



## **4.0 DESIGN GUIDELINES - Development**

This section provides direction to those who will be constructing trails in the future. The contents are technical, providing facility types and locations, construction methodologies and defining guidelines by which Sault Ste. Marie cycling routes can be enhanced.

### **4.1 Route Considerations**

#### **4.1.1 Cycling Facility Types**

For the Sault Ste. Marie Cycling Master Plan Route, cycling facilities have been divided into three main facility types:

- Bike Lanes
- Paved Shoulders; and
- Shared Roadway Facilities

In addition, the Cycling Route will also include multi-use trails and retrofitting of existing roadways.

#### **4.1.2 Spoke Routes and Connecting Cycling Links**

**Spoke Routes** will consist of cycling facilities designed to provide direct connections and access to primary, secondary, and retail / commercial destinations, as well as employment areas throughout Sault Ste. Marie. Stemming from the Hub Trail, the spokes will connect to areas located outside and inside of the Hub perimeter loop providing travel routes for both frequent utilitarian (commuter) and recreational cyclists.

The proposed spoke routes will consist primarily of on-road bike lanes, paved shoulder bikeways and some linear off-road multi-use trails. The cycling facilities encompassing the spoke routes would be located mainly on arterial roads to serve as a “higher-order” cycling network geared towards more experienced and confident cyclists. However, the spoke route may also include segments of signed-only cycling routes and wide curb lanes.

**Connecting Cycling Links** will provide ties between local destinations in a specific neighbourhood and “feed” into the spoke system. Connecting cycling links will be designed to serve both utilitarian and recreational cyclists. Routes along this system may be less direct than the spoke system routes, and take advantage of quieter streets, providing links to local destinations such as schools, community centres, residential areas, local stores and commercial nodes, parks and recreational areas. The connecting cycling links also provide an alternative to the spoke system for longer-distance trips or primarily recreational cyclists who simply prefer a quieter cycling environment.

The connecting cycling links would consist primarily of signed-only routes on local residential streets and wide curb lanes as well as off-road multi-use trails; however, bike lanes and paved shoulders may comprise minor segments of the connecting cycling links.

Design standards associated with cycling facilities, spoke routes and connecting cycling links are subject to site conditions, location, potential level of use and appropriate surface materials. The following outlines the recommended design parameters for cycling facilities in the City of Sault Ste. Marie.



## 4.2 Design Parameters

### 4.2.1 General Considerations

Bicycles are distinct from other modes of transport and are typically the lightest and smallest vehicles on the road network. To assure safety and comfort, the design of cycling facilities should account for the minimum amount of space required by a moving cyclist.

The Transportation Association of Canada's (TAC) *Geometric Design Guide for Canadian Roads* (1999) suggests that for design purposes the following dimensions of a bicycle should be used:

- length, 1.75 m
- width at pedals, 400 mm
- height to lowest pedal position, 100 mm
- width at handlebars, 800 mm
- height to handlebars, 1.25 m
- height to top of seated rider, 2.0 m

The operating envelope for a cyclist consists of the actual space occupied by a bicycle and cyclist, typically 0.7 m wide by 2.0 m high. It includes an operating space allowance to accommodate the natural side-to-side movement of a cyclist plus variations in bicycle tracking. The amount of manoeuvring space, varying from 0.1 m to 0.4 m on each side of the bicycle footprint depends on the cyclist's driving skill, the type of vehicle being operated and the travelling speed. The essential manoeuvring space for design is 0.2 m on each side of the bicycle in order to maintain *balance*<sup>1</sup> while the preferred width is 0.4 m on each side plus 0.5 m above the cyclist.

Considering that additional space is required to prevent handlebars from touching walls, railings, other bicycles, etc., and to give cyclists the manoeuvring space they need to avoid obstacles, pass slower riders and to steer clear of oncoming bikes, a preferred bike lane width of 1.5 m is recommended for low speed (<60 km/h), moderate traffic volume roadways. Although providing for the operating envelope for a cyclist is always recommended, it cannot always be achieved. In constrained conditions, such as on low speed, low to moderate traffic volume roadways, an absolute minimum 1.2 m bike lane may be applied for short distances. For higher speed, higher volume multi-lane roads, a width of 1.8 m is recommended. Bike lanes in excess of 1.8 m for one-way are undesirable as they encourage riding two abreast and also may be mistaken for a motor vehicle lane<sup>2</sup>.

