One per project per mix used.

3. The City Engineer may check pavement temperatures, segregation, rolling patterns and other construction means and methods, which affect the performance of the pavement system. The Contractor shall provide assistance in sampling and testing at all facilities and at the job site.
4. Nuclear density gauges used for quality control and quality assurance testing shall be correlated to a correction factor prior to official issuance of test results. Coring of asphalt pavements for field density tests or determination of correction factors shall be in accordance with Colorado Procedure

44, Method B (AASHTO T230). Density gauge correction factors will be determined and applied in accordance with the Appendix of Colorado Procedure 81 (ASTM D2950).

5. The in-place compacted thickness for hot mixed asphalt pavement shall not vary from the required design thickness by more than 1/4 inches less than the required design thickness and shall have no limitation on the greater thickness.
6. The surface tolerance for pavement shall not be greater than three sixteenths (3/16) inch, as measured with a ten (10) foot straight edge. If 10% or more of the final pavement surface fails to meet these tolerances, or requires repairs in the form of patching, the Contractor shall be required to overlay the entire surface prior to final acceptance.
7. Suspend pavement operations when density requirements are not met.

221.00 PAVEMENT RESTORATION – (PATCHING AND MATCHING EXISTING)

221.01 GENERAL

1. In areas where the City allows patching, the Contractor shall cut out the old pavement and clean, fill and compact the area with new pavement material. Applicable Sections for Asphalt Pavement, Concrete Construction and Aggregate Base Course shall be followed as they relate to materials and construction requirements. See Details in Section 100. Applicable details include Detail 100-02, 100-03 and 100-04 and as designated by the City Engineer.

221.02 CONSTRUCTION REQUIREMENTS

1. Proof rolling as described in these City Standards is required on subgrades and base courses prior to placement of pavement materials. If the area is too small for a proof roll, field density tests shall be provided.
2. Remove the area to be restored the full depth of pavement material to one foot outside the entire area of the failure, trench width or as marked in the field by the City Engineer. Limits of restoration may be expanded as needed to capture additional pavement failures encountered during the initial removal. Refer to Detail 100-02. Cut the sides of the patched area vertically, perpendicular and parallel to the direction of traffic flow. All subgrade material shall be compacted to 95% of standard proctor, ASTM D698 or AASHTO T99. All aggregate base course shall be compacted to 95% minimum density, Modified Proctor, ASTM D1557 or AASHTO T-180. Remove and dispose of the spoiled material and clean the area thoroughly.

221.03 PAVEMENT REPLACEMENT

1. For APM, apply a tack coat to the contact edges of previously constructed asphalt layers Portland Cement concrete surfaces and metal surfaces abutting or projecting into the asphalt pavement.
2. Patches for Portland Cement Concrete Pavement shall be constructed with CDOT Class "P" concrete and in accordance with Detail 100-03. Prior to beginning removal operations, the removal limits shall be double saw cut (full-depth). The Contractor shall make an initial full-depth saw cut at the

limits of removal and then complete a second saw cut approximately one foot inside the removal limits. The Contractor shall utilize properly sized equipment during the removal operations to prevent damage to the adjacent pavement that is designated to remain.

3. Concrete shall not be placed until all the forms and dowels have been inspected and approved. Dowels shall be installed at the spacing shown on Detail 100-03 or as directed by the City Engineer. Dowels shall not be installed less than twelve (12) inches from an existing joint. The Contractor shall drill holes perpendicular to the exposed surface of the existing concrete pavement and at a depth equal to one-half (½) the thickness of the slab. Prior to placement of the dowels in the drilled holes, the Contractor shall remove all dirt, dust or other foreign debris to ensure a good bond between the epoxy and existing concrete. The dowels shall be coated on one end with the epoxy and placed in the drilled holes. The exposed end of the dowel shall be lightly greased or have an approved expansion cap installed.
4. For trails, sidewalks or other non-vehicular pavements, tie-bars shall be installed at locations designated by the City Engineer to prevent vertical displacement. For concrete with a thickness of six (6) inches or less, #4 tie-bars (eighteen (18) inches in length) shall be used. Concrete more than six (6) inches thick shall use #5 tie-bars (eighteen (18) inches in length).

221.04 SURFACE TOLERANCES

1. All patches shall be constructed true to grade with the existing pavement section. Variation from grade shall not exceed one-quarter (1/4) inch in ten feet. If the variation exceeds one-quarter (1/4) inch in ten feet, the pavement and backfill shall be repaired or replaced to the satisfaction and at the option of the City Engineer.

