



1 **DETAIL 1 - BUS STOP LAYOUT FAR SIDE APPLICATION**
 SCALE: 1" = 10'
DETACHED WALKWAY

5.8.7 Transit Queue Jump Lanes at Signalized Intersections

Signalized roadway intersections along a transit route may offer the opportunity to provide transit queue jump lanes for buses operating in the corridor. Queue jump lanes expedite transit service by allowing buses to move to the front of the line when a traffic signal is red. Buses using the queue jump lanes pass through the intersection when the signal turns green and often access a “far side” transit stop.

Transit queue jump lanes are often the continuation of a “right lane must turn right” lane for automobiles. The lane becomes a “bus only” lane straight through the intersection beyond the point where right turning automobiles have turned. In this context, the lane approaching the intersection is a “buses and right turns only” lane.

At larger intersections with multi-lane approaches and right turn bypass islands that channelize right turning vehicles, a bus queue jump lane shall be located along the left edge of the island, immediately to the right of the outside automobile through lane. The bus lane located against the island shall be at least 11 feet wide.

A bus queue jump lane next to a right turn island shall be designated as a “BUS AND BIKE ONLY” lane where the roadway has a bicycle lane or bikeable shoulder on the intersection approach. See Standards Drawing 6 and the MUTCD for additional signing and marking guidance.

5.9 Storm Drainage Design Standards

This section presents general recommended guidelines for the design of road drainage systems. For specific design parameters as well as procedures for determining drainage performance for urban and rural roads, refer to the latest version of the Boulder County Storm Drainage Criteria Manual (BCSDCM).

5.9.1 Design Criteria for Storm Drainage in Roadways

Minimum standards for inundation and conveyance of storm drainage in roadways are defined based on street classification and provided in the BCSDCM.

5.9.2 Culverts

5.9.2.1 Materials

Roadway cross culverts shall be constructed with reinforced concrete, unless otherwise approved by the County Engineer and Road Supervisor. Private driveways may be constructed with corrugated steel. The minimum pipe size shall be an 18-inch diameter round pipe or shall have an equivalent 18-inch round cross sectional area for other shapes.

5.9.2.2 Inlets and Outlets

An important consideration in the design of a culvert is the inlet configuration, since the inlet often limits the hydraulic capacity of the culvert. The inlet type can also increase the overall structural integrity by retaining the fill slope, and by preventing inlet scour with subsequent undermining of the culvert.

All culverts in the public right-of-way shall be designed using headwalls, wingwalls, or flared-end sections at the inlet and outlet. Additional protection using riprap may also be required at the inlet and outlet due to the potential scouring velocities.

5.9.2.3 Hydraulics

When evaluating the capacity of a culvert, refer to the BCSDCM.

5.9.2.4 Velocity

Minimum culvert velocity shall be 3 feet per second (fps) to ensure a self-cleaning condition. The maximum culvert velocity is dictated by the channel conditions at the outlet. If the outlet velocities are less than 7 fps for grassed channels, then only a minimal amount of protection is required, due to the eddy currents generated by the flow transition. Higher outlet velocities will require substantially more protection. The maximum outlet velocity shall be 12 fps along with the proper erosion protection.

5.9.2.5 Structure

All culverts, as a minimum, shall be designed in accordance with the procedures of AASHTO Bridge Standards or ASTM Pipe Standards and with the pipe manufacturer's recommendations.

5.9.3 Roadside Ditches

In rural areas or areas where no curb and gutter is required, roadside ditches should be designed with adequate capacity to convey the 5-year storm runoff peak. Where storm runoff exceeds the capacity of the ditch, a storm sewer system may be required. For capacity definitions and maximum allowable velocity, refer to the BCSDCM.

Roadside drainage ditches shall be grass lined. Revegetation and/or soil preparation for grass-lined ditches shall be in accordance with the Urban Drainage Storm Drainage Criteria Manual (UDSDCM), or as directed by the County.

5.9.4 Conveyance Systems

Refer to the latest version of the BCSDCM for storm water conveyance system design criteria that is not listed here.

5.9.4.1 Materials

Pipe material shall be reinforced concrete or corrugated steel pipe with a minimum of 18-inch diameter.

5.9.5 Hydraulic Criteria

Refer to the latest version of the BCSDCM for hydraulic design criteria.