Since two cyclists passing each other in opposite directions benefit from a shared central manoeuvring allowance, the minimum recommended operating space allowance for two-way traffic is 2.2 to 2.5 m. This is one of the reasons why cycling on standard width sidewalks of 1.5 m should not be permitted or encouraged. Figure 4.1 illustrates the recommended design dimensions that define the operating space for cyclists.

To design cycling facilities, it is important to understand that geometric design considerations such as width, clearance heights and sight lines for on-road bicycle routes are typically governed by roadway design criteria. In Ontario, the Ministry of Transportation's (MTO) *Geometric Design Standards for Ontario Highways* (GDSOH, 1994) and TAC's *Geometric Design Guide for Canadian Roads* (GDGCR, 1999) are the primary provincial references for roadway design.

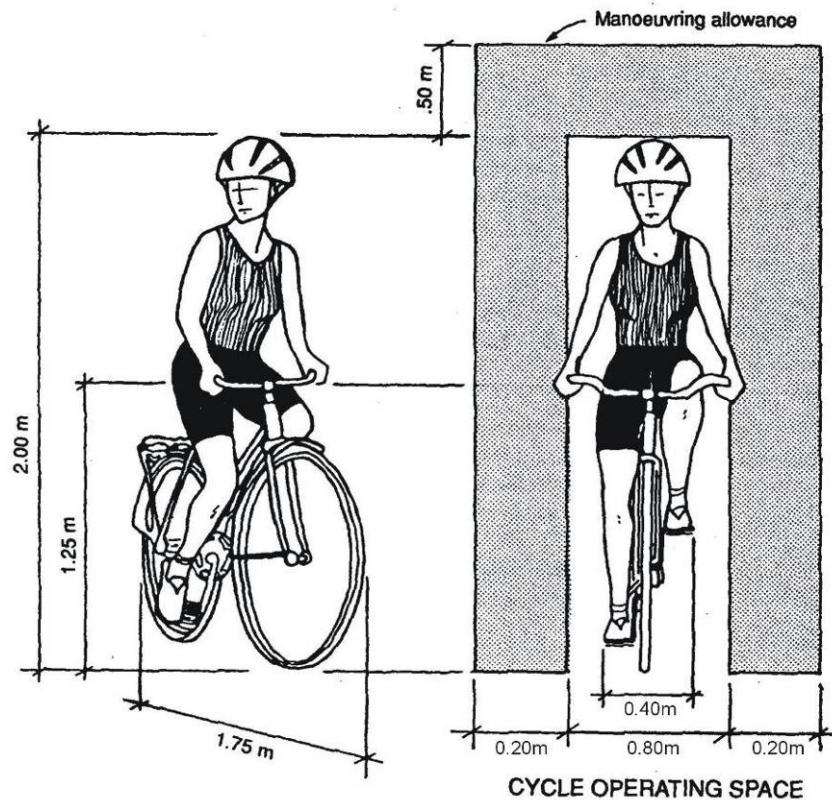
---

<sup>1</sup> Vélo Québec, Technical Handbook of Bikeway Design, 2<sup>nd</sup> Edition, 2003.

<sup>2</sup> Ministry of Transportation (MTO), Ontario Bikeways Planning and Design Guidelines, 1996.



Figure 4.1: Operating Envelope for Cyclists



Source: Revised from Community Cycling Manual, June 2004

Although roadway design standards typically exceed the requirements for on-road cycling facilities, the operational aspects for on-road cycling must be understood. Off-road cycling facilities such as multi-use pathways outside of a road right-of-way should be designed to accommodate cyclists and other trail users of all skill levels and ages, and should be designed in a way to maximize the user's security and personal safety. Key design parameters for off-road cycling routes include bicycle operating speeds, horizontal and vertical curvature, width, clearances, gradients, sight distances, superelevation, cross slope and drainage. Key elements associated with off-road trail safety measures include location, landscaping, surveillance and lighting.

The following sections in this Chapter discuss typical on and off-road bicycle route design considerations. The guidelines and practices that follow are intended to assist the City of Sault Ste. Marie in meeting this responsibility. However, as noted by TAC: "the bicycle is a distinct vehicle, which is often used in locations of substandard geometrics. In such cases, providing suitable warning signs along bicycle routes is a significant consideration in maintaining safety."<sup>3</sup>

**Guideline:**

**4.1:** Provide an operating envelope design width of 1.8 m wide x 3.0 m height for a cyclist on one-way routes and 2.5 m x 3.0 m on two-way routes.