221.05 TEMPORARY PATCHES

1. When weather limitations prevent the placement of pavement patches as defined herein, the Contractor shall obtain the approval of the City Engineer to install a temporary patch of cold mix asphalt or other suitable material. As soon as conditions allow, the Contractor shall remove the temporary patch and install a permanent patch in accordance with these specifications. The Contractor shall be responsible for maintaining temporary patches in a manner satisfactory to the City Engineer until they are replaced. In case of an emergency, the City Engineer may elect to repair the temporary patch and back charge the Contractor for the repair of the patch.

221.06 LIMITS OF PAVEMENT RECONSTRUCTION/ REPLACEMENT

1. The City Engineer may determine overlay requirements for any particular development project based on existing pavement conditions and extent of asphalt impact as a result of construction activities.
2. If more than three test holes / potholes are located within a fifteen (15) feet by fifteen (15) feet concrete or asphalt area, the entire area shall be replaced.
3. If more than fifty percent (50%) of the existing pavement area is disturbed or if the number of pavement cuts on any given project on a City roadway exceeds five cuts in 600 feet, the pavement shall be milled and resurfaced from flowline to flowline for the entire width of the roadway within the project limits or up to the City Engineer's discretion.

221.07 TIME LIMITS FOR PATCHING STREET CUTS

1. All patches shall be made within the time frame stipulated in the appropriate permit.

222.00 CONCRETE CONSTRUCTION

222.01 MATERIALS

1. All concrete shall be ready mixed and conform to the requirements of Section 601.02 and 601.03 of the current version of CDOT Standard Specifications for Road and Bridge Construction. The addition of admixtures or additives on-site will not be allowed, unless approved by the City Engineer. Field mixed concrete will not be allowed.
2. Sidewalks, curb ramps, curb and gutters, valley gutters, crosspans, concrete paths, driveway and alley approaches shall be constructed with CDOT Class B, D or P concrete unless otherwise approved by the City Engineer. Concrete used in Portland Cement Concrete Pavement shall conform to the requirements for CDOT Class P concrete.
3. The Contractor shall submit a concrete mix design for each class of concrete being placed on the project. The Concrete Mix Design Report shall be stamped by a Colorado licensed Professional Engineer and include the information listed in Colorado Procedure 62 (CP 62). The concrete mix design shall be submitted for review and approval by the City Engineer no less than seven (7) days prior to placing concrete. The proposed concrete mix shall be tested in accordance with ACI requirements.
4. Proportioning of the concrete shall conform to Section 601.05 of the current version of CDOT Standard Specifications for Road and Bridge Construction. If sulfate resistance is required, the Contractor shall include Class F fly ash in the concrete per Section 601-04 in the current version of CDOT Standard Specifications for Road and Bridge Construction.
5. Additives for concrete, other than those specified in the mix design, shall not be used without prior approval of the City Engineer. When approved for use, chemical admixtures or additives shall comply with applicable ASTM or AASHTO standards. Calcium chloride or admixtures containing chloride shall not be allowed in reinforced concrete.
6. For curb ramps, cross pans and concrete paths, the mix shall include one and one half (1½) pounds of fiber mesh reinforcing fibers per cubic yard of concrete. The use of fiber mesh in sidewalks and curb and gutter is allowed but not required.
7. The batching of concrete shall conform to Section 601.06 of CDOT's Standard Specifications for Road and Bridge Construction.

   The Contractor shall submit to the City Engineer the ready mix delivery tickets for each load upon request by the City indicating the following information:

a. Supplier's name and date
b. Truck number.
c. Project number and location.
d. Concrete class designation.
e. Cubic yards batched.
f. Time batched.
g. Mix design identification.
h. Type, brand, and amount of cement and fly ash.
i. Brand and amount of all admixtures.
j. Weights of fine and coarse aggregates.
k. Moisture content of fine and coarse aggregates.
l. Gallons of batch water.
m. Time at which water was added.
n. Elapsed time between when water was added and concrete load was in place.
o. Amounts of initial and supplemental water added.
p. Name of individual authorizing supplemental water.
q. Numerical sequence of delivery by indicating cumulative yardage delivered on each ticket.
r. Provide the following titles with blank space to record discharge time, water-cement ratio, air content, slump, and revolutions.