5.9.6 Stormwater Permitting

Storm water is regulated by the State of Colorado and permits may be required based on the size of the disturbed area.

- Colorado Department of Public Health and Environment (CDPHE) requirements- A permit is required for work that disturbs greater than 1.0 of an acre, the Stormwater Discharge Permit must be obtained from the CDPHE for other construction site runoff control requirements. Refer to Article 7-903 of the Boulder County Land Use Code.
- U.S. Army Corps of Engineers (USACoE) 404 Permit – This permit shall be required for all projects within ordinary high water (in the absence of wetlands) in waters of the United States. Ordinary high water is defined as the level to which water rises in a typical spring runoff. Waters of the United States includes essentially all surface waters and their tributaries, all wetlands adjacent to these waters, and all impoundments of these waters. The need for a 404 permit will be determined by contacting the USACoE Denver Regulatory Office to request a pre-application consultation and/or official determination.

5.10 Bridges, Underpasses, Low Water Crossings and Retaining Walls

5.10.1 Vehicular Bridges

The intent of bridge design is to provide a safe waterway, vehicular or railroad crossing that provides adequate load carrying capacity, hydraulic capacity, and clearances for motorized vehicles, pedestrians and bicycles. Vehicular bridges are often community landmarks that are noticed by hundreds and perhaps thousands of residents daily. Because of this, it is important that their design reflects the character of Boulder County.

5.10.1.1 Standards

- Table 5.10.1.1 defines the standards for vehicular bridges.
- Vehicular bridge design shall be performed in accordance with the latest AASHTO Bridge Standards on public right-of-way and private roads (or IBC requirements on private driveways) as identified on Table 5.10.1.1.
- Vehicular bridge lane widths, shoulder widths and sidewalk widths shall match the approach roadway widths, but in no case shall they be less than identified in Section 5.3.1.
- Pedestrian sidewalks and/or bikeable shoulders shall be provided on all vehicular bridges in the public right-of-way.
- Vehicular bridges may need to be designed aesthetically, as determined through the Land Use Code process or by the County Engineer, to meet the character of the location. Architectural renderings of bridges shall be submitted to the County Engineer for approval when aesthetics are required.
- Vehicular bridges shall be constructed of concrete and/or structural steel. Timber bridges will only be allowed for residential and local roads with County Engineer approval.
- Bridge longitudinal slope shall be between 0.5 percent minimum to 4 percent maximum.
- Bridge foundation scour depth shall be designed according to the requirements as indicated in Table 5.10.1.1 below

Roadway Classification	Design Standard	Design Vehicle (1)	Bridge Rail Test Level (TL)	Min. Freeboard (2)	Scour Depth (3)
Residential	IBC or AASHTO (1)	50 psf (IBC), HS 15-44 min. or HL-93	TL-2	1'	4' min.
Local, Local Secondary	AASHTO	HL-93	TL-2	Per AASHTO	100-year or 6'
Collector	AASHTO	HL-93	TL-2	Per AASHTO	500-year (3)
Arterial	AASHTO	HL-93	TL-3	Per AASHTO	500-year (3)

Table notes:

- 1) Design vehicle per local fire department loading requirements. Truck loading shall be used where grades permit permanent truck access or where the bridge is required for construction.
- 2) Freeboard at ditch crossings shall be coordinated with the ditch company.
- 3) Scour depths for indicated flood events to be determined through scour analysis using HEC-RAS.

5.10.1.2 Submittal Requirements

- Submittals shall be according to Section 2.8.3
- A geotechnical investigation and recommendations shall be submitted with each bridge design. A minimum of two borings, one at each abutment, shall be provided at each bridge location.
- A floodplain analysis according to the requirements of the Boulder County Storm Drainage Manual shall be performed for all vehicular bridges over waterways.
- Bridge design shall be signed and sealed by a registered Colorado Professional Engineer qualified in structural bridge design. Calculations with an independent design check and load rating shall be submitted on all bridges located on the public right-of-way.
- A Boulder County Building Permit is also required.

5.10.2 Pedestrian Bridges

The intent for pedestrian bridges in Boulder County is to provide a safe waterway, vehicular, or railroad crossing that provides adequate load carrying capacity, hydraulic capacity and clearances for pedestrians, bicycles, equestrians and maintenance vehicles. Pedestrian bridges, like vehicular bridges, are landmarks and should be designed with appropriate aesthetics for their particular location.