<sup>3</sup> Transportation Association of Canada (TAC), Geometric Design Guide for Canadian Roads, 1999, p. 3.4.5.1.



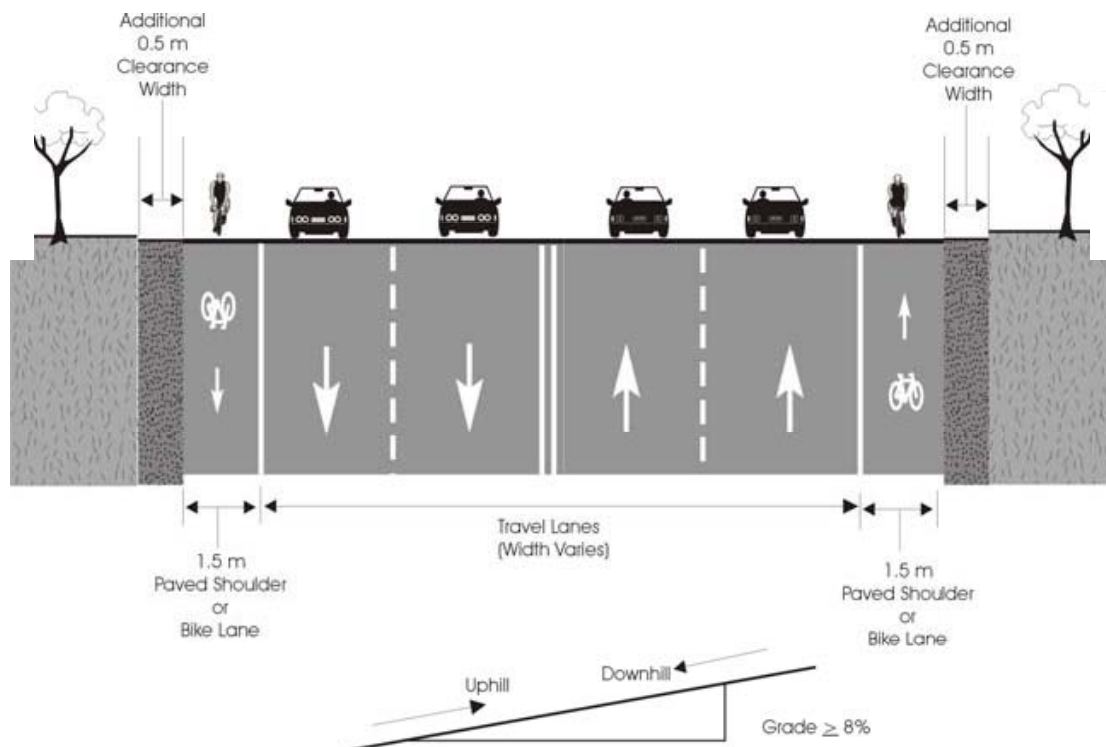
#### 4.2.1.1 Gradients

Recreational and touring cyclists prefer moderate variations in topography (rolling hills) when cycling. However, most utilitarian cyclists prefer to ride on relatively flat routes to avoid climbing hills. When hills must be climbed, cyclists tend to require a wider operating area to accommodate the increased side-to-side movement or ‘wobble’ that often occurs when exerting the additional effort necessary to power up a hill.

#### *On-Road*

For paved shoulders or bike lanes, an additional clearance width of 0.5 m should be added where feasible to the side of the 1.5 m paved shoulder or bike lane on steep hills with grades exceeding 8%. Figure 4.2 illustrates this scenario.

Figure 4.2: Example of On-Road Cycling Facilities on Steep Grades



On steeper grades, additional width is recommended in order to allow cyclists extra manoeuvring space to make corrections to their trajectory when descending downhill at higher speeds, or to accommodate cyclists who may weave from side to side in order to maintain balance when ascending uphill at lower speeds. It is not necessary to widen cycling facilities (e.g. bike lanes) on grades shorter than 75 m or less than 6%. Table 4.1 provides a guideline on the extra cycling facility width that may be required on grades as a function of steepness and length.



