CHAPTER 6. DESIGN GUIDELINES

This chapter contains Design Guidelines for the application of bicycle, pedestrian and trail facilities. These are not engineering specifications and are not intended to replace existing applicable mandatory or advisory standards, nor the exercise of engineering judgment by licensed professionals. The document provides information and concepts relevant to the design of bicycle, pedestrian and trail facilities in the Town of Mammoth Lakes. Where applicable the existing relevant standards and specifications have been referenced. In certain cases some material and recommendations contained herein fall outside current standards but are of sound principle and have been employed successfully in many communities throughout the United States and abroad. Other treatments are purely conceptual and were developed to address specific local issues. These conceptual treatments should be implemented on an experimental basis. Any facilities to be built that fall outside the applicable state and local standards will require the approval of the Director of Public Works.

This chapter is organized in the following sections:

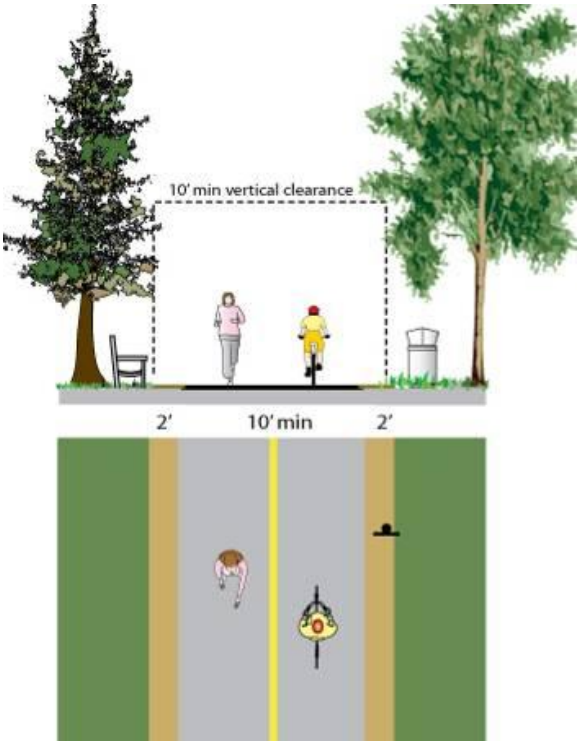
- Multi-Use Paths
- On-Street Bicycle Facilities
- Bicycle Parking
- Pedestrian Facilities
- Soft-Surface Trails
- Easements

Each section discusses the standard facility design as well as variations on that design that may be applicable to the Town of Mammoth Lakes. Ancillary features and supporting design elements such as crossings, signage and signalization treatments are also provided.

Note: The design guidance provided in this chapter is considered subject to change. It will be incorporated into the appropriate section of the Mammoth Lakes Trail System Standards Manual, and/or the Town of Mammoth Lakes Public Works Standards Manual, as appropriate, and available for use by the USFS if determined appropriate by that agency. The Standards Manual will be a living document intended to provide uniform guidance for the development of the Mammoth Lakes Trail System.

6.1. Multi-Use Paths (MUP)

Also known as Class I Bike Paths, multi-use paths facilitate two-way off-street bicycle and pedestrian traffic, which also may be used by skaters, wheelchair users, joggers and other non-motorized users. Given the unique and varied recreation opportunities in Mammoth Lakes, multi-use paths in Mammoth Lakes anticipate the potential to serve as winter recreation facilities, with the potential for a full complement of winter maintenance and use options. Multi-use paths are frequently found in parks, along rivers, and in greenbelts where there are few conflicts with motorized vehicles. In Mammoth Lakes, multi-use paths can potentially offer access to unique wilderness destinations. The guidelines for Town of Mammoth Lakes multi-use path facilities reflect the full complement of recreation opportunities unique to Mammoth Lakes.

Existing Design	**Figure 6-1. Multi-Use Path Design**
	**Existing Guidance:** - AASHTO Guide for the Development of Bicycle Facilities - Caltrans Highway Design Manual (Chapter 1000) - TOML Public Works Standards **Local Issues:** Minimum design width under existing standards is eight feet. This may not be sufficient if user volumes are high or in steep sections where higher speeds necessitate greater separation. MUP design width also needs to consider potential winter use.
Recommended Design	
	**Width:** 10 feet is required by the Town of Mammoth Lakes as the minimum width of new multi-use paths. This requirement exceeds existing standards and will be adequate for moderate to heavy use. This provides an unobstructed right-of-way wide enough to accommodate typical trail grooming equipment. However, shoulders wider than two feet should be considered in areas that will receive regular winter grooming. 12 feet is recommended for heavy use areas with high concentrations of multiple users such as joggers, bicyclists, rollerbladers and dog walkers. May also be appropriate for safety reasons in areas with limited sight lines or where speeds may be high (steep grades). The 10' minimum clearance should be exceeded as necessary to account for winter snow pack. **Striping:** Striping on multi-use paths is optional, and may be desired in steep or high-use locations where proper lane positioning could reduce conflicts. Striping is also useful in areas where MUPs intersect a roadway (see "Typical At-Grade Crossing"). Standards for MUP striping can be found in Caltrans Chapter 1003.1.
Applicable Locations: Existing and future MUPs.	

Other Design Considerations for Multi-Use Paths:

Multi-use paths can provide a good facility, particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. As previously identified, the opportunities for multi-use paths in Mammoth Lakes span a vast array of recreation and seasonal opportunities consistent with a recreational based resort economy. Multi-use path design guidelines for Mammoth Lakes should anticipate the unique needs and environmental and seasonal conditions for which the multi-use paths may be reasonably expected to be employed. Multi-use paths should generally provide directional travel opportunities not provided by existing roadways, and can potentially provide safe alternatives for winter pedestrian travel. Some of the elements that enhance multi-use path design include:

- Implementing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use.
- Placing directional signs to direct users to and from the path.
- Building to a standard high enough to allow heavy maintenance equipment to operate on the path without causing it to deteriorate.
- Limiting the number of at-grade crossings with streets or driveways.
- Terminating the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the end of a local street. Paths should not terminate at major roadways without pedestrian and bicycle facilities.
- Taking special care to provide clear and direct transitions between the MUP and bike lanes or sidewalks.
- Identifying and addressing potential safety/security problems up front.

Both the California Highway Design Manual and the AASHTO Guide for the Development of Bicycle Facilities generally recommend against the development of multi-use paths directly adjacent to roadways. The realities of snow removal and snow storage in Mammoth Lakes only compound the inherent and problematic nature of these alignments. Also known as "sidepaths" these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in bicyclists going against traffic when either entering or exiting the path. This can also result in an unsafe situation where motorists entering or crossing the roadway at intersections and driveways do not notice bicyclists or other trail users coming from their right, as they are not expecting traffic coming from that direction. Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may frequently block path crossings. Even bicyclists or other fast moving trail users coming from the left may also go unnoticed, especially when sight distances are poor.

Multi-use paths may be considered along roadways under the following conditions:

- The path will generally be separated from all motor vehicle traffic.
- Bicycle and pedestrian use is anticipated to be high.
- In order to provide continuity for an existing path through a roadway corridor.
- The path can be terminated at each end onto streets with good bicycle and pedestrian facilities, or onto another safe, well-designed path.

- There is adequate access to local cross-streets and other facilities along the route.
- The total cost of providing the proposed path is proportionate to the need.
- Any needed grade separation structures do not add substantial out-of-direction travel.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, many stop riding on paths placed adjacent to roadways. Bicyclists may also tend to prefer the roadway as pedestrian traffic on the multi-use path increases due to its location next to an urban roadway. When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bicycle lane width on the roadway, as the on-street bicycle facility will generally be superior to the "sidepath" for experienced cyclists and those who are cycling for transportation purposes. Providing a comfortable option for cyclists on the roadway, can improve safety on the path by luring faster cyclists off the MUP where conflict with other users could arise. In fact, bicycle lanes should be provided as an alternate (more transportation-oriented) facility whenever possible. Bike lanes on the adjacent roadway will serve as an important alternative for (1) faster bicyclists, (2) bicyclists who need to access destinations on the other side of the roadway, (3) when pedestrian traffic levels on the MUP are high, and (4) when the MUP is snow-covered and inaccessible or groomed for winter recreation.

Surfacing:

Asphalt and concrete are the most common surface treatment for multi-use paths, however the material composition and construction methods used can have a significant determination on the longevity of the pathway. Thicker asphalt sections and a well-prepared sub-grade will reduce deformation over time and reduce long-term maintenance costs.

Off-street paths should be designed with sufficient surfacing structural depth for the sub-grade soil type to support maintenance and emergency vehicles. If the path must be constructed over a very poor sub-grade (wet and/or poor material), treatment of the sub-grade with lime, cement or geotextile fabric should be considered.

Alternative surface materials such as decomposed granite may be appropriate in some circumstances. The Town would need to consider durability and snow removal needs (grooming vs. clearing) when selecting an alternative surface material such as decomposed granite. Surface selection should take place during the design process.

Snow Removal/Grooming:

Many of the multi-use paths in the Town of Mammoth Lakes serve non-motorized uses year-round. In the winter months these paths can be cleared of snow for pedestrian and bicycle use, or groomed to serve as cross-country ski routes. During these months it is important that snow removal and grooming equipment have ease of access to these paths. Any gates, bollards, or other access control measures that restrict access to the paths should be removable for winter maintenance equipment. Path access points and at-grade crossings should be kept clear of snow accumulations and berming from adjacent on-street snow removal operations. In times of heavy snow accumulations, snowblower vehicles should be employed to move the snow as far from the multi-use path as possible. Where large snowpack elevation differentials exist, effort should be made to provide a smooth transition.

Pavement Markings:

Directional pavement markings on multi-use paths are optional, and may be desired for higher-use locations where providing directional markings could reduce conflicts. Pavement markings can also be used to mark mileage and customized stencils can be created to "brand" each path with a unique identity.

Multi-Use Path Amenities

Trail amenities for multi-use paths can enhance the experience for the user and increase the functionality of the trail. Amenities include signage, benches, lighting, shaded areas, and dog-bag dispensers. There are some existing guidelines and standards found in the existing Town of Mammoth Lakes Design Guidelines. These are referenced below with recommended additions.

User Conflicts along Multi-Use Paths

Typical user groups for multi-use paths include cyclists, rollerbladers, skateboarders, and several pedestrian-oriented groups consisting of walkers, joggers, dog walkers, and families with strollers. Each of these user groups have varying travel speeds, special requirements, and levels of trail awareness as they use the multi-use paths. On multi-use pathways with heavier use, conflicts between user groups can occur. It is recommended that multi-use pathways in the Town of Mammoth Lakes have custom signage installed to guide trail users on proper trail etiquette (see **Figure 6-2** below), especially in areas where conflicts are likely to occur. The sign below on the left provides an for use example on multi-use path segments where bicyclists, walkers and roller bladders would be the predominant user groups. The sign on the right provides yielding procedures for multi-use paths where equestrian may be present. Both are primarily applicable only to MUPs in their summer condition, or MUPs that are cleared and see significant use in the winter. Custom signage may need to be developed to address yielding procedures for winter conditions.

Figure 6-2. User Etiquette Signs along Multi-Use Paths

6.1.1. Paved Median Paths

Example #1 (non-local)	Figure 6-3. Median Bike Paths
	**Existing Guidance:** Current bike path design guidelines and standards apply. Local Issues: Main Street is consistently seen as the area of greatest concern for bicycle and pedestrian safety. It is also the most important gap in the Main Path loop. Providing bike lanes on Main Street will be an important improvement. Providing wide sidewalks or 'promenades' will be good for pedestrians, but may present conflicts at driveways and between faster moving bicyclists and pedestrians. A median path will require significant planning and investment, but will provide multiple benefits for bicycle safety, pedestrian safety and snow removal.
Example #2 (non-local)	
	**Design Discussion:** Median bike paths should only be used in situations where they can provide a superior level of experience and reduce conflicts and safety concerns associated with other options. Median paths generally have an advantage over bike lanes and sidewalk paths because there are less conflict points associated with driveways and with buses pulling in and out of bus stops. These conflicts can be easily managed by experienced riders using bike lanes, but are more difficult for less experienced riders. Wherever possible, median paths should be used in conjunction with bike lanes because bike lanes will provide connections to adjacent land uses where median paths cannot.
Applicable Locations: Main Street is a potential location.	

6.1.2. Typical At-Grade MUP Crossings

When a grade-separated crossing cannot be provided, the typical at-grade crossing occurs at a location with light traffic. A trail-sized stop sign (R1-1) should be placed about 5 feet before the intersection. Direction flow should be treated either with physical separation or a centerline approaching the intersection for the last 100 feet.

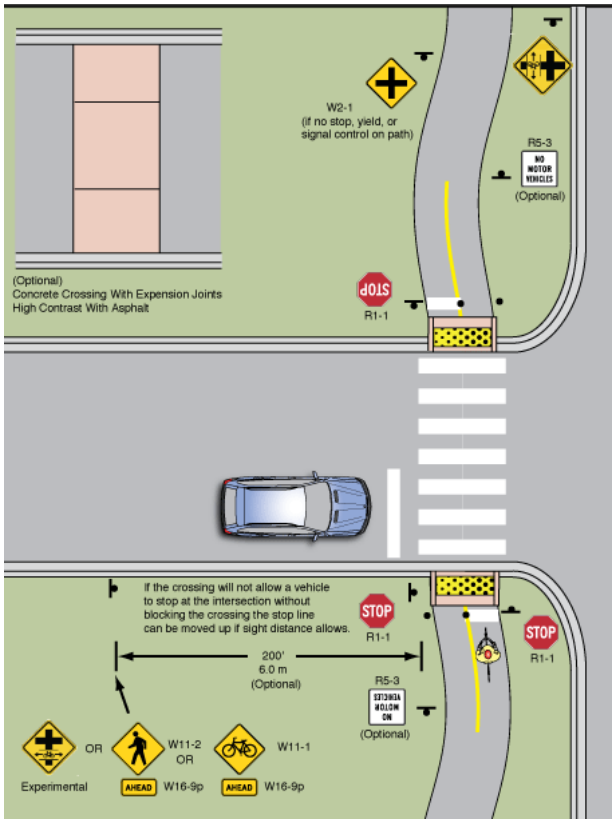
Existing Design

Figure 6-4. Typical At-Grade MUP Crossing

Existing Guidance:
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Highway Design Manual (Chapter 1000)

Local Issues:
While most at-grade crossings traverse minor streets or driveways, they generally occur on multi-use paths that are located directly adjacent to major roadways. The traffic turning from the major roadway onto the minor street is not required to stop and may not see or anticipate a bicyclist entering the crossing.

Recommended Design



The recommended "typical" at-grade crossing includes all of the current treatments shown in the above photo (ADA-compliant ramps, removable bollards, trail-sized stop signs, etc.)