8. The mixing of concrete shall conform to Section 601.07 of the current version of CDOT Standard Specifications for Road and Bridge Construction. Equipment used for concrete mixing, conveyance and placement shall conform to Section 412.07 of the current version of CDOT Standard Specifications for Road and Bridge Construction.
9. Concrete shall be deposited within ninety (90) minutes after batching. If water is added on-site and prior to the 90 minute time limit, then the time to place the concrete may be extended to one-hundred and twenty (120) minutes. Concrete placement shall cease if the temperature of the concrete exceeds 90^{o}F.
10. Truncated domes used in the construction of curb ramps shall comply with the truncated dome detail included in these City Standards and the latest edition of the Americans With Disabilities Act Access Guidelines (ADAAG). Truncated dome sections shall be "wet set" in the concrete. Surface applied products will not be allowed. The type and color of truncated dome product shall be per the Approved Materials List.

222.02 CONSTRUCTION REQUIREMENTS

1. Before starting concrete placement, the Contractor shall ensure that utility lines, piping, general grading and heavy trucking are complete so such operations will not damage the Work.
2. Prior to concrete paving operations, the Contractor shall adjust manhole frames, valve boxes and other fixtures within the paving limits.
3. All concrete shall be placed on a compacted subgrade. The subgrade shall be damp but free from standing water. Subgrade requirements for the construction of sidewalks, curb ramps, curb and gutters, valley gutters, crosspans, concrete paths, driveway, alley approaches and concrete pavement shall meet the requirements of these City Standards.
4. Concrete shall be placed in a manner that prevents segregation of the materials. Concrete shall not be dropped more than five (5) feet, unless confined by closed chutes, pipes or approved concrete placement methods. When directed by the City Engineer, the concrete shall be vibrated with a mechanical vibrator operating within the concrete, to ensure proper consolidation.
5. Weather limitations for the construction of concrete items (e.g. sidewalks, curb ramps, curb and gutters, valley gutters, crosspans, concrete paths, driveways and concrete pavement) shall follow the requirements listed in Sections 412.15 and 601.12 of the current version of CDOT Standard Specifications for Road and Bridge Construction.
6. Where a section of a concrete sidewalk, curb ramp, curb and gutter, valley gutter, crosspan, concrete paths, driveway or alley approach has been damaged or disturbed, it shall be removed to the nearest joint if the removal limit is situated within five (5) feet of a proposed or existing joint. The City Engineer will identify the limits of removal. If the removal limits do not fall on an existing joint, the Contractor shall make a straight saw cut (full-depth) prior to the removal of concrete. Replacement sections of concrete shall not be less than five (5) feet.
7. Construction requirements for concrete sidewalks, curb ramps and concrete paths shall conform to Section 608.03 of the current version of CDOT Standard Specifications for Road and Bridge Construction except as modified by these City Standards. Construction requirements for concrete curb and gutter shall conform to Section 609.03 of the current version of CDOT Standard Specifications for Road and Bridge Construction except as modified by these City Standards. Face forms for concrete curb, if used, shall be removed for finishing curb face and fillets as soon as the concrete will retain its shape. Do not remove the back forms for concrete curbs until the concrete has been in place for at least six (6) hours.
8. Prior to concrete placement, the Contractor shall remove all construction debris and extraneous matter from within the forms. Stays, bracing and blocks, serving temporarily to hold the forms in correct shape and alignment, shall be removed as the concrete placement progresses.
9. All sidewalks, curb ramps, curb and gutter, valley gutters, crosspans, concrete paths, driveways, and alley approaches shall be formed and placed true to line, grade, and cross section. All flowlines shall not vary by more than one eighth (1/8) inch in ten (10) feet. Round the back edge of curbs, lip of gutters adjacent to pavement, and edges adjacent to joints with an edger.
10. Transverse joints shall be located at intervals of ten (10) feet in curbs, gutters, and crosspans. For curbwalks, tooled joints shall be at ten (10) feet. Joints for concrete paths shall be zip strip or sawcut at eight (8) foot intervals, no tooled joints shall be allowed on any concrete sidepath. Sawcutting of joints shall be performed as soon as the concrete surface is hard enough to allow the sawing operation without otherwise marring the concrete surface, prior to any development shrinkage cracks. Joints shall be continuous through gutter, curb and sidewalks. Joint depth shall be a

minimum of one third (1/3) the thickness of the concrete for saw cut joints. Set joints at right angles to face, top, and flow line of curb and gutter, valley gutter, or crosspan. Provide expansion joints at curb ramps and along sidewalks and concrete paths at a maximum spacing of two hundred (200) feet. Where templates are used, the tooled joint shall be placed at the same location of the template.