Table 4.1 – Extra Cycling Facility Width Required on Grades

Grade %	Length, m		
	25-75	75-150	150+
3-6	-	20 cm	30 cm
6-9	20 cm	30 cm	40 cm
9+	30 cm	40 cm	50 cm

Source: Technical Handbook of Bikeway Design, 2nd Edition, Vélo Québec, 2003

In locations where grades exceed 8%, applying the preferred guideline may not always be possible because of constraints in the existing right-of-way (ROW) width. Opportunities to widen the ROW to accommodate a paved shoulder / bike lane with the additional clearance recommended to suit the road grade may be limited because of a number of factors, including existing geography, property ownership, environmental concerns and cost. An alternative approach is to select a parallel route that, although less direct, is better suited to accommodate a cycling route.

If selection of a parallel route is not an option, a combination of edge lines and motor vehicle passing prohibition (descent) and *Share the Road* (ascent) signs should be considered. For instance, in the City of Sault Ste. Marie there may be segments of proposed cycling routes where it is difficult to accommodate even a minimum 1.2 m paved shoulder or bike lane. In these cases, and only on rural cross-section roads, edge lines (pavement markings) should be provided to mark the vehicle travel lane width and to delineate as much additional shoulder or “lane” width as possible for cyclists to use (if they choose to use the shoulder instead of cycling with traffic in the travel lane). On roads where sight lines are also an issue because of the horizontal or vertical curvature of the road, additional cautionary signs may be warranted to restrict passing manoeuvres.

The TAC Guideline to address these conditions is to post a *Motor Vehicle Passing Prohibited* sign (RB-33) and a *Do Not Pass Bicycle* tab sign (RB-33S) to warn motorists that they must not overtake a cyclist within a specified zone. These signs are illustrated in Figure 4.3. When a no passing zone is specified, the termination of this zone should also be specified by use of a *Motor Vehicle Passing Prohibited* sign with the supplementary *Ends* tab sign.<sup>4</sup>

Figure 4.3: No Passing Sign



RB-33 (600 mm x 600 mm)



RB-33S (600 mm x 300 mm)

<sup>4</sup> TAC, Bicycle Route Traffic Control Guidelines for Canada, 1998, Section 3.5, p.16.



In addition to the City of Sault Ste. Marie adopting this TAC guideline, it is also recommended that on the ascent (up-grade) direction of these same road segments that *Share the Road* signs, as illustrated in Figure 4.4, be posted along with bicycle route markers.

Figure 4.4 “Share the Road” Signing



In locations where cyclists will be traveling in the downhill direction, steeper or longer grades are not as much of a concern. It should be recognized, however, that speeds and stopping distances increase when traveling downhill, and that the available sight distances must be checked accordingly.

### ***Off-Road***

With regard to off-road bicycle route design, there are two major considerations when designing grades: the effort to climb, and conditions required for a safe descent.

For a cyclist riding on a bike without multiple gears (some mountain bikes have upwards of 24 different gears for power and speed variation), it is almost impossible to climb a 50 m long 10% grade. Bicycles equipped with multiple gears allow almost every cyclist to climb a 50 m 15% grade. However, grades greater than 5% should normally be avoided, and long uphill grades should ideally not exceed 3%. Where possible, on long steep grades it is desirable to introduce relatively flat rest areas approximately every 100 m.

### ***Guidelines:***

- 4.2: *Widen roads or trails with steep grades to provide extra space for cyclists to either make corrections to their trajectory at higher speeds going downhill, or to maintain their balance at lower speeds heading uphill. Widen cycling facilities on grades shorter than 75 m or shallower than 6%.*
- 4.3: *When conditions permit, add 0.5 m where possible in the width of the paved shoulder or bike lane for on-road facilities where the grade of the road approaches or exceeds 8%.*
- 4.4: *Add motor vehicle passing prohibition (descent), Share the Road (ascent) signs and a combination of edge lines when grades exceed 8% and sufficient facility width is not available. On roads where sight lines are also an issue because of the horizontal or vertical curvature of the road, additional cautionary signs may be warranted to restrict passing manoeuvres.*





- 4.5: Reduce the posted speed limits on steep road segments where motor vehicle volumes or the percent of commercial traffic exceed a desirable threshold for a cycling facility.*
- 4.6: Design multi-use pathways that are part of the Sault Ste. Marie Cycling Route Network with grades less than 10%.*

#### **4.2.1.2 Design Speed for Cyclists**

Design speed is used to determine cycling facilities geometric characteristics including the width, minimum curve radius, and banking to ensure cyclists have adequate space and time to safely approach and navigate sharper curves along the route. The design speed must reflect the speed of cyclists taking into account, the cyclists' power, the grade and wind.