Recommended additional treatments should include—at a minimum—advance warning signs for motorists and centerline striping on the MUP as it approaches the intersection.

Other optional features include:

Speed reducing features for vehicles:
- Transverse rumble strips approaching the trail crossing
- Sinusoidal speed humps (compatible with slow speed snow removal operations)
- Advance warning signs for motorists
- Colored, textured, and/or high visibility crosswalks (can be raised as part of a speed hump if crossing is mid-block)

Speed reducing features for bicyclists:
- Chicane, or swerve in multi-use path approaching the crossing

Applicable Locations: Existing and new at-grade crossings parallel to Old Mammoth Road and Meridian Boulevard.

Other Design Considerations for Typical At-Grade Crossings:

Guidance for at-grade crossings can be found in Section 1003 of the Caltrans HDM and the AASHTO Guide for the Development of Bicycle Facilities. These documents relay standard treatments which many jurisdictions typically exceed with a combination of many of the features outlined above.

If the street is above four or more lanes or two/three lanes without adequate gaps, a median refuge should be provided in the middle of the street crossed (see Toucan Crossing). The refuge should be 8 feet wide at a minimum, 10 feet is desired. If a signal is provided, signal loop detectors may be placed in the pavement to detect bicycles if they can provide advance detection, and a pedestrian-actuated button provided (placed such that cyclists can press it without dismounting.)

While some optional treatments may be necessary only in some areas, it is important for the basic overall design of each crossing to be consistent so that motorists and trail users are able to easily recognize and assess at-grade crossing situations.

6.1.3. Signalized At-Grade Crossings of Major Streets (Toucan or Hawk Crossing)

A Toucan crossing (derived from: "two can cross") is used in higher traffic areas where pedestrians and bicyclists are crossing together. A Hawk (**H**igh-Intensity **A**ctivated Cross**w**al**k**) signal is a combination of a beacon flasher and traffic control signaling technique for marked crossings.

Example #1: Toucan Crossing (non-local)	**Figure 6-5. At-Grade Crossing of Major Street (Toucan or HAWK Crossing)**
	**Existing Reference:** - ITE – Alternative Treatments for At-Grade Pedestrian Crossings **Local Issues:** Grade-separated crossings are typically used in Mammoth where a multi-use path crosses a major street. However, a treatment similar to the one pictured here may be applicable in a situation where both bicyclist and pedestrians need to cross a major street in order to access a multi-use path. Because the Lake Mary Road Path is on the south side of the road, bicyclists and pedestrians coming from the north will have to cross Lake Mary Road in order to access the path. This configuration shown left also functions well in a mid-block crossing situation such as may be necessary with the proposed median path along Main Street.
Example #2: HAWK Crossing (non-local)	
	**Design Guidance:** A traffic engineering analysis should precede the installation of either treatment. Toucan crossings are generally used only when significant volumes of bicyclists and pedestrians are anticipated, and the crossings are generally at least 14 feet wide. Hawk crossings are typically used in both bike/ped and pedestrian-only situations. Accompanying signage can be adapted as needed.
Applicable Locations: At intersections or mid-block where bicyclists and/or pedestrians need to cross a major street in order to access a multi-use path on the other side (i.e. Lake Mary Road, Meridian Boulevard).	

Additional Guidance for Toucan and Hawk Crossings:

Typically, Toucan crossings have both bicycle and pedestrian signal heads on both sides of the crossing and is button or sensor actuated (bicycle loop detectors are often implemented with Toucan crossings). Toucan crossings are usually used with multi-use trail crossings of higher traffic roadways. Refuge islands, curb extensions or other crossing treatments can be used in conjunction with a Toucan crossing. Crossings can be at intersections, or occur mid-block. If the crossing occurs mid-block vehicle stop lines should be provided 20' minimum in advance of the crossing.

If a refuge island is used with a Toucan crossing, it should be 8 feet wide at a minimum and 10 feet is desired. If a signal is provided, signal loop detectors may be placed in the pavement to detect bicycles if they can provide advance detection, and a pedestrian-actuated button provided (placed such that cyclists can press it without dismounting.)

On Hawk crossings, the beacon signal consists of a traffic signal head with a red-yellow-red lens. The unit is normally off until activated by a pedestrian or bicyclist. When bicyclists/pedestrians wish to cross the street, they press a button and the signal begins with a flashing yellow indication to warn approaching motorists. A solid yellow, advising motorists to prepare to stop, then follows the flashing yellow. The signal is then changed to a solid red, at which time the user is shown a WALK indicator. The beacon signal then converts to an alternating flashing red, allowing drivers to proceed after stopping at the crosswalk while the bicyclist/pedestrian is shown the flashing DON'T WALK signal. The HAWK signal is still considered experimental by the Federal Highway Administration, but the concept is gaining acceptance quickly.

6.1.4. Signalized At-Grade Crossings of Minor Streets (Cross Alert System)

The Cross Alert system enhances visibility at multi-use path (or other recreational path) and public road intersections. This device is ideal for mid-block crossings and rural scenarios with light to moderate traffic and no intersection signalization.

Cross Alert Crossing (non-local)	**Figure 6-6. Signalized At-Grade Crossing (Cross Alert System)**
	**Existing Reference:** - www.crossalert.com **Local Issues:** Some at-grade crossings may require additional safety features to encourage compliance and alert motorists to the presence of cyclists and other trail users. Some crossings may require only seasonal signalization. Cross Alert System can be seasonally removed and reinstalled as necessary.
	**Specifications:** The Cross Alert system consists of a red LED light and stop sign which are presented to path users and an amber LED light and warning sign which are presented to vehicular traffic. The sign is powered by a solar panel, which is backed up by a battery. The system is activated by path activity via an infrared motion sensor. The companion sign on the other side of the road is activated via radio signal when the first sign detects motion on the path. This system includes an integrated trail counter to provide a count of trail users who cross the intersection.
Applicable Locations: Currently unsignalized intersections or mid-block at-grade crossings with safety concerns.	

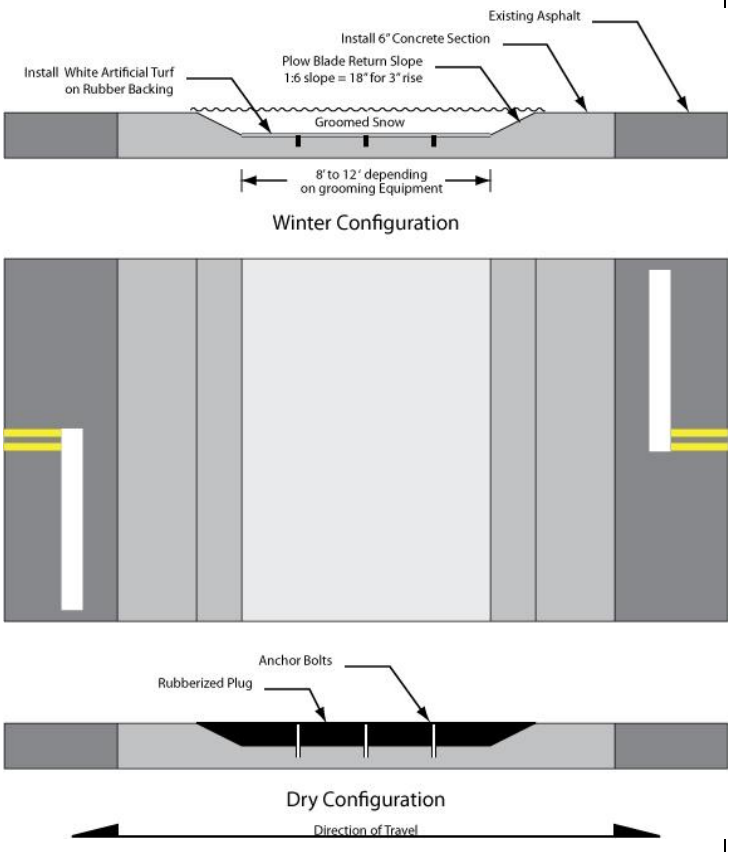
6.1.5. At-Grade Cross-Country Ski Crossing

Figure 6-7. Concept for At-Grade Cross Country Ski Crossing

Existing Guidance:
There are currently no official federal, state or local design standards that deal specifically with at-grade cross-country ski crossings. The design described below is conceptual and has not been tested.

Local Issues:
Winter cross-country ski trails can require skiers to remove ski equipment and walk across road crossings. An innovative crossing that is designed to hold more snow and is friendly to all users would be a great benefit to local and visiting skiers.

Potential Design



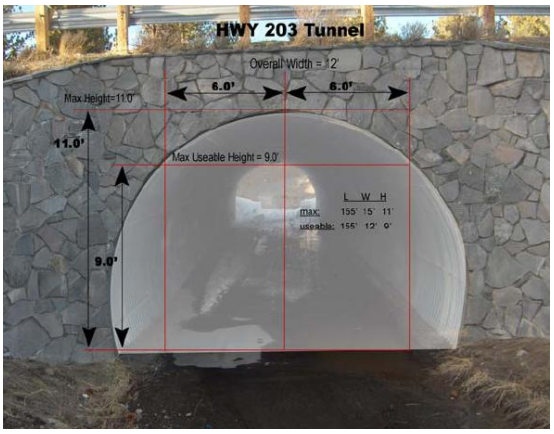
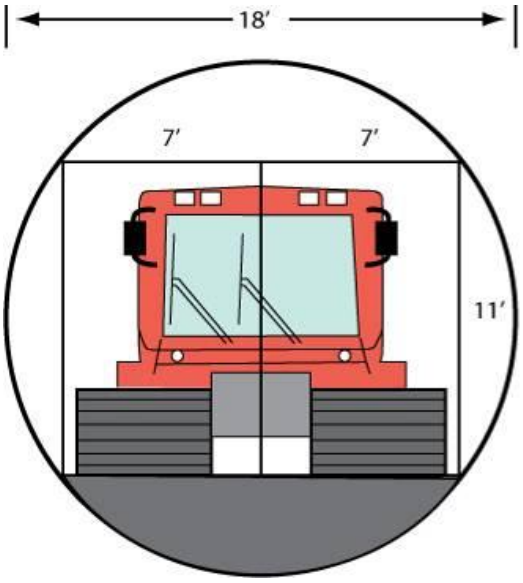
Design Guidance:

- Crossing should be cross-sloped to adequately drain any melted water away from the roadway. Small channels could be added to facilitate drainage if necessary.
- Snow removal crews should be directed to not plow the crossing closely or sand, salt, or gravel the crossing.
- Light colors, such as concrete and white artificial turf are recommended to reduce solar heat gain and faster melt out.
- This design is conceptual and would have to be tested as a pilot project before widespread implementation.
- Because of the approximately 3" drop, this should only be used in areas with stop signs where motorists are forced to come to a full stop before the crossing.
- Durable hard plastic rails could be attached to anchor bolts to reduce the downward movement of automobiles, but would have to be tested to determine their resistance to damage by snow removal equipment. Spacing between rails would have to be wide enough to accommodate common ski widths.
- A variation on this concept using a cast concrete speed table may be considered at mid-block crossing location.

Applicable Locations: Intersections or mid-block locations where groomed cross-country ski trails cross cleared asphalt roadways.

6.1.6. Grade-Separated Crossings

When the decision to construct an off-street multi-use path has been made, grade separation should be considered for all crossings of major thoroughfares. For the Town of Mammoth Lakes the preferred type of grade-separated crossing is an undercrossing due to weather and visual considerations.

Existing Design	**Figure 6-8. Design of Grade-Separated Crossings**
	**Existing Reference:** - AASHTO Guide to the Planning and Design of Pedestrian Facilities - TOML Public Works Standards **Local Issues:** Several grade-separated crossings currently exist in Mammoth Lakes including the Highway 203, Meridian, and Mammoth Creek tunnels. Current undercrossings do not accommodate a full-size snow cat for efficient tunnel clearing or grooming.
Recommended Design	
	**Design Guidance:** The graphic to the left shows the recommended design of a corrugated tunnel using an 18-foot diameter pipe. Alternately, the tunnel should be designed to accommodate the snow cat based on the design vehicle dimensions above. The wider tunnel will also allow more light to enter the tunnel and provide for greater horizontal separation as users pass each other in the undercrossing.
Applicable Locations: All multi-use path tunnels where winter grooming is desirable.	

6.1.7. Bicycle 'Scramble' Signals

Bicycle signal heads are standard signals fitted with red, yellow, and green bicycle indicators installed at intersections or mid-block crossings where there is heavy bicycle use, special circumstances, or intersection geometry where the use of a bicycle signal head would be beneficial. Bicycle signals should be combined with bicycle detection sensors or convenient push buttons.

Recommended Design	**Figure 6-9. Bicycle 'Scramble' Signal Design**
	**Existing Guidance:** - Section 4D.104(CA) of the California MUTCD **Local Application:** The eventual terminus of the Lake Mary Road Path at the southwest corner of Minaret and Main may leave some cyclists confused as to how to proceed safely through the intersection. The use of a bicycle signal with accompanying signage will clarify this situation and allow eastbound bicyclists to easily continue north on Minaret Road toward the North Village or east on Main Street via bike lanes or a median bike path. Without this treatment, bicyclists will have to use crosswalks in an area with potentially high pedestrian activity. Use of crosswalks will also tend to lead cyclists onto crowded sidewalks rather than the street.
Recommended Design	
 	**Description:** Portland, Oregon and San Luis Obispo, CA have introduced a concept of a 'Bicycle Scramble' where a bicycle only signal was given a dedicated signal phase to allow bicycles to enter and exit a popular bicycle trail that terminated at one corner of an intersection. During winter months, the bicycle signal phase could be deactivated or converted to a "pedestrian scramble" phase as new developments such as Mammoth Crossing bring significantly higher levels of pedestrian activity at that intersection. **Features:** Diagonal breaks in the crosswalk striping help direct bicyclists through the intersection in conjunction with the dedicated signal phase. Additionally, special sensors, with accompanying pavement markings detect bicycles and trigger the special phase. Conveniently-located push buttons or video detection could substitute for in-pavement sensors.
Applicable Locations: Lake Mary Road Path Terminus, a future Main Path crossing at Main Street and Old Mammoth Road would be another location if a median bike path is installed along Main Street.	

6.2. Bike Lanes

Bike lanes (Class II bicycle facilities – Caltrans) are defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bicycle lanes are generally found on major arterial and collector roadways and are five to six feet wide.