11. Where sidewalk, curb ramp, or concrete sidepath become adjacent to curb and gutter, the sidewalk, curb ramp, or concrete sidepath must be poured monolithic with the curb and gutter.

12. Curb ramps shall be constructed in accordance with Details 200-11, 200-12, 200-13, 200-14 Alt. A, 200-14 Alt. B, and 200-15. Truncated domes shall be installed across the full width of the ramp as depicted in the details.

13. Following the finishing of all concrete surfaces, such as curb ramps, curbs and gutters, sidewalks, concrete paths, valley gutters, driveways and alley approaches, the Contractor shall slightly roughen the concrete surface by brooming. Concrete sidepaths shall be given a light broom finish. For sidewalks, concrete sidepaths, and driveways, broom the surface in the direction perpendicular to the main traffic flow. For all concrete surfaces that are designed to carry storm water such as curbs and gutters, valley gutters, and crosspans, broom the surface in the direction of flow.

14. Immediately after finishing operations are complete, the concrete shall be cured by either applying moistened materials (e.g. burlap) for a minimum period of three (3) days or by applying a membrane forming curing compound. Curing compound shall be white pigmented (apply clear curing compound for colored concrete) and shall be applied uniformly to the entire concrete item. The back side of the curb and gutter shall receive an application of curing compound after the forms are removed. The Contractor shall take extra measures during hot weather (90^{o}F or greater) and windy conditions to prevent shrinkage cracking.

15. Construction requirements for concrete pavement shall be in accordance with Section 412 of the current version of CDOT's Standard Specifications for Road and Bridge Construction, except as modified herein.

16. The Contractor shall submit to the City Engineer for approval a construction joint pattern showing types of each joint and joint spacing prior to paving operations. The pattern shall be based upon the current version of Colorado Department of Transportation, M-Standard M-412-2, except that Expansion Joint Detail A shall be revised to a non-thickened section and shall include a smooth dowel sized one eighth (1/8) the concrete slab thickness at the mid-thickness of the slab, and fourteen (14) inches long placed at twelve (12) inch centers with an expansion cap on one side of the joint.

17. The surface tolerance for Portland cement concrete pavement shall not be greater than three sixteenths (3/16) inch, as measured with a ten (10) foot straight edge. For collector and arterial streets, the City reserves the right to require a profilograph test with the specifications established by the CDOT standard specifications for the design criteria of the street.

18. The opening of concrete pavement to vehicular traffic, including the Contractor's vehicles, will not be permitted until the compressive strength of the concrete test cylinders, tested in conformity with the latest ASTM Standard Method of Test for "Compressive Strength of Molded Concrete Cylinders," Designation C-39 is at least three thousand (3,000) pounds per square inch. If permanent shoulders or curbs are not in place, a six (6) foot wide temporary earth shoulder shall be placed against the outside pavement edges before traffic is allowed on the pavement. Prior to opening to vehicular traffic, all joints shall be properly sealed and the roadway shall be cleaned. The opening of concrete

pavement to vehicular traffic shall not constitute a final acceptance of the pavement. No steel blades shall be used to clean the concrete surface.

222.03 TESTING REQUIREMENTS

1. The Contractor shall provide the necessary testing of concrete for acceptance by the City Engineer including: temperature, unit weight, air content and slump testing, as well as the casting of concrete cylinders for compression testing. Sample concrete test cylinders shall be made in sets of five 4-inch X 8- inch cylinders. One cylinder shall be broken at seven (7) days and two, 4-inch X 8-inch cylinders shall be and broken at twenty eight (28) days. The remaining test cylinder is a hold cylinder for additional testing if there is failure to meet the specified strength on one of the twenty eight (28) day tests. If the twenty eight (28) day average strength does not meet the specified minimum compressive strength, then a representative number of concrete cores, as determined by the City Engineer, may be taken by the Contractor to determine if the in-place concrete meets the specified strength. If high-early strength concrete is required, additional test cylinders may be molded at the discretion of the City Engineer. High early strength concrete shall require additional testing at twenty four (24) hours.
2. Concrete cylinders for strength tests shall be molded and cured in accordance with the "Practice for Making and Curing Concrete Test Specimens in the Field", ASTM C31 and tested in accordance with "Test Method for Compressive Strength of Cylindrical Concrete Specimens", ASTM C 39.
3. The following is the minimum number of sets of concrete test cylinders that are required for concrete used in the Work for each day's placement. Sets that are taken shall generally represent equal volumes of concrete that are placed within each day's placement.