##### ***On-Road***

Most recreational cyclists can maintain a speed of 15 to 20 km/h, while utilitarian and fitness-oriented cyclists usually travel at higher speeds. On-road cycling networks utilize existing roadways and are generally constructed to a design speed of 70 to 100 km/h for motorized vehicles (20 km/h over the posted speed limit). For these roads, sight distances and curvatures should, in most cases, exceed the minimum bicycle route design parameters. In addition, in the majority of cases, a cyclist's eye height will be above that of the driver in a typical automobile. Therefore, the cyclist will actually be able to observe hazards at a greater distance than a motorist.

Although the design speed for cyclists is typically not a significant factor for on-road bicycle routes, this may need to be considered for some older roads in the City that are sub-standard and have significant horizontal and / or vertical curves. For road designs with severe physical constraints due to topography, environmental and / or right-of-way constraints, roadway designers may need to develop a context-sensitive solution. Additional signing and / or pavement markings to caution motorists and cyclists should be considered when implementing cycling facilities on such roadways.

##### ***Off-Road***

To ensure that the off-road cycling network is safe for all users, a minimum design speed of 40 km/h (not to be confused with the posted speed limit) should be assumed for off-road trails. On descents with steeper grades (exceeding 4%), the design speed should be increased to 60 km/h as well as additional path width provided to allow for cyclists' increased velocity bearing in mind that the speed varies with the length and steepness of the grade. It is recognized that these guidelines may not always be feasible or may take away from the character of a particular multi-use trail. That said, trail designers should be cognizant of the issue associated with steep grades on trails.

##### ***Guidelines:***

- 4.7 Although new or improved City roads will typically be designed to the roadway standard and thus exceed the minimum design parameters related to speed for cycling facilities, some existing roads may not. In these cases, additional signing and / or pavement markings to caution motorists and cyclists should be considered when implementing or updating cycling facilities.*
- 4.8: Design off-road cycling facilities to minimum design speed of 40 km/h to ensure that the network is safe for all users.*



#### 4.2.1.3 Sight Distance

The design of both on and off-road bicycle routes should take into consideration minimum stopping sight distance for both motor vehicles and bicycles.

##### *On-Road*

On-road cycling facilities should typically be located on roads that provide for adequate sight lines to accommodate the minimum *stopping* distance required for motor vehicles. Minimum stopping sight distance is the least visible distance required by a driver to bring the vehicle to a stop before reaching an object in the vehicle's path. In other words, motorists approaching a cyclist on a road must be able to see the cyclist at a sufficient distance. This is necessary so that a motorist can effectively make the decision on when to pass a cyclist or when to stop in the event the cyclist has fallen and / or is blocking all or part of a travel lane.

MTO's *Geometric Design Standards for Ontario Highways* (GDSOH, 1994) provides minimum stopping sight distances for a range of design speeds that are based on a driver's perception time of 1.5 seconds, reaction time of 1.0 second and longitudinal friction values for wet pavements. Table 4.2 sets out MTO's minimum motor vehicle stopping sight distances based on speed.

Table 4.2: Minimum Motor Vehicle Stopping Sight Distance on Wet Pavement

Speed v		Perception and Brake Reaction		Coefficient of Friction on wet pavement	Braking Distance on level pavement	S-Min. Stopping sight distance	
Design	Assumed Conditions	Time	Distance			calculated	rounded
Km/h	Km/h	s	m	f	m	m	M
40	40	2.5	28	0.380	17	45	45
50	50	2.5	35	0.358	27	62	65
60	60	2.5	42	0.337	42	84	85
70	70	2.5	49	0.323	60	109	110
80	79	2.5	55	0.312	79	134	135
90	87	2.5	60	0.304	98	158	160
100	95	2.5	66	0.296	120	186	185
110	102	2.5	71	0.290	141	212	215

Source: Geometric Design Guide for Canadian Roads, Transportation Association of Canada (TAC), 1999

Although all existing and new roads should ideally be designed with regard to these minimum standards, it is recognized that some older roads in Sault Ste. Marie may not. For road designs in which there are a number of severe physical constraints due to topography, environmental and / or right-of-way constraints, roadway designers may need to compromise on one or more of the standards. If stopping sight distance is sub-standard, the driver may not see an object in time to come to a safe stop. However, the driver may be able to steer around the object or sufficiently reduce speed to minimize damage or injury. Additional signing to caution both motorists and cyclists should be considered in these situations when they have been identified. While sub-standard design should be avoided and is not advocated, if sub-standard designs are dictated by other constraints, the consequences should be clearly understood and good engineering judgment applied to minimize potential risk.