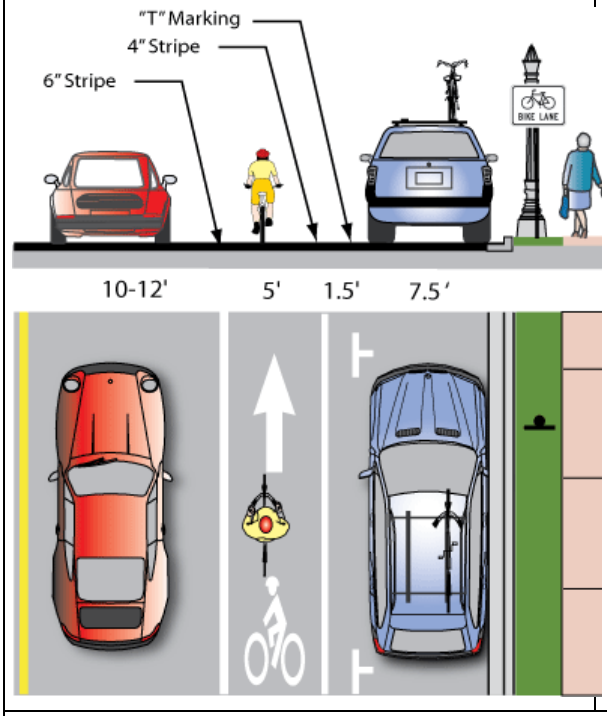
Existing Design

Figure 6-10. Bike Lane Design

Existing Guidance:
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Highway Design Manual (Chapter 1000)
- TOML Roadway Cross Sections

Local Issues:
The Town's only existing bike lanes are located on roadways without curbs, gutters or parking. As development increases and new bike lanes and sidewalks are installed, the typical bike lane section will likely include these elements.

Recommended Design



Width:
6 feet is recommended for bike lanes without on-street parking. This width will allow for added separation between bicyclists and vehicles and will allow for increased snow storage capacity in winter.

Bike lanes should be cleared when possible to keep the facility open for bicycling (see Operations and Maintenance Chapter). Bike lanes in the Town of Mammoth Lakes should adhere to the following standards:

6' (1.8 m) minimum if no gutter exists, measured from edge of pavement

6' (1.8 m) minimum with normal gutter, measured from curb face; or 3' (0.9 m) measured from the gutter pan seam

5' (1.5 m) when parking stalls are marked

Applicable Locations: Arterials or collector streets with traffic volumes to justify bike lanes and sufficient width to provide them.

Additional Guidance on Bicycle Lanes in TOML

Existing typical sections for roadways such as Old Mammoth Road, Laurel Mountain Road, Tavern Road, and Sierra Nevada Road have many good design principles incorporated, including narrow travel lanes, five-foot bike lanes, and appropriate turning lanes and parking. The Town of Mammoth Lakes has recognized an issue with bike lanes adjacent to on-street parking and has made an attempt to increase the distance between parked cars and cyclists to reduce the potential for a 'dooring' accident by specifying a nine-foot parking lane. Studies have shown that narrow parking lanes produce tighter parking behavior with drivers positioning their vehicles closer to the curb. It is recommended that the proposed roadway sections for Old Mammoth Road, Laurel Mountain Road, Tavern Road, and Sierra Nevada Road maintain the nine-foot space between parking and the bike lane, but create 7.5-foot parking stall within that lane by using parking 'tics' as shown in **Figure 6-10**. The 1.5 feet of buffer space left over will produce the following benefits:

- Buffer area for cyclists to decrease the chance of dooring accidents
- Buffer area for drivers to enter or exit the vehicle without being in the bike lane
- Narrower parking lane to improve parking performance and maximize road space
- Narrower parking lane to discourage parking by large vehicles such as RVs
- Parking 'tic' striping defines each space and can improve overall parking capacity by optimizing spacing between parked cars

Bike Lanes and Drainage Grates:

Installing bike lanes may require more attention to continuous maintenance issues. Bike lanes tend to collect debris as vehicles disperse gravel, trash, and glass fragments from traffic lanes to the edges of the roadway. Striping and stenciling will need periodic replacing. Good examples of bicycle-friendly drainage grates within TOML can be found along the recently paved portions of Lake Mary Road.

Poorly designed or placed drainage grates can often be hazardous to bicyclists. Drainage grates with large slits can catch bicycle tires. Poorly placed drainage grates may also be hazardous, and can cause bicyclists to veer into the auto travel lane.

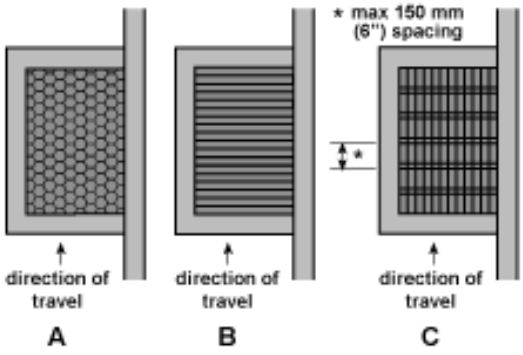
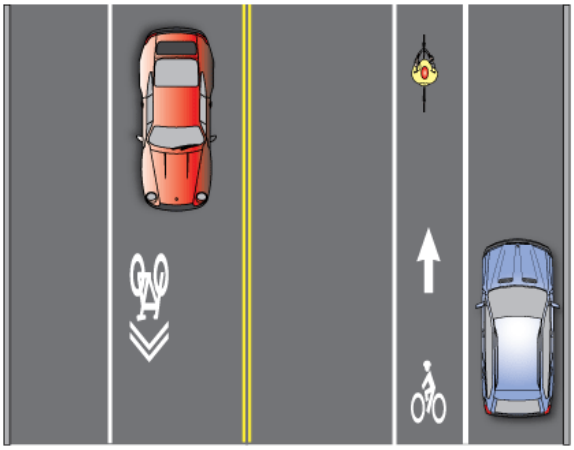


Figure 6-11. Examples of Bicycle Friendly Drainage Grates

6.2.1. Uphill Bicycle Climbing Lanes

Short sections of bicycle lane may be applied to steep grades on otherwise shared roadway (Class III) situations. These uphill climbing lanes get slow moving cyclists out of the travel lane and should be six feet wide to provide extra room for maneuvering. At downhill grades where cyclists will move at speeds approaching those of automobile traffic, bike lanes in the downhill direction are not needed or advised.

Existing Design (non-local)	**Figure 6-12. Uphill Bicycle Lane Design**
	**Existing Guidance:** - AASHTO Guide for the Development of Bicycle Facilities - Caltrans Highway Design Manual (Chapter 1000) **Local Issues:** On streets with steep grades it may be most appropriate to provide a bike lane only in the uphill direction. This configuration also requires less right-of-way than installing traditional bike lanes on both sides of the street.
Recommended Design	
	**Design Guidance:** Uphill bike lane should be 5 or 6 feet wide (6 is preferable since extra maneuvering room on steep grades can benefit bicyclists) Can be combined with Shared Lane Markings for downhill cyclists who can match prevailing traffic speeds. Shared Lane Markings are discussed in section 7.3.5. Placing the shared-lane marking in the center of the travel lane has advantages of being more visible to motorists and lasting longer since it goes between tire tracks.
Applicable Locations: Canyon Blvd, Forest Trail, Old Mammoth Road (between UGB and Lake Mary Rd) and other streets designated for bike lanes that have steep or persistent grades.	

6.2.2. Bike Lanes Adjacent to Right-Turn-Only Lanes

Right-turn only lanes present challenges for through-cyclists who must merge to the left to position themselves in the through travel lane. Jurisdictions will sometimes stripe bike lanes on the right-side of right-turn only lanes, which places the through-cyclist in direct conflict with a right-turning vehicle.

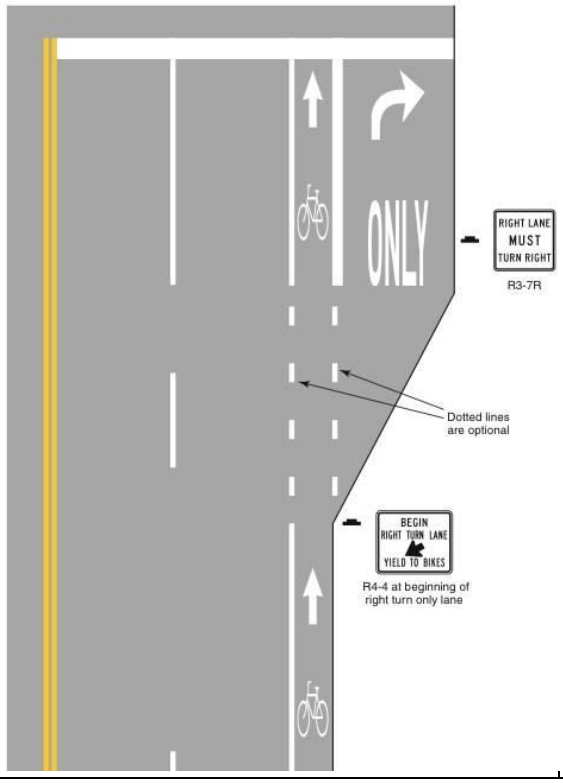
Existing Design (non-local)

Figure 6-13. Bike Lane Adjacent to Right-Turn-Only Lane

Existing Guidance:
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Highway Design Manual (Chapter 1000)
- Manual of Uniform Traffic Control Devices – California Supplement Chapter 9C-3

Local Issues:
In the TOML Public Works Standards, Mammoth exceeds Caltrans and AASHTO guidance by requiring 5' minimum in the recommended typical sections.

Recommended Design



Design Guidance:

The appropriate treatment for right-turn only lanes is to either drop the bike lane entirely approaching the right-turn lane, or to place a bike lane pocket between the right-turn lane and the right-most through lane. The design at left illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the merge area.

Applicable Locations: All bike lanes adjacent to designated right turn lanes or pockets.

6.2.3. Bike Boxes

Bike boxes, also known as 'advance stop lines', are being used on American roadways with increasing frequency. Bike boxes are intersection safety treatments that help reduce bicycle/car collisions, especially those between right turning vehicles and cyclists going straight.

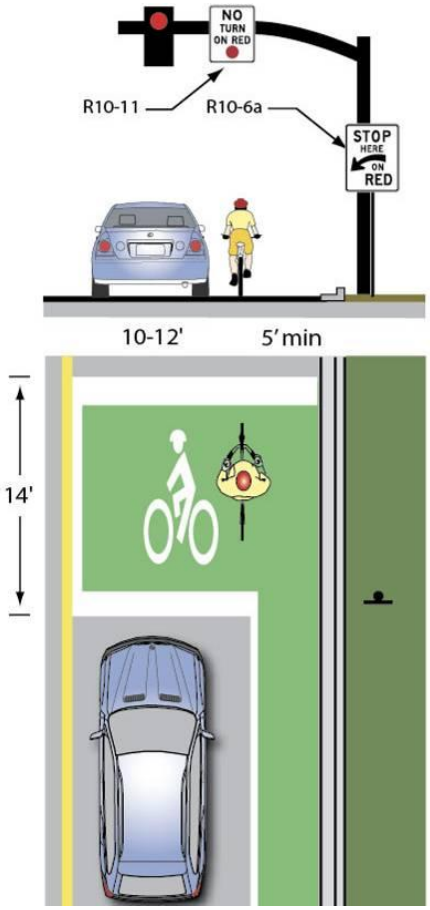
Existing Design (non-local)

Figure 6-14. Bike Box Design

Existing Guidance: None

Local Issues:
As more bike lanes are developed and the level of on-street cycling increases the Town of Mammoth Lakes may want to consider installing bike boxes at key intersections to improve intersection safety. At a red light, cyclists are more visible to motorists by being in front of them rather than at the side in the vehicle's blind spot. Vehicles must stop behind the white stop line at the rear of the bike box.

Recommended Design



Design Guidance:

Bike boxes can be combined with dashed lines through the intersection for green light situations to remind vehicles to be aware of bicyclists traveling straight. Bike Boxes have been installed with striping only or with colored treatments to increase visibility.

Bike Boxes should be located at signalized intersections only, and right turns on red should be prohibited. A bike box should always be to the left of right-turn only lanes as shown in the first photo (above). An engineering analysis should be conducted

Applicable Locations: At intersections on streets with bike lanes.

6.2.4. Colored Bike Lanes

Colored bike lanes are increasingly being used across the United States and are typically found with two distinct methodologies. The first involves coloring being added to the bike lane in conflict or merging areas with the second involving coloring the entire bike lane.

Existing Design	**Figure 6-15. Colored Bike Lanes**
	**Existing Guidance: None** **Local Issues:** In Fall 2009 the Town of Mammoth Lakes installed its first colored bike lane at the corner of Old Mammoth Road and Minaret Road. Pending satisfactory evaluation of the durability of the installation method and material, other locations should have this treatment installed. This treatment would be most effective when provided 100' in advance of a merging area or intersection (preferably in conjunction with the guidance on the previous page), and 50-100' after the intersection. The Town of Mammoth Lakes may also choose to color entire bike lanes to take advantage of the benefits below.
Recommended Design	
 Before  After	**Design Guidance:** A contrasting color for the paving of bicycle lanes can also be applied to continuous sections of roadways. These situations help to better define road space dedicated to bicyclists and make the roadway appear narrower to drivers resulting in beneficial speed reductions. Colored bike lanes require additional cost to install and maintain. Techniques include: • Paint – less durable and can be slippery when wet (currently under evaluation in TOML) • Colored asphalt – colored medium in asphalt during construction – durable. • Colored and textured sheets of acrylic epoxy coating. May not be compatible with snow removal operations.
Applicable Locations: Any existing or planned bike lane.	

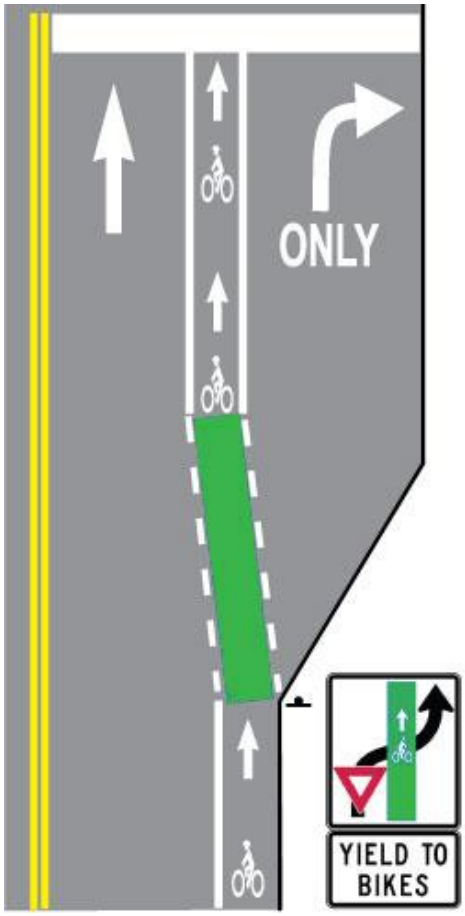
Existing Design (non-local)

Figure 6-16. Colored Bike Lanes – Conflict Areas

Existing Guidance: Portland's Blue Bike Lanes Study

Local Issues:
Certain merging/conflict/or intersections may benefit from having the bike lane made more visible to motorists while aiding bicyclist positioning.