5.10.2.1 Standards

- Table 5.10.2.1 defines the standards for pedestrian bridges.
- Pedestrian bridges located on public lands shall be designed according to AASHTO requirements. Pedestrian bridges on private lands may be designed according to AASHTO or IBC requirements.
- Architectural renderings of bridges shall be submitted to the County Engineer for approval when aesthetics are required.
- Pedestrian bridges should be constructed of steel, concrete, or timber.
- Pedestrian bridges shall have longitudinal slope of 5 percent maximum.
- Pedestrian bridge foundation scour depth shall be designed according to the requirements as indicated in Table 5.10.2.1.
- Pedestrian bridges shall have 1 foot minimum freeboard over the 100-year flood elevation, or they shall be designed with break-away abutments that allow the bridge superstructure to swing to the side so as to not impede flows.

- The low chord of pedestrian bridges shall be a minimum of 16 feet above collector, arterial roads, and local roads; 14 feet over private and local roads; and 25 feet over railroads. Bridges less than 16 feet over roads shall be posted with the actual clear height.

Classification	Design Standard	Vehicle/ Live Load	Min. Width	Deck Surface	Rail Height	Rub Rail Required	Footing Scour Depth
Public Land	AASHTO	per AASHTO	Trail Approach width, but not less than 8'	Concrete or Timber (Concrete where plowing occurs)	42"	Yes	4' min.
Private Property	IBC or AASHTO	60 psf (Per IBC)	Trail Approach Width, but not less than 4'	Concrete or Timber	42"	No	Equal to frost depth

5.10.2.2 Submittal Requirements

- Submittals shall be according to Section 2.8.3
- A geotechnical investigation and recommendations shall be submitted with each bridge design. A minimum of two borings, one at each abutment, shall be provided at each bridge location.
- A floodplain analysis according to the requirements of the BCSDM shall be performed for all new pedestrian bridges over waterways where impacts are expected.
- Bridge design shall be signed and sealed by a Colorado Professional Engineer qualified in structural bridge design. Calculations shall be submitted for all pedestrian bridges on public lands.
- A Boulder County Building Permit is also required.

5.10.3 Shared-Use Path Underpasses

The intent for shared-use path underpass design is to provide, via an underground structure, a safe waterway, vehicular or railroad crossing that provides adequate load carrying capacity, hydraulic capacity, and clearances for pedestrians, bicycles, equestrians and maintenance vehicles. Underpasses may be stand-alone structures or they may be constructed under a bridge that has a span considerably greater than the required underpass width.

5.10.3.1 Standards

- Underpass design shall be performed in accordance with the latest AASHTO Bridge Standards as identified on Table 5.10.1.1 or standard Concrete Box Culvert sections from the M & S Standards. M & S Standards may be used for the underpass structure.
- Underpass width shall be the same width as the approaching path plus a minimum of 2-foot shoulders on each side; but in no case shall underpasses be less than 14 feet wide.
- Underpass vertical clearance shall be 8.5 feet minimum for normal use, and 10 feet for equestrian use. Vertical clearances as low as 7.5 feet may be used, with the approval of the County Engineer, in locations where utility and/or water table impacts will be significantly reduced.
- Underpasses may need to be designed aesthetically, as determined through the Land Use Code

process or the County Engineer, to meet the character of the location. Aesthetic treatment may consist of architecturally detailed vehicular railings on the roadway and/or veneer or form liner applied to wingwalls. Architectural renderings of bridges shall be submitted to the County Engineer for approval when aesthetics are required.