### *Off-Road*

Minimum stopping sight distance for both on and off-road cyclists is the distance required to bring a bicycle to a full controlled stop upon spotting an obstacle. It is a function of the cyclists' perception and reaction time prior to braking, the initial speed of the bicycle, the coefficient of friction between the tires and the bicycle route surface, and the braking capacity of the bicycle.

The stopping sight distance is given by the formula:

$$S = 0.694V + V^2 / 255 (f + G/100)$$

Where: S = stopping sight distance, m

V = speed, km/h

f = coefficient of friction

G = grade, % (upgrade +, downgrade -)

Table 4.3 illustrates minimum stopping sight distances for a range of speeds and grades for bicycles. It is based on 2.5 seconds of perception-reaction time and a coefficient of friction (f) of 0.25 that accounts for paved surfaces during wet weather plus typical braking characteristics of bicycles. The coefficient of friction for unpaved surfaces should be reduced to 50% of those for paved surfaces such as asphalt or concrete.

Table 4.3: Minimum Stopping Sight Distances for Cyclists

Grade (%)	Design speed (km/h)								
	10	15	20	25	30	35	40	45	50
Minimum Stopping Sight Distance (m)									
+12	8	13	18	-	-	-	-	-	-
+10	8	13	18	24	-	-	-	-	-
+8	8	13	19	25	32	-	-	-	-
+6	8	13	19	25	32	40	-	-	-
+4	8	13	19	26	33	41	49	-	-
+2	8	14	20	26	34	42	51	61	-
0	9	14	20	27	35	44	53	63	74
-2	9	14	21	28	36	45	55	66	77
-4	9	15	21	29	38	47	58	69	81
-6	9	15	22	30	39	50	61	73	86
-8	9	16	23	32	42	53	65	68	92
-10	10	16	24	34	44	56	70	84	100
-12	10	17	26	36	48	61	76	92	110

Note: a positive grade is uphill, and a negative grade is downhill  
Source: Geometric Design Guide for Canadian Roads, TAC, 1999

### **Guideline:**

4.9: *Design both on and off-road cycling facilities with a minimum stopping sight distance for both motor vehicles and bicycles using Geometric Design Guide for Canadian Roads, TAC, 1999. In constrained conditions, add signing to caution both motorists and cyclists.*



#### 4.2.2 Alignment Elements

##### 4.2.2.1 Horizontal Alignment

Also referred to as horizontal curve, horizontal alignment describes the critical point “at which users will instinctively decelerate to maintain a comfortable degree of lateral acceleration while traversing a curve.”<sup>5</sup>

##### *On-Road*

With respect to horizontal alignments, the design of on-road cycling facilities are typically governed by the controls and design considerations for accommodating motor vehicles. The horizontal alignment of a roadway is the configuration consisting of tangents, circular curves and spiral curves. Controls such as design speed, classification, topography, climate, traffic volumes and soils will influence the horizontal alignment of the roadway. Design considerations such as safety, driver expectation, cost, aesthetics and environmental factors are also taken into account.

Roadway design standards set out in MTO’s *Geometric Design Standards for Ontario Highways* (GDSOH, 1994) and TAC’s *Geometric Design Guide for Canadian Roads* (GDGCR, 1999) with respect to horizontal curves exceed the minimum requirements for cyclists.

Although a number of existing roadways in Sault Ste. Marie that are proposed to include on-road cycling facilities may not have been designed to current road standards, it is expected that the existing horizontal alignment should be adequate to accommodate cyclists. Where this condition does not occur, appropriate signing should be considered or the cycling facility implemented in the future when the road is reconstructed to current standards.

##### *Off-Road*

The minimum radius of a curve on an off-road cycling facility depends on the bicycle speed, super-elevation and coefficient of friction between the bicycle tires and the cycling facility surface. The following formula should be used to determine the minimum radius of horizontal curves:

$$R = V^2 / (127 \times (e + f))$$

Where: R = radius, m  
V = speed of bicycle, km/h  
E = super-elevation, m/m  
f = coefficient of lateral friction

For most applications, the coefficient of lateral friction varies from 0.3 at 25 km/h to 0.22 at 50 km/h, and for unpaved surfaces the coefficient is reduced to 50% of the paved surfaces value. Table 4.4 provides the coefficient of lateral friction and minimum radius for a range of design speeds and super-elevation rates.