Recommended Design



Design Guidance:

Many cities in the United States use colored bike lanes to guide cyclists through major vehicle/bicycle conflict points. These conflict areas are locations where motorists and cyclists must cross each other's path (e.g., at intersections or merge areas). Cyclists are especially vulnerable at locations where the volume of conflicting vehicle traffic is high, and where the vehicle/bicycle conflict area is long. Colored bike lanes typically extend through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection, or through the transition zone where motorists cross a bike lane to enter a dedicated right-turn lane.

Although colored bike lanes are not an official standard in California at this time, they continue to be successfully used in other cities. Portland, Oregon, Philadelphia, Pennsylvania, Cambridge, Massachusetts, Toronto, Ontario, Vancouver, British Columbia and Tempe, Arizona uses colored bike lanes in select locations. This treatment typically includes accompanying signage alerting motorists of vehicle/bicycle conflict points. Portland's 'Blue Bike Lane' report found that significantly more motorists yielded to bicyclists, and slowed or stopped before entering the conflict area after the application of the colored pavement.

Applicable Locations: Before intersections in merge areas and/or in conflict areas.

6.3. Bike Routes

The following recommendations provide several design options for the existing and future Class III bike routes. These designs meet Caltrans requirements but are not required as elements of a Class III facility and are provided for information only.

6.3.1. Bike Routes with Wide Outside Lanes

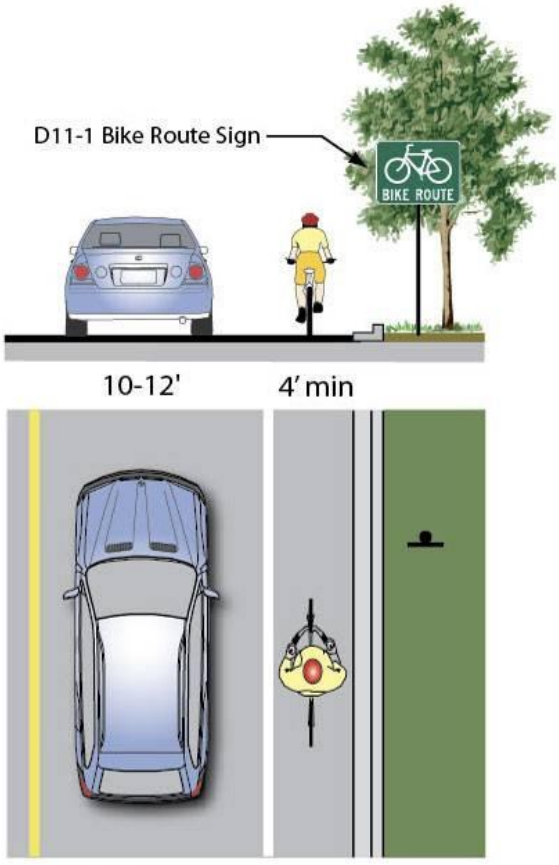
Signed Bike Routes are shared facilities with motor vehicles. They are typically used on roads with low speeds and traffic volumes, however can be used on higher volume roads with wide outside lanes or with shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

<table>
<tr><td>Existing Design</td><td>Figure 6-17. Bike with Wide Outside Lane</td></tr>
<tr><td colspan="2">Existing Guidance:
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Highway Design Manual (Chapter 1000)</td></tr>
<tr><td>Recommended Design</td><td></td></tr>
<tr><td> 
</td><td>Local Issues:
If recommended bike lanes are determined to be infeasible because of insufficient right-of-way or operational concerns, providing a wide outside lane and bike route signage should be considered. This can also be used as a short term solution or a gap closure measure in constrained areas. Additional warning signage and/or pavement marking should be considered as necessary.

Design Guidance:
If bike lanes are infeasible on a roadway because of insufficient width or operational concerns, a wide outside lane can be provided. A curb lane of 14 feet generally provides enough space for bicyclists and motorists to safely ride side-by-side within the lane. Generally if the outside lane is consistently wider than 15-16 feet, bike lanes should be provided unless operational concerns make them impractical.</td></tr>
<tr><td colspan="2">Applicable Locations: Where sufficient width exists and bike lanes are infeasible or impractical</td></tr>
</table>

6.3.2. Bike Routes with Shoulders

<table>
<tr><td>Existing Design</td><td>Figure 6-18. Bike Route Design</td></tr>
<tr><td>  </td><td>Existing Guidance:
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Highway Design Manual (Chapter 1000)

Local Issues:
The combination of ‘Bike Route’ signage with a shoulder stripe provides many of the same benefits of a bicycle lane with less infrastructure investment and maintenance requirements. This type of Class III facility works well in areas with existing shoulders and low demand for on-street parking.</td></tr>
<tr><td>Recommended Design</td><td></td></tr>
<tr><td> 
</td><td>Width:
4’ suggested minimum. If sufficient space is available (5’ min) a bike lane is preferred.</td></tr>
<tr><td colspan="2">Applicable Locations: Roadways where bike lanes cannot be implemented due to insufficient or inconsistent width, or on roadways where shoulder use by motor vehicles is necessary, but infrequent.</td></tr>
</table>

6.3.3. Bike Routes with Wide Shoulders and Rumble Strip

Rumble strips are an effective safety treatment on many rural roadways and state highways but can be unpleasant for bicyclists. The rumble strip design and placement are also important; placing the rumble strip as close to the fog line as possible leaves the maximum shoulder area available for cyclists. Certain rumble strip designs are safer for bicyclists to cross, and still provide the desired warning effect for motorists. Because rumble strips can disrupt air flow from passing vehicles that often blows debris toward the edge of the roadway, regular sweeping operations should be conducted on this type of bike route.

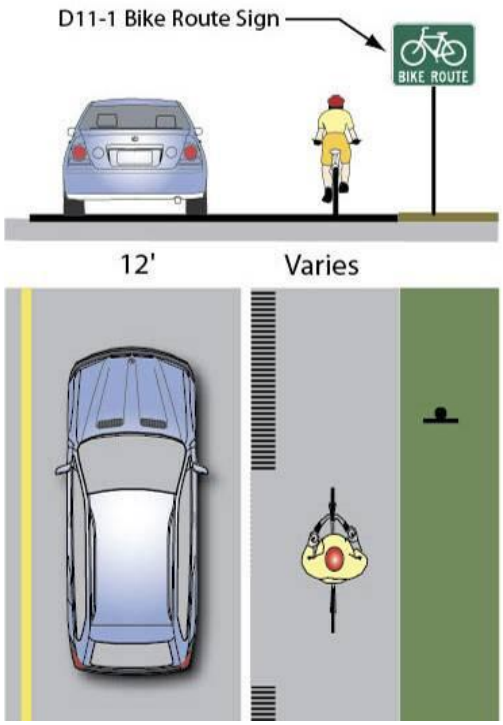
Existing Design

Figure 6-19. Rumble Strip Design

Existing Guidance:
- Caltrans Highway Design Manual

Local Issues:
Many of the major highways and rural roads accommodate high speed motor vehicle travel but are not suitable for bike lanes because motorists need to be able to legally use the shoulder to pull off the highway and in emergency situations.

Recommended Design



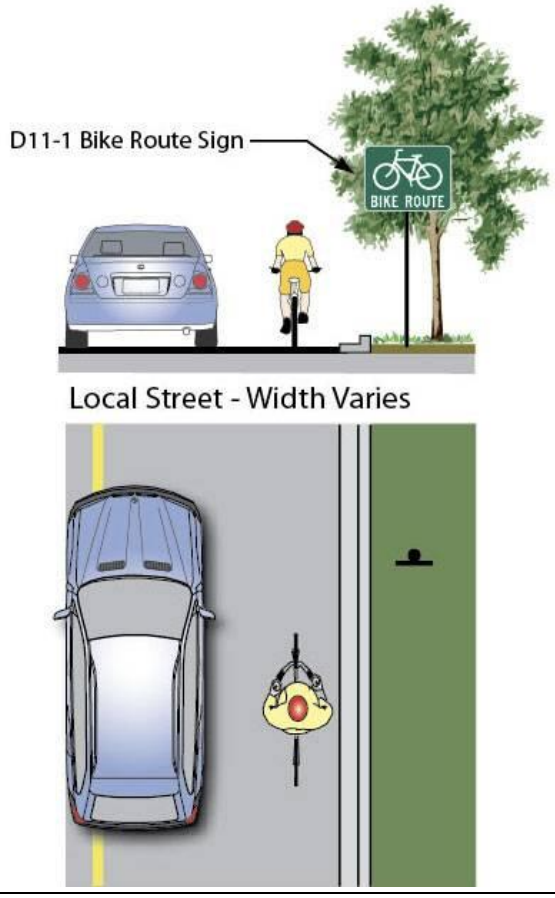
Design Guidance:
In 2001, Caltrans performed a study of various rumble strip designs involving 6 test vehicles and 55 bicyclists of various skill levels. The recommended design resulting from the study constituted a milled rumble strip design that is 1 foot (300mm) wide with 5/16 ± 1/16 in (8 ± 1.5 mm) in depth.

Rumble strips are recommended to be installed only on roadways with shoulders in excess of 5 feet (1.5 m). A shallow depth of the milled portions of the rumble strips are preferred by bicyclists. A skip (or gap) in the rumble strip may be provided to allow bicyclists to cross from the shoulder to the travel lane when preparing to make a left turn or when encountering debris. This skip pattern is recommended to be 12 feet (3.7 m) in length with intervals of 40 or 60 feet (12.2 or 18.3 m) between skips.

Applicable Locations: Highways and other rural roads with wide shoulders that will need to be used occasionally by motorists.

6.3.4. Bike Routes on Narrow Roadways

<table>
<tr><td>Existing Design</td><td>Figure 6-20. Bike Route Design</td></tr>
<tr><td>  </td><td>Existing Guidance:
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Highway Design Manual (Chapter 1000)

Local Issues:
This example of a bicycle route can be applied to most narrow residential and local streets.</td></tr>
<tr><td>Recommended Design</td><td></td></tr>
<tr><td> 
</td><td>Width:
Bike Route signage should be applied more frequently to indicate to motorists that bicycles may be present. A combination of engineering and enforcement efforts to slow motor vehicle speeds on these roadways should also be considered for increased safety.</td></tr>
<tr><td colspan="2">Applicable Locations: Majestic Pines, Kelley Road, Lakeview Boulevard and other bike routes on narrow roadways.</td></tr>
</table>

6.3.5. Shared-Lane Markings

Recently, Shared Lane Marking stencils (also called "Sharrows") have been introduced for use in California as an additional treatment for Class III facilities. The stencil can serve a number of purposes, such as making motorists aware of bicycles potentially in their lane, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to bike further from parked cars to prevent "dooring" collisions. **Figure 6-18** illustrates recommended on-street Shared Lane Marking stencil placement. The "Chevron" marking design recommended by Caltrans is also shown in **Figure 6-18**. The following pavement markings were adopted for official use by Caltrans on 9/12/2005 as MUTCD 2003 California Supplement Section 9C.103 and Figure 9C-107. Guidance language provided by Caltrans for use of the Shared Lane Marking is as follows:

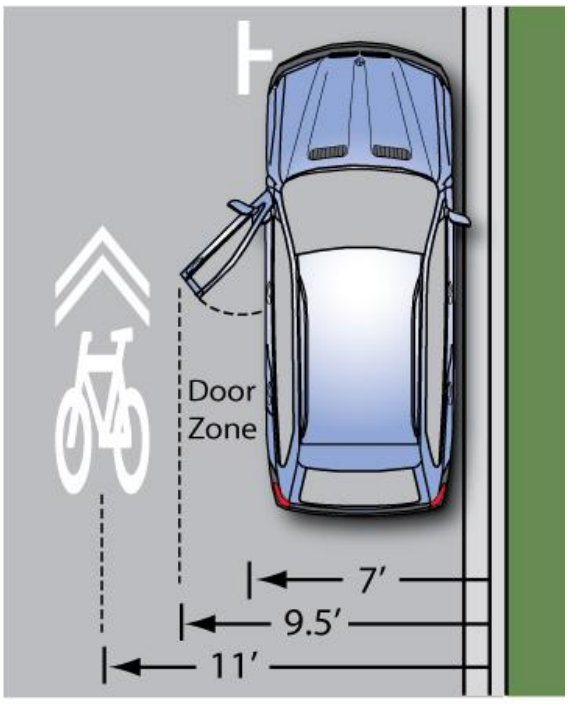
Existing Design	**Figure 6-21. Shared-Lane Markings**
Existing Guidance: - Manual of Uniform Traffic Control Devices Chapter 9 – 2008 draft - Caltrans Highway Design Manual (Chapter 1000) **Local Issues:** Shared Lane Markings may be useful in areas with on-street parking where bike lanes cannot be implemented. They will be especially useful in downhill situations where cyclists are traveling at speeds similar to those of motor vehicle traffic. In these situations bicyclists should be encouraged to move more toward the center of the travel lane to prevent dangerous passing and to avoid roadside hazards such as debris and parked cars.	
Recommended Design	
	**Design Guidance:** CA MUTCD recommends a minimum width from the curb of 11' feet (see figure on next page). This minimum may be insufficient where wide vehicles use on-street parking or where motorists tend to park farther from the curb. Exceeding the minimum width from the curb and placing the marking closer to the center of the travel lane has several potential benefits. These may include: - May encouraging cyclists to ride farther from parked cars and avoiding "dooring" injuries, as well as making cyclists more visible to motorists pulling out of driveways. - May be more clearly visible to motor vehicle operators since drivers are on the left side of the vehicle and tend to look at the road ahead. - Durability may be increased since the markings will pass between tire tracks. This may be particularly beneficial where vehicles use snow chains.
Applicable Locations: Streets with on-street parking and insufficient room for bike lanes. (Minaret Road at North Village, Canyon Boulevard).	

Figure 6-22. Shared Lane Marking Guidance (CA MUTCD)

Design Guidance (from California MUTCD):

Section 9C.103 Shared Roadway Bicycle Marking

Option:

The Shared Roadway Bicycle Marking shown in Figure 9C-107 may be used to assist bicyclists with positioning on a shared roadway with on-street parallel parking and to alert road users of the location a bicyclist may occupy within the traveled way.

Standard:

The Shared Roadway Bicycle Marking shall only be used on a roadway which has on-street parallel parking. If used, Shared Roadway Bicycle Markings shall be placed so that the centers of the markings are a minimum of 3.3 m (11 ft) from the curb face or edge of paved shoulder. On State Highways, the Shared Roadway Bicycle Marking shall be used only in urban areas.