Quantity of Concrete	Number of Sets of Test Cylinders
50 cubic yards or less	One
50 cubic yards or more	One set plus one set for each additional 50 cubic yards or fraction thereof of concrete.

4. Conduct air and slump tests from each of the first three batches mixed each day and pull cylinders from one of the first three batches for each compressive strength test set, and whenever consistency of concrete appears to vary. If water is added after testing, contractor shall re-test the concrete. If air content does not meet project specifications, field adjustments shall be made in accordance to procedures in Section 601.08 CDOT Standard Specifications for Road and Bridge Construction.
5. Mark or tag each sample of compression test cylinders with the date and time of day the cylinders were made. Identify the location in the Work where the concrete represented by the cylinders was situated or stationed. Identify the delivery truck or batch number, air content, and slump. Submit to the City Engineer a copy of the test results.
6. Concrete shall meet the minimum acceptance standards of CDOT's Standard Specifications for Road and Bridge Construction. Concrete that does not meet the acceptance criteria shall be removed and replaced or assessed a pay reduction per CDOT Table 601-3 CDOT Standard Specifications for Road and Bridge Construction.
7. The City Engineer will make the final decision in whether non-conforming concrete is to be removed and replaced or if it is allowed to remain in place at a reduced price.

223.00 TRAFFIC CONTROL DEVICES

223.01 GENERAL

All traffic control devices, such as signs, pavement markings, traffic signals, and other devices that are used to regulate, warn or guide traffic as defined in the current Manual on Uniform Traffic Control Devices (MUTCD), must be installed in compliance with the current MUTCD, City of Longmont Standards, and CDOT standards where applicable.

223.02 SIGNS

1. These specifications for traffic sign installation are intended to provide a minimum standard that shall be followed when traffic sign installation work is done for the City of Longmont. These specifications shall apply to all materials supplied and methods and procedures of work to be followed. Work shall conform to these specifications and the Colorado Department of Transportation Standard Specifications for Road and Bridge Construction (current edition). In situations where there is a conflict or question of interpretation, these specifications shall prevail.
2. Legal Requirements - All traffic control devices including signs and sign materials shall be incompliance with the Manual on Uniform Traffic Control Devices (MUTCD), the Colorado Supplement thereto, US Department of Transportation Federal Highway Administration (FHWA) Standard Highway Signs (current editions), and the Approved Materials List.

3. Signing Plan - A complete signing plan shall be required with the Public Improvement Plans, but may also be required with the Site Plan or any other design documents as determined by the City Engineer. The signing plan shall specify the various types, combinations and locations of the signs and sign supports and any existing signs to be removed or replaced.
4. Conditions of Materials Furnished - All items furnished by the Contractor shall be new and in proper working order. For any items not included in the Approved Materials List, the Contractor shall submit a sample to the City Engineer for approval.
5. Removal of Existing Traffic Signs and Posts - No signs and/or posts shall be removed by any Contractor or person unless authorized by the City. All signs and/or posts removed from the right-of-way will remain property of the City. Anyone removing signs and/or posts is responsible for the condition of the sign and post and will be responsible for the cost of replacing any damaged or missing items.

223.03 STANDARDIZATION OF SIGNS

1. Signs in the City of Longmont are standardized following MUTCD standards.
2. Purpose and location - Each sign shall be displayed only for the specific purpose prescribed by the MUTCD. Each sign shall be displayed only in the proper location and at the proper height as prescribed by the MUTCD and the approved signing plan.
3. Symbols - Symbol designs shall in all cases be essentially like those shown in the MUTCD. All symbol signs, which are readily recognizable by the public may be erected without educational plaques. Whenever applicable, symbols shall be used in place of word messages.
4. Word messages - Where applicable, standard wording as shown in the MUTCD shall be used. Abbreviations shall follow guidelines in the MUTCD unless otherwise approved by the City Engineer.
5. Lettering - Sign lettering shall follow requirements in the MUTCD.
6. Reflectorization - All signs shall be retroreflectorized to show the same shape and color both day and night regardless of light conditions. Retroreflectivity shall be achieved by using sheeting that conforms to the requirements of ASTM D 4956 and the Approved Materials List and shall be applied in accordance with the manufacturer's specifications.