- Underpasses shall be constructed of cast-in-place or precast concrete. Cast-in-place concrete is preferred; however, precast may be used in locations where the water table is sufficiently below the underpass structure and where the speed of installation of precast members will provide substantial benefit to reduced construction time on roads with high traffic volumes. Three or four sided underpass structures are acceptable.
- Underpass longitudinal path slope shall be between 0.5 percent minimum to 4 percent maximum, with 2 percent being optimum.
- Concrete surfacing shall be used for the underpass and underpass approach to facilitate adequate drainage. Cross slope shall be 2 percent. The underpass path may be crowned or may be sloped to one side. A minimum 2-foot wide drainage pan shall be provided on the path side(s) to convey surface drainage to a storm inlet and manhole with a gravity outfall. A pumped drainage system may be used where site grading does not allow a gravity drain and electricity is accessible.
- All underpasses shall be provided with a subgrade drainage system, regardless of observed water table depth. The drainage system should consist of perforated drainpipe located behind the underpass structural walls and underneath the underpass slab. Drainage shall be carried to the same manhole used for collecting surface drainage.
- The exterior surface of underpass walls shall be coated with bituminous damp proofing and the top surface of underpass roofs shall be provided with waterproofing membranes.
- Exposed underpass wall, roof, and wingwall surfaces shall be provided with either a sacrificial graffiti resistant coating or textured form liner to resist graffiti.
- Underpass approach grades shall be according to ADA requirements, wherever possible. Underpass approach grades shall be as straight as possible entering and exiting the structure. In no instance shall the tangent at each end of the underpass be less than 10 feet long.
- Grading at underpass entrances shall be as physically and visually open as possible, using gentle slopes and/or tiered retaining walls to provide as open and inviting an entrance as possible.
- Lighting shall be considered for use in long underpasses or where public safety requires.

5.10.3.2 Submittal Requirements

- Submittals shall be according to Section 2.8.3
- A geotechnical investigation and recommendations shall be submitted with each underpass design. A minimum of two borings, one at each abutment, shall be provided at each underpass location. Water table elevations shall be indicated on all boring logs. Seasonal conditions at the time of recording water table depth shall be considered in determining water table impacts.
- A floodplain analysis according to the requirements of the BCSDM shall be performed for all underpasses that serve a dual purpose of transportation and floodplain mitigation. This includes stand alone precast or cast-in-place structures, or underpasses that travel below a bridge structure.
- Underpass structural design shall be signed and sealed by a Colorado Professional Engineer. Calculations with an independent design check and load rating shall be submitted on all underpasses located in the public right-of-way.

5.10.4 Low Water Crossings

The intent for low water crossing design is to provide via a series of culverts, safe waterway crossings that provide adequate load carrying capacity, hydraulic capacity and clearances for motorized vehicles, pedestrians and bicycles.

5.10.4.1 Standards

- Refer to the BCSDCM for Low Water Crossing details and design standards.
- Low water crossing design loads shall be the same as for vehicular bridges.
- Road approach grade shall be between 0.5 percent minimum and 12.0 percent maximum.
- Side slopes shall not be steeper than 3:1 and shall be protected by a six-inch concrete facing or by 18-inch riprap.
- The culverts used shall be corrugated steel pipe or reinforced concrete pipe with a minimum diameter of 18 inches.
- Minimum cover over culverts shall be 12 inches or as recommended by manufacturer for round pipe down to 6 inches for concrete pipe; 18 inches or as recommended by manufacturer for arch pipe; or 12 inches if HS 10-44 loading is applied.

5.10.4.2 Submittal Requirements

- Submittals shall be according to Section 2.8.3
- A floodplain analysis according to the requirements of the BCSDCM shall be performed for all low water crossings.

5.10.5 Retaining Walls

The intent for retaining walls is to safely retain soil to minimize site impacts.

5.10.5.1 Standards

- Retaining walls shall be designed according to AASHTO or IBC requirements.
- Retaining walls may need to be designed aesthetically, as determined by the County Land Use Code process or the County Engineer, to meet the character of the location. Architectural renderings of walls shall be submitted to the County Engineer for approval when aesthetics are required.
- Footing depth shall be 24 inches minimum for retaining walls susceptible to frost heave in mountainous areas; 30 inches minimum for walls susceptible to heave on the plains.
- Provide adequate surface and subsurface drainage, with erosion protection, behind the wall to carry drainage without damaging the retaining wall.
- Retaining wall height shall be limited to 6 feet (exposed height) tiers, although taller walls may be utilized if visual impacts are mitigated.
- Distance between wall tiers shall be determined by calculation, but shall not be less than the lower tier height.
- The entire retaining wall structure shall be contained within property or right-of-way, otherwise right-of-way shall be obtained for portion of the retaining wall that is beyond the existing property line.

5.10.5.2 Submittal Requirements

- Submittals shall be according to Section 2.8.3
- A geotechnical investigation and recommendations shall be submitted with each retaining wall design.
- Retaining wall design shall be signed and sealed by a Colorado Professional Engineer for retained heights greater than 4 feet. Calculations shall be submitted for all retaining wall heights over 6 feet in height.
- A Boulder County Building Permit is also required.