Option:

For rural areas, the SHARE THE ROAD (W16-1) plaque may be used in conjunction with the W11-1 bicycle warning sign (see Sections 2C.51 and 9B.18). Information for the practitioner regarding classification of rural versus urban roadways can be found at the following California Department of Transportation website:

http://www.dot.ca.gov/hq/tsip/hpms/Page1.php

Guidance:

If used, the Shared Roadway Bicycle Marking should be placed immediately after an intersection and spaced at minimum intervals of 75 m (250 ft) thereafter. If used, the Shared Roadway Bicycle Marking should not be placed on roadways with a speed limit at or above 60 km/h, (40 mph).

Option:

Where a Shared Roadway Bicycle Marking is used, the distance from the curb or edge of paved shoulder may be increased beyond 3.3 m (11 ft). The longitudinal spacing of the markings may be increased or reduced as needed for roadway and traffic conditions. Where used, bicycle guide or warning signs may supplement the Shared Roadway Bicycle Marking.

Support:

The Shared Roadway Bicycle Marking is intended to:

- Reduce the chance of bicyclists impacting open doors of parked vehicles on a shared roadway with on-street parallel parking.
- Alert road users within a narrow traveled way of the lateral location where bicyclists ride.
- Be used only on roadways without striped bicycle lanes or shoulders.

6.3.6. Bicycle Detection at Signalized Intersections

Traffic detectors for traffic-actuated signals including video or embedded loop detectors should be set to detect bicycles. Loops should be located in bicycle lanes in the bicyclist's expected path. All signalized locations with vehicular actuation and without bicycle lanes for the left turn and outside through lanes should have pavement markings to indicate to bicyclists where they should be to activate signal detection. If the loop is invisible, the pavement marking should be installed; if the loop is visible and bicycle use anticipated to be low (e.g., in a remote location), a pavement marking may not be necessary.

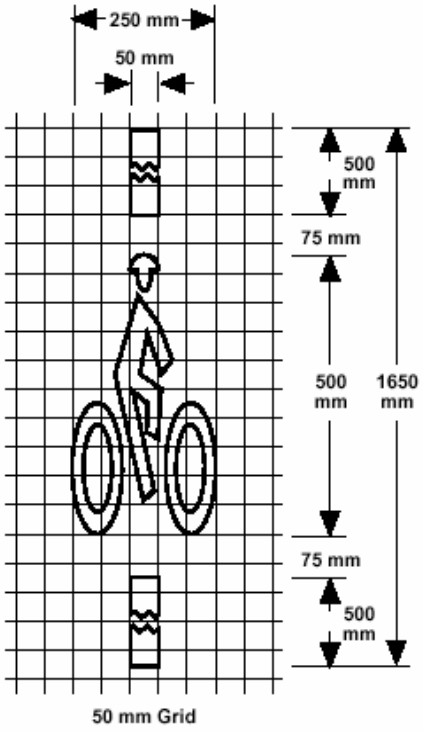
In some cases, the use of pedestrian-actuated buttons may be an alternative to the use of detectors, provided the button can be pushed by a cyclist from the street.

Figure 6-23. Bicycle Detection at Intersections

Existing Guidance:
- Caltrans Highway Design Manual (Chapter 1000)
- AASHTO Guide for the Development of Bicycle Facilities

Local Issues:
If bicyclists arrive at a roadway intersection with an actuated traffic signal that uses loop detectors, they may not get a green light unless (1) the loop detectors are bicycle sensitive and (2) the bicyclist can identify and stop their bicycle over the sensitive portion of the loop.

Recommended Design

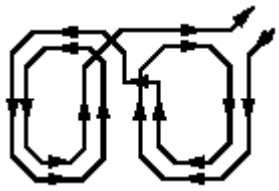


Design Guidance:
Any signalized intersection should be able to detect the presence of a bicyclist. In certain circumstances the positioning of the bicyclist is crucial to accurate detection. In such cases the figure to the left illustrates the standard pavement stencil to indicate proper positioning.

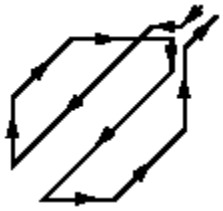
Applicable Locations: All intersections using loop detector where bicyclist can be expected.

Additional Guidance for Bicycle Loop Detectors

The purpose of bicycle loops is to detect bicyclists waiting at intersections, and to give cyclists extra green time (e.g. five seconds) before the light turns yellow to make it through the light. Traffic signal actuators unable to detect bicycles may cause delays for bicycle and even motor vehicle traffic (in situations where the cyclists is occupying the area above the signal actuator). Current and future bicycle detection loops should use the Caltrans Standard bicycle detection stencil shown in **Figure 6-21** to indicate to cyclists where to position themselves over the loop. Two loop detector types appropriate for bicycle detection, Type "C" (quadruple) and Type "D" (diagonal slashed), are shown in the figure below. Details of saw cuts and winding patterns for inductive detector loop types appear on Caltrans Standard Detail ES5B. Loop types B (5' square diamond), C (quadruple), D (diagonal-slashed), Q (figure-8) and modified Type E (circle with a slash) can reliably detect bicycles across their full width. Type D loop is preferred as it has a good, fairly uniform response to bicycles across its area. Types A (6' square) and E (unmodified circle) are not bike-sensitive in their center.



Quadruple Loop – Type "C"
Detects most strongly in center
Sharp cut-off sensitivity
Used in bike lanes



Diagonal Quadruple Loop – Type "D"
Sensitive over whole area
Sharp cut-off sensitivity
Used in shared lanes

Figure 6-24. Bicycle-Sensitive Loop Detector Types

6.4. Bicycle Parking

The Town of Mammoth Lakes currently uses the 'Wave' or 'Ribbon' type bicycle racks as a standard, with additional encouragement to designs that serve both as functional bicycle parking and attractive public art. Wave racks are not the optimal design for high traffic bicycle parking areas as they only support the bicycle frame at one point creating the potential for bicycles rotating, or tipping and becoming entangled with surrounding bicycles. Additionally, many cyclists use the wave rack in a sideways configuration to get a more stable interface; this limits the capacity of the rack. The theoretical capacity of a wave rack is usually much higher than the practical capacity.

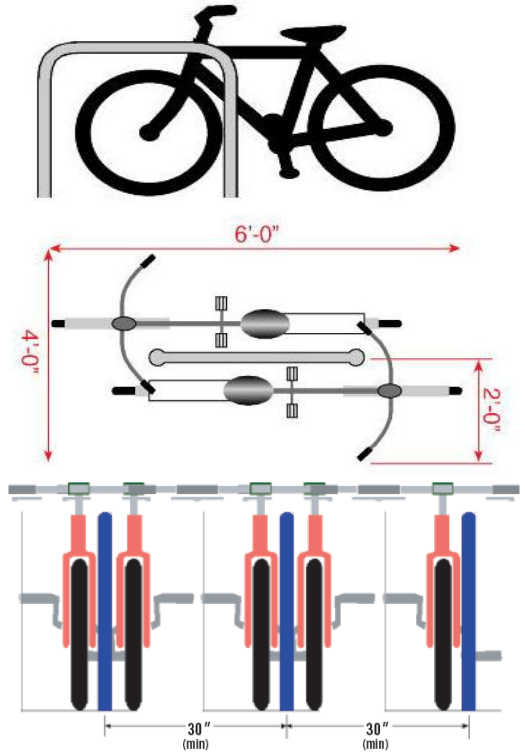
Existing Design

Figure 6-25. Bike Parking Design

Existing Guidance:
Town of Mammoth Lakes Design Guidelines -5.3.9

Local Issues:
Bicycle parking in Mammoth needs to be functional, usable throughout the year and if possible, incorporate additional artistic features, or dual-use features with ski/snowboard equipment. Existing "wave" or "ribbon" racks are adequate for existing installations, but "inverted-u" racks should be considered for future installations especially for single installations.

Recommended Design



Design Guidance:
Bicycle racks should be designed so that bicycles may be securely locked to them without undue inconvenience and will be reasonably safeguarded from accidental damage.

Bicycle racks must hold bicycles securely, and meet the following criteria:

- Support the frame of the bicycle and not just one wheel
- Allow the frame and one wheel to be locked to the rack when both wheels are left on the bike
- Allow the frame and both wheels to be locked to the rack if the front wheel is removed
- Allow the use of all common lock types (u-locks, chains, and cables).
- Be securely anchored
- Be usable by bikes with no kickstand
- Be usable by bikes with water bottle cages
- Be usable by a wide variety of bicycles

The images to the right show the inverted-u rack in single and multiple installations.

Applicable Locations: Public sidewalks fronting commercial developments (single installations) and for businesses and shopping centers with demand for bicycle parking (multiple installations).

Additional Guidance for Bicycle Parking

Bicycle Rack Design and Installation

Bicycle racks and the area required for parking and maneuvering must meet the standards below.

Bicycle Parking Space Dimensions

Bicycle parking spaces must be at least 6 feet long and 2 feet wide, and in covered situations the overhead clearance must be at least 7 feet.

An aisle for bicycle maneuvering must be provided and maintained beside or between each row of bicycle parking. This aisle must be at least 5 feet wide.

Each required bicycle parking space must be accessible without moving another bicycle.

Areas set aside for bicycle parking must be clearly marked and reserved for bicycle parking only.

Parking Location

Bicycle parking must be located within 50 feet on an entrance to the building. Bicycle parking should be permanently secured to a paved surface and be located such that it will not become buried by snow removal operations. Covered bicycle parking is recommended wherever possible.

Bicycle parking may be provided within a building, but the location must be easily accessible.

Bicycle Parking Signs

Bicycle parking signs should be used where bicycle parking is not viewable from the street or building entrance. The Manual on Uniform Traffic Control Devices specifies a bicycle parking guide sign (D4-3) which can be used to inform bicyclists of parking areas.

Combination Bicycle-Ski Racks

In the Town of Mammoth Lakes, it makes particular sense to employ bicycle parking in certain locations as dual-purpose devices capable of holding bicycles in the summer months and skis/snowboards in the winter. As bicycle storage devices these racks should meet the guidelines outlined above in addition to considerations for skis and snowboards. A rubberized surface or other device capable of reducing wear to the metal edges of skis or snowboards is also recommended. Artistic racks are encouraged provided they are functional and meet the above guidelines.

Figure 6-26. Existing Bicycle/Ski Rack (left) & Concept Bicycle/Ski Rack (right)

Figure 6-26 above shows an existing and conceptual bike/ski rack. The existing rack is aesthetically appropriate and functions for skis, but does not work as a bike rack if the user intends to use a typical locking device to secure the bicycle. In addition the existing rack does not support the frame of the bicycle and may have some difficulty accommodating wider skis or snowboards. The image on the right portrays a rack that would provide a better balance of functionality between bicycles, skis, and snowboards, but would require further refinement in both in terms of aesthetic design and functionality.

Artistic Rack Design

This discussion above should be used as a starting point for a bicycle/ski rack design competition involving local artists and designers. The competition could be divided into categories for best bike-only rack, best ski/snowboard rack, and best multipurpose/all-season rack. Racks should be judged on functionality and aesthetics based on the Town's Design Guidelines document and the bike rack design discussion in this chapter.

Figure 6-27. Examples of Newer 'Artistic' Style Bicycle Racks

Recommended Bicycle Parking Requirements

Bicycle rack design standards should be applied to both public and private installation to ensure consistency and quality of bicycle parking throughout town. **Table 6-2** provides an example of bicycle parking requirements for residential and commercial developments. The installation of bicycle parking shall be mandatory for any new commercial or multi-family residential development. Sample Short Term Bicycle Parking Requirements are based on existing requirements in Portland, Oregon and can be customized to conform with local land use designations. Racks installed in accordance with Multi-Family residential developments should be covered to provide service year-round if enclosed private garages do not exist.

Table 6-1. Sample Short-Term Bicycle Parking Requirements

Category	Minimum Req Bicycle Spaces
Residential Categories	
Multi-Family	The greater of 2, or 1 per unit
Single Family	None
Commercial Categories	
Retail sales and services	The greater of 2,or 1 per 5,000 ft^2 floor area
Office	The greater of 2,or 1 per 10,000 ft^2 floor area
Entertainment uses	The greater of 10,or 1 per 40 seats
Religious Institutions	The greater of 2,or 1 per 2,000 ft^2 floor area

Additional Discussion on current guidance and installations

The 'Inverted-U' rack and variants with similar characteristics are generally considered superior to the wave rack. Snow removal around a single Inverted U rack requires no additional effort over the wave rack, but an array of racks could make snow removal more difficult since the spaces between each rack would have to be cleared. The photo below from Jackson Hole, illustrates the need for bicycle parking to be covered wherever possible in order to ensure that bicycling remains an option for winter mobility while minimizing the additional labor required for snow removal around bicycle racks. Likewise, bicycle parking should not hamper snow removal efforts. During winter months, the Town of Mammoth Lakes may want to consider removal of bicycle parking in some locations as a part of routine

seasonal maintenance efforts. Bicycle racks intended for winter removal would need to be designed and installed in a manner that facilitates this process.

Figure 6-28. These Inverted U Racks Are Not Maintained in Winter

The "inverted-u" or "staple" rack is universally recognized as the best bike rack design and is recommended by the Association of Pedestrian and Bicycle Professionals, but other rack types may be adequate for the Town of Mammoth Lakes in certain locations. It is recommended that 'Inverted U' rack become standard for single installations, covered areas, or areas with heated sidewalks or plazas. The preceding guidelines provide more information and standards for bicycle rack selection and placement than existing TOML Design Guidelines. Any rack may be used provided it meets the recommended guidelines and standards for bicycle parking above.

6.5. Pedestrian Facilities

The design of the pedestrian environment will directly affect the degree to which people enjoy the walking experience. If designed appropriately, the walking environment will not only serve the people who currently walk, but also be inviting for those who may consider walking in the future. Therefore, when considering the appropriate design of a certain location, designers should not just consider existing pedestrian use, but how the design will influence and increase walking in the future. Additionally, designers must consider the various levels of walking abilities and local, state, and federal accessibility requirements. Although these types of requirements were specifically developed for people with walking challenges, their use will result in pedestrian facilities that benefit all people.

The Municipal Code, which includes the zoning ordinance, the traffic code, and the public improvements code, contains language regulating some elements. State laws and rules regulate others. Standard Construction Details, issued by the Town of Mammoth Lakes Standard Plans for Public Works, apply to the pedestrian realm. There are also numerous guidelines issued by various national organizations that constitute the canon of standard engineering practice. These include the Manual on Uniform Traffic Control Devices (MUTCD) and the Americans with Disabilities Act Access Board (ADAAG) Guidelines.

It should be noted that the operative plan for pedestrian facilities will be the anticipated Mobility Plan. The discussion of pedestrian facilities is included to inform the development of the Mobility Plan and to illustrate the overlap between mobility and recreational trails planning in Mammoth Lakes.