223.04 STREET NAME SIGNS

1. Unless the current MUTCD requires a larger size sign and/or letter size, the following standards shall apply. For street name signs at non-signalized intersections, the sign panel shall be extruded aluminum, nine (9) inches in height by twenty four (24) inches to forty eight (48) inches in length, with approved sheeting on both sides of the sign panel. The legend shall be 6 inches in height, the exception being on numbered streets where the number shall be six (6) inches in height with "ND", "RD", "ST" and "TH" being three (3) inches in height and is to be held in line with the top of the number it follows. The legend shall be a minimum of series C alphabet approved by FHWA, first letter shall be upper case and the remainder shall be lower case lettering. The legend shall be centered and placed on a single side of two separate panels. These panels shall be placed back to back, and spaced apart using two (2) ½" diameter X 1 ¾" long PVC spacers with a 3/8" Aluminum Shell/Steel Pin Rivet and washer at the left and right edges of the signs. The spaced sign blades shall then be mounted to the end of a 1 ¾" X 2' long section of sign post using two Cherry Mate Balm #34

rivets on each side of the sign. The complete assembly shall be slid into the end of a 2” sign post using two (2) Cherry Mate Balm #34 rivets per side.

223.05 SIGN POST AND SIGN PLACEMENT

1. Sign location, height and lateral clearance shall be in accordance with the MUTCD. Signs shall be placed no less than five (5) feet from any fire hydrant so that operation of the hydrant will not be obstructed. For electrical equipment clearances, provide ten (10) feet from access doors and no less than three (3) feet from the sides and back and three (3) feet from the underground electric lines. Where overhead utilities are found, maintain ten (10) feet separation from a wooden pole.
2. Signs should be mounted at right angles to the direction of and facing the traffic that they are intended to serve. Parking signs and parking restriction signs shall be turned to a 45-degree angle toward the road in the direction of travel.
3. Sign posts shall be two (2) inch, fourteen (14) gauge galvanized steel square tubing with a three (3) foot long, two and one quarter (2¼) inch square base as per the Approved Materials List. The signpost shall be installed into the ground using the manufacturer’s specifications so that it is designed to break away, bend over or to fracture upon impact by an errant vehicle. The support system shall meet the criteria specified in the American Association of State Highway and Transportation Officials (AASHTO) publication, Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. The design and installation of sign posts shall follow criteria specified in the American Association of State Highway and Transportation Officials (AASHTO) publication, Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.
4. Using sign posts that meet these specifications and using lateral clearance listed in the MUTCD, install base (2 1/4" x 2 1/4" x 3’") eighteen (18) inches into the ground, leaving approximately Three (3) inches above ground. If concrete, rock, gravel, etc. is going to be placed around the base, the Contractor shall place a) four (4) inch round PVC sleeve around the outside of the base to the depth of the material to be placed around it. Place post into base so that the sign meets vertical clearance and is stable. Posts shall be connected to the base using two (2) three eights (3/8) inch drive rivets in accordance with the manufacturer’s recommendations to insure proper breakaway.
5. Signs placed on sign posts shall be attached using three eight (3/8) inch drive aluminum rivets and nylon washers designed specifically for sign installation.
6. Signs shall not be placed on utility poles, street light poles or traffic signal poles without permission from the City When authorized, signs mounted on existing supports such as traffic signal poles, street light poles, or utility poles shall be mounted using bands and brackets specified in the Approved Materials List.
7. The Contractor is responsible for obtaining and verifying underground utility locates prior to installation. Signs mounted to an existing support such as signal poles or light poles require no utility locates.
8. When only a street name sign is on the post, the post shall be at a height of nine and a half (9-1/2) feet.
9. For Signs related to any concrete side path infrastructure, refer to Section 600 in theses City Standards.

References:

Title 15, City of Longmont Land Development Code, 2018

AASHTO A Policy on Geometric Design of Highways and Streets (PGDHS), 2011, 6th Edition

AASHTO Roadside Design Guide, 2011, 4th Edition

AASHTO Guide of the Development of Bicycle Facilities, 4th Edition, 2012

AASHTO LRFD Bridge Design Specifications, 8th Edition (2017)

AASHTO LRFD Guide Specifications for the Design of Pedestrian Bridges, 2nd Edition, 2015 Interims

State Highway Access Code, March 2002

American Association of State Highway and Transportation Officials (AASHTO) publication, LRFD Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals.

Roadway Design Guide, CDOT, 2018

Manual of Uniform Transportation Control Devices for Streets and Highways (MUTCD), US Department of Transportation, 2009

Standard Specifications for Road and Bridge Construction, CDOT, 2017

2018 International Fire Code

Metropolitan Government Pavement Engineers Council (MGPEC), Title 20, 2017