6.5.1. Promenades

Promenades are wide pedestrian walkways along major streets. Currently promenades are used along Main Street as a combination sidewalk and multi-use path extension. This configuration can work as long as pedestrian volumes and bicyclist speeds are relatively low, but numerous at-grade crossings of intersecting streets and driveways can present a problem as motorists may not anticipate fast moving bicyclists. Crossings can be of particular concern where motorists turning right onto Main Street cross and block the promenade as a fast moving bicyclist comes downhill in the opposite direction of traffic. As pedestrian and bicyclist volumes increase, TOML should consider measures to slow cyclists to speeds more compatible with pedestrian activity and encourage faster cyclists to use adjacent streets by providing bike lanes.

Existing Design	**Figure 6-29. Pedestrian Promenade Design**
	**Existing Guidance:** Town of Mammoth Lakes Design Guidelines **Local Issues:** Existing Main Street promenades provide ample space and an attractive walking environment for pedestrians and low volume bicycle traffic. Increased bicycle and pedestrian activity may lead to future conflicts especially in areas where they are directly connected to multi-use paths. In anticipation of increased bicycle and pedestrian activity, the Town should begin to provide attractive alternatives for bicyclists such as bike lanes and a median bike path along Main Street.

Design Guidance:

- Pedestrian promenades should be designed to reinforce their function as high use pedestrian areas. Promenades should continue to be designed with sidewalk coloring or special paving and should not maintain the appearance or function of a multi-use path.
- Where users transition from a multi-use path to a promenade, signage should change accordingly (i.e. from :"Main Path" to "Main Street Promenade").
- Wherever possible, bike lanes should be provided on adjacent streets to encourage faster bicyclists to use the street rather than the promenade.

Applicable Locations: Main Street and major pedestrian thoroughfares

6.5.2. Curb Extensions

Curb extensions (sometimes called curb bulbs or bulb-outs) have many benefits for pedestrians. They shorten the crossing distance, provide additional space at the corner (simplifying the placement of elements like curb ramps), and allow pedestrians to see and be seen before entering the crosswalk. Curb extensions can also provide an area for accessible transit stops and other pedestrian amenities and street furnishings. Curb extensions are not currently included in the Town of Mammoth Lakes Public Works Standards.

<table>
<tr><td>Existing Design</td><td>Figure 6-30. Curb Extension Design</td></tr>
<tr><td colspan="2">Existing Guidance:
AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities

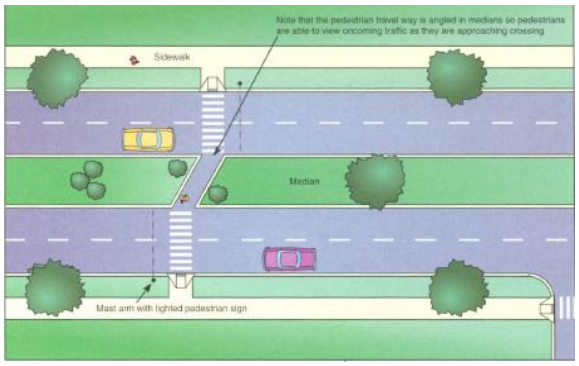
Local Issues:
In areas with on-street parking and mid-block pedestrian crossings, curb extensions can be used to shorten the crossing distance for pedestrians and make pedestrians waiting to cross more visible to motorists.</td></tr>
<tr><td>Recommended Design</td><td></td></tr>
<tr><td>  </td><td>Design Guidance:
Curb extensions may be used at any corner location, or at any mid-block location where there is a marked crosswalk, provided there is a parking lane into which the curb may be extended. Curb extensions are not generally used where there is no parking lane because of the potential hazard to bicycle travel.

In high pedestrian use areas, curb extensions are a preferred element for corner reconstruction except where there are extenuating design considerations such as the turning radius of the design vehicle, or transit and on-street parking factors.

Curb extensions can be compatible in areas with heavy snowfall provided that they are visibly marked for snow removal crews. The photograph left shows curb extensions with reflective snow posts to ensure that motorists are aware of the curb extensions at night and to indicate the location of the curb for snow removal crews. Curb extensions in Mammoth should be accompanied by reflective posts suitable for local snow depths and careful design for drainage.</td></tr>
<tr><td colspan="2">Applicable Locations: Pedestrian crossings (especially mid-block) on roads with on-street parking.</td></tr>
</table>

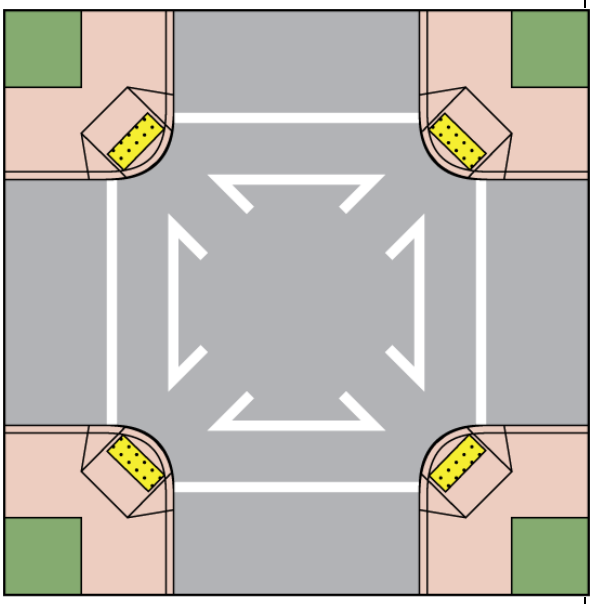
6.5.3. Refuge Islands

Refuge islands allow pedestrians to cross one segment of the street to a relatively safe location out of the travel lanes, and then continue across during the next gap in traffic. At unsignalized crosswalks on a two-way street, a median refuge island allows the crossing pedestrian to navigate each direction of traffic separately. This can significantly reduce the time a pedestrian must wait for an adequate gap in the traffic stream. Like curb extensions, refuge islands should be marked for snow removal crews.

Existing Design	**Figure 6-31. Refuge Island Design**
Existing Guidance: MUTCD, AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities **Local Issues:** Wide roadways can be intimidating and difficult to cross. The provision of refuge islands can increase the comfort and safety of pedestrians (and bicyclists).	
Recommended Design	
  Source: AASHTO (above) 	**Design Guidance:** - Accompanying crosswalks should have higher visibility markings such as Piano Key, Ladder, or some variation of colored or textured paving. - Refuge Islands work well in mid-block situations but can also occur at intersections as a part of the median. - Continuous medians can provide multiple opportunities for refuge islands and can also reduce the surface area of roadways that have to be cleared of snow. - Continuous Medians can also be used as bike paths (see 5.1.2 Median Bike Paths) - Medians and refuge islands may be used for snow storage as long as snow banks are not allowed to reach heights that impair pedestrian visibility at crossings. - Medians in Mammoth should be accompanied by reflective posts suitable for local snow depths.
Applicable Locations: Main Street, Meridian Boulevard	

6.5.4. Pedestrian 'Scramble' Crossing

A pedestrian scramble is an exclusive phase of signal operations at a signalized intersection. This phase permits crossings for pedestrians in any direction including diagonal crossings. This phase must be paired with a prohibition of right turn on red for vehicles and typically involves unique pavement markings such as those shown below.

Recommended Design	**Figure 6-32. Pedestrian 'Scramble' Crossing**
	**Existing Guidance:** MUTCD 3B-17 AASHTO Guide for the Planning, Design and Operation of Pedestrian Facilities **Local Issues:** As development increases and becomes more pedestrian-oriented, the need for high-volume pedestrian crossings may be necessary. Providing a unique signal phase for pedestrians that allows crossing in all directions, including diagonal crossing. The intersection of Minaret Road and Main Street will likely see pedestrian activity increase significantly as the Mammoth Crossing, Mammoth Hillside, Holiday Haus, and Sierra Star developments are completed. The installation of a pedestrian scramble in these locations has potential to significantly improve access between the Lake Mary Path and the North Village recreation portal. The intersection of Old Mammoth Road and Meridian Blvd may also see significant increases in pedestrian activity with new development in that area.
Recommended Design	
	**Design Guidance:** This type of treatment should be considered at intersections with high levels of pedestrian activity, especially at locations with commercial activity or other common pedestrian destinations at all four corners.
Applicable Locations: Four way intersections with high levels of pedestrian activity.	

6.6. Soft-Surface Trail Design Guidelines

The Town of Mammoth Lakes does not currently design, construct, or maintain soft-surface trails. These guidelines for soft-surface trails have been included for informational purposes and would only be used if the Town were to begin developing and maintaining soft-surface trails. The successful design, construction, and management of natural soft-surface trails is critical to the pursuit of making Mammoth a year-round destination resort community, as the trails offer a significant recreational amenity to both residents and visitors. The community is fortunate to have the winter and summer trail facilities at Mammoth Mountain and it is important that future offerings complement, not duplicate, what is already offered in order to maximize resources and best meet the needs of trail users.

The following guidelines are not a "how-to" for building and maintaining trails, rather they offer a framework for management and decision making to help build a premier trail system in and around the Mammoth Lakes region. In addition, this guide establishes standard terms and definitions that can aid communication with planning partners about trail needs, design standards and environmental issues.

6.6.1. Soft Surface Summer Trails

Type 4 – Shared Multi-Use

- Suitable to share non-motorized or motorized
- Tread 8' to 12'
- Allowance for passing
- Native or imported material
- Minor obstacles in trail
- Grades less than 5%
- Good sightlines throughout

Type 3 – Shared Non-Motorized

- Tread narrow – up to 48"
- Allowance for passing
- Native materials
- Obstacles occasionally present
- Blockages cleared to define route and protect resources
- Grade to 10%
- Clearances and turning radius to accommodate all uses

Type 2 – Preferred Mountain Bike

- Tread narrow – less than 36"
- Minimal allowance for passing
- Native materials
- Overhead obstacles may be present over 6'
- Grades may occasionally be steeper than 8%
- Obstacles and challenge to be expected

- Climbing turns will be incorporated
- May not be suitable or enjoyable for horses
- Insloped turns and tread allowed where adequate drainage exists

Type 2 - Preferred Equestrian

- Tread narrow – less than 30"
- Minimal allowance for passing
- Native materials
- Head clearances over 12'
- Grades may occasionally be steeper than 10%
- Obstacles and challenge to be expected
- Turns will be switchbacks or climbing turns
- May not be suitable or enjoyable for bikes

Type 2 - Preferred Hike

- Tread narrow – less than 36"
- Minimal allowance for passing
- Native materials
- Overhead obstacles may be present
- Grades may occasionally be steeper than 10%, including stair steps
- Obstacles and challenge to be expected
- Turns will be switchbacks
- May not be suitable or enjoyable for horses or bikes

Type 1 - Route Only

- Narrow trail or route
- Narrow single-file travel
- Natural tread
- Obstacles frequent or continuous
- Overhangs, water, or steep exposure may be present
- Boulders or tunnels may be present
- Route may not be constructed
- Grades may be steeper than 25%

Table 6-2. Trail Type Classifications

Trail Type	Tread Width	Trail Corridor	Surface	Average Grade*	Max Grade*	Outslope (soil)	Turn Radius	
							Climbing	Switchback
Type 4 Shared Multi-use	1-way: <8' 2-way: 12-20'	12-16' (w) 12'-15' (h) 22' (w) 12-15' (h)	Native soil and rock	</= 5%	10%	2-5%	15-20 ft*	>/=10 ft
Type 3 Shared NM	24"-48"	4-8' (w) 10-15' (h)	Native soil	</= 5%	15%	3-8%	7-15 ft	3-8 ft
Type 2 Bicycle	12"-36"	2-6' (w) 6-8' (h)	Native soil and rock	</= 10%	25%	3-8%	> 7 ft	2-8 ft
Type 2 Horse	8"-30"	4-8' (w) 12-15' (h)	Native soil	</= 5%	15%	3-8%	> 10 ft	3-8 ft
Type 2 Hike	18"-36"	3'-5' (w) 7-8'- (h)	Native soil and rock	</= 8%	25%	3-8%	> 7 ft	2-8 ft
Type 1 Route or Foot path	6"-30"	Varies by terrain	Native soil and rock	varies	25%	N/A	N/A	N/A

* Grades may exceed recommendation over rock surfaces.

Mountain Bike Difficulty Range Classifications

Ratings are based on the IMBA Trail Difficulty System and symbols adopted from the National recreational symbol standards used on most federal lands. The ratings categorize the technical challenge as well as the physical exertion of a trail user. Ratings are relative to the Mammoth region and may not represent similar ratings in other areas where soils and terrain differ.

Symbol: White Circle **Rating**: Easiest

Semi-improved (i.e., compacted gravel) or natural surface that is generally firm and stable. Trail grades average 5% or less with a maximum trail grade of 10%. No unavoidable obstacles should be present. Typically associated with Trail Types 4 and 3

Symbol: Green Circle **Rating**: Easy

Semi-improved (i.e., compacted gravel) natural surface that is generally firm and stable. Trail grades average 5% or less with a maximum trail grade of 15%. May have unavoidable obstacles three inches tall or less and taller avoidable obstacles. Typically associated with Trail Types 4 and 3

Symbol: Blue Square **Rating**: Moderate

Stable natural surface that has some avoidable rocks and roots embedded. Soils may be loose around corners. Trail grades average 10% or less with a maximum trail grade of 20% or greater. Unavoidable obstacles eight inches tall or less and taller avoidable obstacles may be present. All obstacles are rollable. Typically associated with Trail Types 3 and 2

Symbol: Black Diamond **Rating**: Difficult

Widely variable natural surface trail with roots, rocks, or built features. Soils may be loose around corners and at grades steeper than 8 %. Trail grades average 10-15% or less with a maximum trail grade of 20% or greater. There can be unavoidable obstacles fifteen inches tall or less and taller avoidable obstacles. Steep drop-offs, tight turns, low over-hangs, and other conditions may exist. Trail Type 2 only.

Symbol: Double Red Diamond **Rating**: Extreme

Widely variable natural surface trail with obstacles and hazards such as roots, rock, build features, steep drop-offs, tight turns, and over-hangs. Soils may be loose and rutted. Trail grades average 15-20% or more with a maximum trail grade of 25% or greater. Risks exceed difficult due to height, narrow widths, and exposure. Trail Type 2 or 1.

Range of Difficulty Specifications by User

Not all rating categories are specified by user. The Easiest category is easiest for all users.

Table 6-3. Trail Type Specifications - Bicyclist

Skill Level	Tread Width	Trail Corridor	Average Grade – Soil*	Max Grade – Soil*	Outslope (Soil)	Turn Radius*	Skill Level
Easy	30" or more	4' (w) 8' (h)	</= 5%	8%	</= 2"	3-5%	>/=5'
Moderate	18" or more	3' (w) 8' (h)	</= 8%	10%	</=8"	3-8%	>/=3'
Difficult	12" or more	3' (w) 6' (h)	</= 8%	12%	</=15"	3-8%	>/=2'
Extreme	6" or more	2' (w) 6' (w)	</=10%	20%	>/=15"	3-8%	>/=2'

Table 6-4. Trail Type Specifications - Equestrian

Skill Level	Tread Width	Trail Corridor	Average Grade – Soil*	Max Grade - Soil	Outslope (Soil)	Turn Radius
Easy	36" or more	6' (w) 12' (h)	</= 5%	10%	3-5%	>/=6'
Moderate	18" or more	6' (w) 12' (h)	</= 8%	10%	3-8%	>/=5'
Difficult	12" or more	4' (w) 10' (h)	</= 8%	12%	3-8%	>/=5'

Table 6-5. Trail Type Specifications - Hikers

Skill Level	Tread Width	Trail Corridor	Average Grade – Soil*	Max Grade – Soil*	Outslope (Soil)	Turn Radius*
Easy	30" or more	4' (w) 8' (h)	</= 5%	8%	3-5%	>/=3'
Moderate	24" or more	3' (w) 8' (h)	</= 8%	15%	3-8%	>/=2'
Difficult	12" or more	3' (w) 7' (h)	</= 12%	25%	3-8%	>/=2'

* Grades may exceed recommendation over rock surfaces.

Trail Routing Specifications by Soil Type

The Mammoth region has unique soil characteristics that present particular trail development challenges. To mitigate potential undesirable environmental impacts additional guidance is necessary to assure that each trail is located in the correct soil to sustain the proposed Trail Management Objective (TMO).

Pumice, which acts similar to sand in that it is more stable when wet than dry, is dominant in much of the local soil profile. Because Mammoth is a dry region, close attention to trail placement and routing will be required to assure trail TMO's are met. The presence of pumice can make even gentle grades difficult for all users to navigate in dry conditions. The guidelines and chart below should be used in conjunction with Trail Type and Difficulty Classifications to place the correct trail in the proper location. Note that only dominant and relevant soils are analyzed in this section.

Soils and Erosion Control

Evaluation of soils types, topography and drainage patterns should be used to inform trail routing and design to minimize erosion and potential runoff impacts to stormwater systems and adjacent water bodies. Best Management Practices for erosion control, both during construction and operation of the trails should be implemented to minimize potential impacts.

Average and Maximum Grade

Understanding average and maximum trail grades is critical to developing sustainable trails, as it provides the basis for a trail alignment that will minimize maintenance and meet the needs of users for a predictable tread. For this section, average and maximum grades refer to the sustainability of soil-based trails, both in their resistance to user- and water-based erosion.

The first component of determining an appropriate trail grade is The Half Rule. This concept states that for most soils the trail grade should not exceed half the grade of the sideslope that it traverses. Any alignment that does not conform to this standard is considered to be a fall-line trail and will funnel water down the tread, resulting in accelerated water-based erosion. On well-draining soils (such as sand), it is acceptable to create a trail that does not abide by this alignment criterion, but only in situations where the terrain is flat or nearly flat. Trails that travel through flat terrain with well-draining soils should incorporate frequent gentle turns, to slow speeds and provide a more stimulating user experience.

The Average Grade Guideline is the sum elevation gain/loss over the entire length of a climbing or descending trail segment, divided by the length of the segment. This average should not exceed the recommended average grade per soil type.

The Maximum Sustainable Grade is the steepest individual section of trail on the native soil. This grade will vary by soil type, with more cohesive soils, such as clay, sustaining steeper maximum grades while less cohesive soils, such as dry pumice, sustaining only the shallowest of grades. To minimize trail erosion the maximum grade for a trail segment on native soil should not exceed 200 linear feet.

Map 6-1. Mammoth Lakes Regional Soils

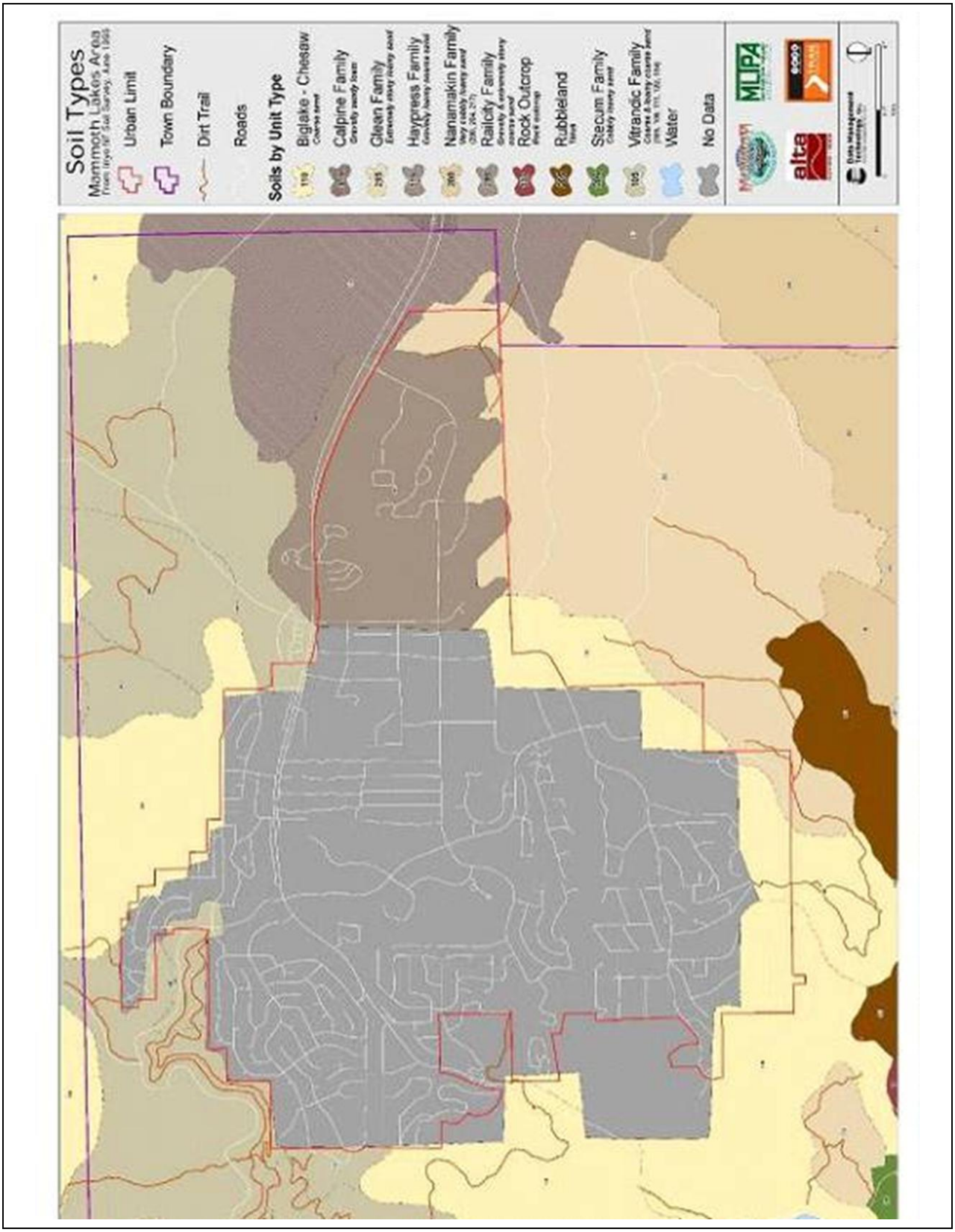


Table 6-6. Trail Specifications by Soil Type

USGS Soil Type	Soil Properties	Average Grade	Maximum Grade	Grade Reversals	Armoring Requirements
105/106/111/122/154 Vitandic Family	Course and loamy sand, weak structure, rapid permeability, high erosion hazard	5%	15%	Knick	Armor all turns using composite technique Surface all grades over 7%
110/108 Biglake-Chesaw	Course sand, weak structure, very rapid permeability, moderate erosion hazard	7%	20%	Rolling grade dip	Flagstone armor grades over 15% Stone pitch grades over 25%
117 Rock Outcrop-Rubble Land Complex	Continuous bare bedrock and detached rock talus. Talus is weak and subject to landslides	Construction not advisable on talus slopes. No max grade for rock. May route on fall line.			
116 Haypress Family	Gravelly loam course sand, moderate structure, rapid permeability, low erosion hazard	10%	25%	Rolling grade dip	Flagstone armor grade dips with an entry greater than 15% Stone pitch grades over 25%
205 Rubbleland-Nanamkin	Talus slopes and moraine sideslopes, weak-loose blocky structure, rapid permeability, moderate to high erosion hazard	5%	15%	Knick	Armor all turns using surfacing and grade reversal approach
215 Glean Family	Extremely stony loamy sand, loose, moderate permeability, low-moderate erosion hazard	10%	25%	Rolling grade dip	Flagstone armor grade dips with an entry greater than 15% Stone pitch grades over 25%
216 Railcity	Gravelly and extremely stony course sand, weak structure, rapid permeability, low erosion factor	10%	25%	Rolling grade dip	Flagstone armor grade dips with an entry greater than 15% Stone pitch grades over 25%

Trail Design Considerations

Sustainable Trails Discussion

A sustainable trail balances many elements. It has very little impact on the environment, resists erosion through proper design, construction, and maintenance, and blends with the surrounding area. A sustainable trail also appeals to and serves a variety of users, adding an important element of recreation to the community. It is designed to provide enjoyable and challenging experiences for visitors by managing their expectations and their use effectively.

Adhering to the following trail design and construction guidelines for the Mammoth region will allow for a high-quality recreational experience for trail users while protecting the natural beauty and environmental integrity of the region.

Preferred Use

While many trails are managed as open to a variety of user types, construction and maintenance guidelines should follow those specified for the preferred use. Typically, the preferred use for a trail will be the use type that requires the highest level of construction and maintenance.

Trail Management Objectives

Establishing a TMO prior to designing or constructing a trail will assure that it meets the overall goals of the plan and adheres to the highest principals of sustainability.

Best Routing Location (BRL) Principals

BRL for the preferred user(s) and environmental sustainability are as follows:

Environmental Considerations

- Avoid wet meadows and wetlands.
- Avoid hazardous areas such as unstable slopes, cliff edges, faults, crevasses, embankments and undercut streams, and avalanche prone zones (in the winter).
- Avoid sensitive or fragile historic sites.
- Avoid trail routing that encourages shortcutting. Use natural topography or features to screen short cuts.
- Avoid routing trails too close to other trail systems to minimize trail proliferation and user conflict.

Mountain Bike Trails

- Type 2 trails should be located in steep and rugged terrain or in remote areas of varied topography.
- Type 3 and 4 trails may be located on existing or old road grades where standards are not exceeded.

Equestrian Trails

- Type 2 equestrian trails in the Mammoth region should be located on primarily flat loose soils, where user impacts will be lessened and encounters with incompatible users can be minimized through reduced speeds and good sightlines.
- Equestrian use should be supplemented with connecting Type 3 and 4 trails located on existing or old road grades where standards are not exceeded.

Hiking Trails

- Type 1 trails should be located in drainages where terrain is not suitable for other uses.
- Type 2 trails should be located on sideslopes and in canyons where there is the greatest opportunity for elevation gain.
- Hikers are drawn by destinations (views, peaks, interpretive sites) so focus trail routes on these special landscape features.
- Type 3 and 4 trails should be located to provide short walks to a main destination accessible by users of all abilities.

Trail System Configurations

Out-and Back Trails

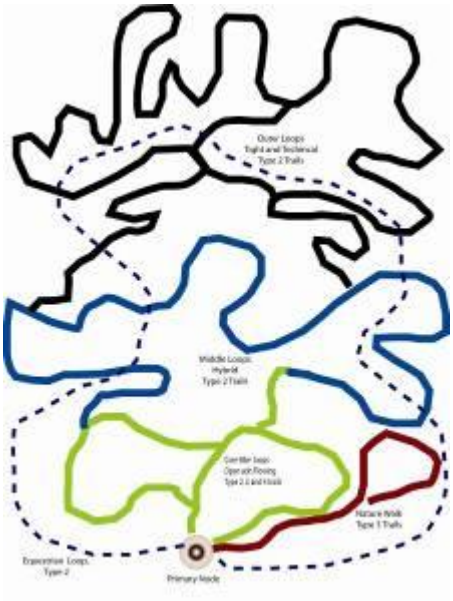
Wherever possible, trails should be designed as loops, or connect with other segments to provide a looping experience. Out-and-back trails are appropriate to sensitive interpretive sites or short distances to other key destinations. Hikers, more than other groups, enjoy out and back trails. These trails are best when managed as preferred for hiking only and routed in areas where topographical constraints prohibit looping, such as in a drainage or canyon.

Open Connecting Trails

This type of trail is most suited to Mammoth's current trail management practices. This system works to assure that various trail types and styles connect at key nodes so that a trail user can "mix and match" various pieces to create their own experience. This system works well when the management goal is to get the most use out of a few trails in a limited region.

Closed System Trails

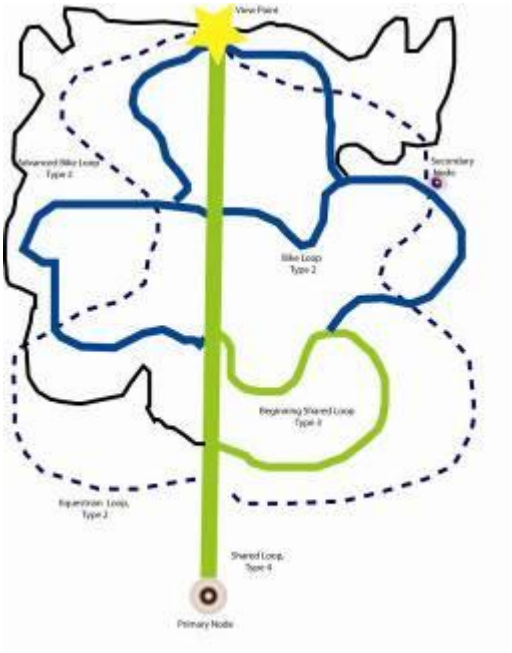
A closed system is one that utilizes one primary node, usually a major trailhead or portal to access a system of trails that all loop back to that primary node. This system usually has topographic, land ownership, or jurisdictional constraints that confine it one specific region. To maximize a trail system, trail segments should be intersecting and progressive. The easiest trails should be located near trailheads and the most difficult trails should be located in the more remote regions. More difficult trails may be longer in distance or more rugged. Technically challenging Type 2 trails should be bisected by Type 3 to 4 trails every three to five miles whenever possible for emergency access or egress. These systems work best for bike and equestrian trails, but can have a secondary nature walk or long distance hike that begins at the same node.



Stacked Loop System

A stacked loop system is a series of interconnecting loop trails that get progressively harder as the trail moves away from the primary node. This system also works well for separating uses that share the same primary node. A great example of this type of system is Fantasy Island Trail in Tucson, Arizona.

Inter-Connecting Loop System



An inter-connecting loop system usually starts with a shared use Type 3 or Type 4 trail as its backbone. Small loop trails branch off and interconnect with the spine of the primary trail at various points along the way. This system usually has a primary node and one or more secondary access points. This type of system allows for users to customize their outing to their ability, energy level, and timeframe. The layout and design of this system usually aims to get all users to a common node, viewpoint, or special feature. A great example of this type of system is Utah's Gooseberry Mesa National Recreation Trail.

Special Systems

Special-use bike parks, also known as terrain parks, skills parks, or challenge parks, can provide a new riding experience in a central, easily managed location. While bike parks come in different shapes and sizes, they share the common thread of helping make mountain biking more readily available to the public—especially kids. These parks usually accommodate a wide range of abilities, with opportunities for skill building and progressively difficult challenges. Bike parks typically include natural and man-made terrain and a compact trail system.

Bike parks do much more than mimic terrain found in nature. They also offer unique obstacles that stretch the imagination. They're typically not a replacement for traditional trails. Rather, they serve as an additional place to ride that is more convenient and controlled. The following guidelines are not a substitute for a professional bike park design, but provide ideas to help the Town decide which type(s) of these special parks are most appropriate to pursue.

Terrain Park

Terrain parks utilize soil to build obstacles in various sizes and shapes, including dirt jumps and pump tracks, with a predictable layout that still provides an exciting and challenging experience. Features frequently include all types of jumps, including tabletops, semi-tabletops, step-ups, and hips. The park should be designed on a slight downhill grade or with a roll-in ramp so that riders will not have to pedal excessively or brake between jumps. Sufficient space should be provided to allow a clear, smooth area to the sides of jumps for missed landings, and also for a corridor for riders to return to the beginning without riding too close to the jumps.

Because the park is constructed of soil the cost of development can be low, although a soil amendment may needed depending on local conditions. The ease with which the soil can be worked also means that features and challenges can be changed each year as the sport progresses. This type of park could also serve as a snow play park for young children in the winter.

Skills Park

Skills Parks incorporate engineered structures like ladder bridges, wooden ramps, skinnies, teeters, and drops. These structures often require artificial materials such as processed lumber and fasteners. Aim for linking features so riders flow immediately from one feature to the next. For many mountain bikers, skill improvement is a big reason they ride. Managers should try to provide stunts of various difficulty levels. Riders love multiple stunts of different difficulty in the same park and they'll return many times to master their skills. These parks can be developed in a relatively small parcel of land or at a trailhead for a larger trail system.

Skills Park Considerations:

- Each feature should be designed and constructed to withstand the assumed forces placed upon it by a user. Horizontal and lateral loads should both be considered.
- Features should have a clear fall zone around them.
- Materials and construction practices should be employed that will minimize the likelihood of rot and subsequent structural failure.
- An inspection and maintenance policy should be employed to ensure that features remain free of hazards.
- Routine modifications ensure that the design of the park is upgraded to keep it interesting.

Challenge Parks

Challenge parks mix natural and built features in a large area to create a truly unique experience for riders to develop their skills. Challenge Parks require a greater amount of land to form various loops that progress in difficulty.

6.6.2. Trail Construction Guidelines and Standards

Basic Terms and Definitions

Contour Trail

A trail designed in a manner where its grade does not exceed half the grade of the surrounding sideslope. This is counter to a fall-line trail (see below).

Fall-Line Trail

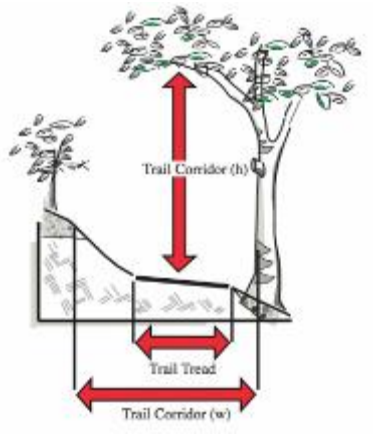
Any trail where the grade of the trail exceeds half the grade of the sideslope of the surrounding terrain (for example, a 25% trail grade on a 30% sideslope). On a fall-line trail water travels the length of the trail instead of sheeting across the tread, accelerating erosion.

Grade

The steepness of a trail, measured by rise-over-run.

Natural-Surface Trail

A tread made by clearing, grading, and compacting the native soil with no outside foreign material imported for stabilization.



Trail Corridor

An area that is maintained clear of obstacles and debris to allow users to travel freely and safely. Dimensions vary based on the anticipated user. The width includes the tread, the out-slope, the back-slope, and any additional clearance requirements. The height dimension is measured from the ground surface upwards.

Tread

The actual portion of a trail upon which users travel.

Technical Trail Feature (TTF)

An obstacle placed on the trail specifically to enhance technical challenge. The feature can be either man-made or natural, such as an elevated bridge or a rock face. Also referred to as "technical features" or "features."

Grade Reversals

A grade reversal is an undulation within the trail tread: a short dip followed by a rise. This grade change in the tread catches water at the low point and diverts it off the trail. Grade reversals are the preferred erosion prevention technique. They are friendly to all users and require little maintenance once installed. When not incorporated into the original construction of the trail, there are two techniques available to retrofit them into the tread:

Knick:

In soils with a high displacement factor, a grade reversal should be accomplished by removing a wedge of soil to create a dip in the tread.

Rolling Grade Dip:

This technique uses the soil excavated from the low section of a trail to build up the entrance and exit to the dip. Ideally dips use natural features, such as trees or rocks, as landscape anchors.

Water Bars:

Water bars are an old fashioned technique for preventing soil erosion. They are usually installed to correct erosion problems on a trail that is traveling the fall line. This technique needs a lot of maintenance, causes trail hazards for all users, and requires a lot of labor to install. With proper trail design and the use of grade reversals, this technique should rarely be needed in the Mammoth region.

Elevation Gaining Techniques

Climbing Turn:

A turn used to change direction that does not have a constructed platform or landing. The upper and lower legs of a climbing turn are joined by a short section of trail (the apex) that lies in the fall line. Water is shed to the inside of the trail turn. Climbing turns may be used where sideslopes are moderate and foot traffic will be minimal. Berming of turns may be

appropriate on preferred mountain biking trails where there is adequate drainage control prior to the turn.

Stairs:

Stairs built of rock or wood are used to gain elevation quickly or where a contour trail is not possible because of environmental constraints. Stairs should be used only when all users are expected to travel by foot.

Switchback:

A technique for moving a trail up steep side slopes. The transition is made by way of a flat landing or pad. A correct switchback will shed water off the back of the landing, and there is an immediate separation of trail segments.

Stabilizing Techniques

These techniques can be employed to address several situations:

- To reduce erosion along trail segments where alignment exceeds guidelines
- To stabilize tread that is routed on unstable pumice soils
- To provide technical challenge
- To slow riders before an intersection, technical challenge, or other situations of flow transition

Flagstone Paving

Large, flat-faced stones are placed directly on a mineral soil base or an aggregate foundation (a mixture composed of sand, gravel, pebbles, and small rocks, which is devoid of organic material). Each stone's largest and smoothest face is placed up, at-grade, to form the tread surface. This is the most common and simple armoring technique. Rocks may need to be imported from outside the area to make this technique viable.

Stone Pitching

This is an ancient road-building technique in which medium-sized rocks are set on end, or "pitched" up on their side. The stones are hand-fitted tightly together, with aggregate packed into the gaps to tighten the construction. Think of a book in a bookshelf—only the spine is showing and the rest of the book is hidden. Small rocks for this technique should be locally available, however they may have to be collected and transported from an area away from the project site.

Surfacing

Surfacing is a technique where stabilizing soils or additives are brought in to give a trail better cohesion. Surfacing can be done on a whole trail or on a select part that is more prone to erosion, such as turns and corners. Bringing in heavy clays mixed with stones can help to stabilize Mammoth's pumice soils.

Reinforcement of Turns

Mammoth soils are particularly susceptible to erosion in climbing turns. Reinforcement needs are directly associated with the speed of the rider and the displacement factor of the soil. Reinforcing a turn should be done by combining grade reversals and armoring techniques through the turn. In the worst soils armoring should be employed both in the approach and exit of the turn. Using a surfacing technique combined with in-slope berming at the apex of the turn should be utilized to avoid displacement of soils.

6.6.3. Winter Trails

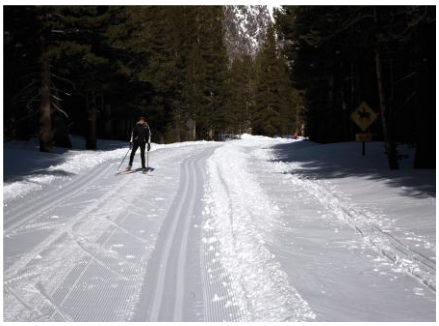
Winter Trail Types:

The major winter trail types found in the Mammoth region are listed below. Not all trail types are feasible for the Town or the USFS to manage, but the following descriptions can aid in deciding which trails are most suitable for Town management and which are better managed by others (USFS or non-profits).

Ungroomed/Unmarked

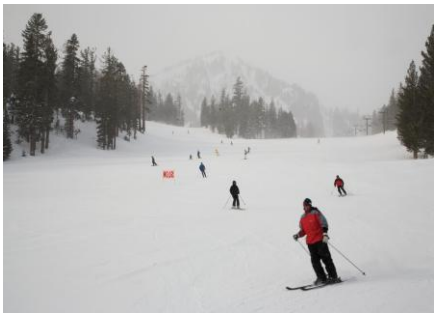
- Users: Backcountry skiers, backcountry boarders, Nordic skiers, snowshoers, sledders, hikers, snowmobilers
- Terrain: Varied
- Evidence of management: Minor
  - Portal signs, place markers
- Infrastructure: Minimal
  - Portal access
- Maintenance: None

Nordic / Skate Ski



- Users: Traditional cross-country skiers and skate skiers
- Terrain: Gentle and rolling
- Evidence of management: Moderate to heavy
  - Portal signs, place markers, assurance signs, directional signs, regulatory signs, fees and passes
- Infrastructure: Moderate
  - Trailhead parking, existing roads and trails
- Maintenance: Grooming, track setting, signage

Alpine



- Users: Downhill skier, snowboarders
- Terrain: Sloping to steep
- Evidence of management: Heavy
  - Portal signs, place markers, assurance signs, directional signs, regulatory signs, fees and passes, patrols
- Infrastructure: Major
  - Parking lots, lifts, lodges, medical facilities
- Maintenance: Grooming, signage, snowmaking, lifts, facilities

Over-Snow Vehicle

- Users: Snowmobilers
- Terrain: Gentle and rolling
- Evidence of management: Moderate to heavy
  - Portal signs, assurance signs, directional signs, regulatory signs, fees and passes
- Infrastructure: Moderate
  - Trailhead parking, existing roads open to motorized travel
- Maintenance: Grooming, signage

Shared Multi-Use

- Users: Walkers, dog walkers, nordic skiers, snowmobilers, snowshoers
- Terrain: Flat to rolling
- Evidence of management: Minor to moderate
  - Portal signs, assurance signs, directional signs, regulatory signs
- Infrastructure: Minimal
  - Trailhead parking, existing roads
- Maintenance: Plowing, signage

Nordic System Classifications

These standards and guidelines were developed in cooperation with Mammoth Nordic and apply directly to current and future winter trails grooming in the Mammoth region.

Type 4 – Shared Multi-Use

- Suitable to share non-motorized or motorized
- Tread 15' to 20'
- Can provide two-way groomed tracks
- Groomed trail with corduroy and Nordic tracks
- Grades less than 5%
- Good sightlines throughout
- Clearances and turning radius to accommodate all users

Type 3 – Shared Nordic/Skate

- Tread 9' to 12'
- Allowance for passing
- Groomed trail with Nordic tracks on right side
- Best if managed for preferred use of skiers
- Grades less than 5%
- Clearances and turning radius to accommodate novices and children

Type 2 – Preferred Snowshoe/Hiking

- Tread 24' to 36"
- Machine groomed corduroy
- Packed surface
- Supports dog walking
- Grades may occasionally be steeper than 10%

Type 2 – Preferred Nordic

- Tread 12" to 18"
- Corridor width 5' to 6'
- May be machine groomed or user-tracked
- Grades may occasionally be steeper than 10%
- Supports more advanced trails

Type 1 – Route Only

- Narrow trail or route
- Single-file travel
- User created tread
- Tread 6" to 30"
- Route may not groomed or maintained
- No removal of trees to create route
- Grades may be steeper than 25%
- Minimally signed with assurance markers only

Table 6-7. Winter Trail Type Classifications

Trail Type	Tread Width	Trail Corridor	Surface	Average Grade	Max Descending Grade	Max Climbing Grade	Turn Radius
Type 4 Shared Multi-use	1 or 2-way Nordic: 15-20'	18-25' (w) 10' (h)	Groomed Tracks and Corduroy Snow	</= 5%	10%	8%	>/=20 ft
Type 3 Shared Nordic/Skate	1-way Nordic: 9-12'	12-15' (w) 7'-9' (h)	Groomed Tracks and Corduroy Snow	</= 5%	15%	10%	>/=15 ft
Type 2 Snowshoe/Hiking	36-48"	5-6' (w) 6-8' (h)	Groomed Corduroy or Packed Snow	</= 10%	20%	20%	2-8 ft
Type 2 Classic Nordic	12"-18"	5-6' (w) 6-8' (h)	Groomed or Trekked-in Tracks	</= 10%	15%	20%	8-15 ft
Type 1 Route	12"-30"	2-4' (w) 6-8' (h)	Power or packed Snow	varies	N/A	N/A	N/A

6.7. Easements

Where required for public access or trail/pathway development, the minimum easement width shall be 20 feet when feasible. Such width will be minimally sufficient for access/egress, pathway surfacing, variation in pathway alignment, amenities, and/or landscaping.

Design Guidelines References:

Alternative Treatments for At-Grade Pedestrian Crossings, ITE
California Manual on Uniform Traffic Control Devices (CA-MUTCD), Caltrans
Guide for the Development of Bicycle Facilities, 3rd Edition, AASHTO
Guide for the Planning, Design and Operation of Pedestrian Facilities, AASHTO
Manual on Uniform Traffic Control Devices (MUTCD), FHWA
Highway Design Manual (HDM), Caltrans
Public Works Standards, TOML
Trail Solutions, IMBA

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