---

<sup>5</sup> United States Department of Transportation (USDOT), *Characteristics of Emerging Road Users and Their Safety*. McLean, Virginia: Federal Highway Administration, 2004, p.86



Table 4.4: Minimum Radii for Paved Trails			
Design Cycle speed, km/h	Coefficient of lateral friction	Minimum radius, m	
		e=0.02 m/m	e=0.05 m/m
25	0.30	15	14
30	0.28	24	21
35	0.27	33	30
40	0.25	47	42
45	0.23	64	57
50	0.22	82	73

Source: Geometric Design Guide for Canadian Roads, TAC, 1999

Horizontal curves must be of sufficiently large radius to ensure that cyclists can safely negotiate the curve at the design speed. When horizontal curves are sharp (i.e. have a very small radius), cycling facility widening should be considered to compensate for the tendency of cyclists to track toward the inside of the curve. Widening is not necessary for curves over a 32 m radius, and will, therefore, not usually be a consideration for on-street routes. Table 4.5 shows the recommended widening of the riding surface on curves.

Table 4.5: Minimum Radii for Paved Trails	
Curvature (m)	Extra width required (grade = 0 to 3%)
24 to 32	250 mm
16 to 24	500 mm
8 to 16	750 mm
0 to 8	1,000 mm

Source: Technical Handbook of Bikeway Design, Vélo Québec, 1992

Horizontal curves must also be checked to ensure that there are no obstructions located on the inside of the curve, which could block the cyclists' line of sight and reduce available stopping sight distance. Vegetation should be maintained to ensure that the line of sight around a curve is not obstructed.

#### **Guidelines:**

*4.10: Horizontal curves of roads proposed for on-road cycling facilities must conform to roadway design standards set out in the MTO Geometric Design Standards for Ontario Highways or the TAC Geometric Design Guide for Canadian Roads. When this condition cannot be met, additional cautionary signing should be introduced to advise the cyclist to slow down and caution that they are approaching a sharp curve(s) ahead.*

*4.11: Provide additional width on off-road cycling segments at curves that have less than a 32 m radius.*

### **4.2.2.2 Vertical Alignment**

#### **On-Road**

The vertical alignment or profile of a roadway defines the vertical dimension of the facility. In roadway design, standards regarding gradients, cross slope, location of passing and climbing lanes, vertical curves and clearances are defined by both MTO's *Geometric Design Standards for Ontario Highways* (GDSOH, 1994) and TAC's *Geometric Design Guide for Canadian Roads* (GDGCR, 1999).



Generally, all vertical alignment standards with respect to roadway design are based on accommodating motor vehicles, which exceed the requirements for bicycles. However, there may be a number of existing roadways in the City of Sault Ste. Marie, particularly in rural areas that may not meet the most current roadway design standards.

On roads where sight lines are also an issue because of the horizontal or vertical curvature of the road, additional cautionary signs may be warranted to restrict manoeuvres by motorists passing cyclists. Reducing the posted speed limit may be another alternative when a particular road segment experiences high motor vehicle volumes (AADT - Annual Average Daily Traffic) and / or commercial vehicle traffic.

### **Off-Road**

The minimum length of crest vertical curves for off-road cycling facilities depends on the minimum stopping sight distance for the design speed of the facility. This is calculated to satisfy the safety requirements of bringing a bicycle from full speed to a full stop when an obstacle is spotted on the cycling facility surface. Table 4.6 shows vertical curve lengths for different design conditions for paved surfaces under wet conditions. Stopping sight distance for unpaved surfaces should be adjusted accordingly to satisfy reduced lateral friction conditions equal to 50% of those for paved surfaces.

As highlighted in Table 4.6, for values above the line, stopping sight distances are greater than the curve length, and  $L=2S-274/A$ , where S = minimum stopping sight distance from Table 4.3, and A = algebraic difference in grades in %. Below the line, stopping sight distances are less than the curve length and  $L=AS^2/274$ .

Table 4.6: Crest Vertical Curve Lengths

Change of grade %	Minimum curve length, m								
	Design bicycle speed, km/h								
	10	15	20	25	30	35	40	45	50
2	-	-	-	-	-	-	-	-	11
5	-	-	-	-	15	32	51	71	100
10	-	-	13	27	44	69	102	145	199
15	-	10	22	40	67	104	153	-	-
20	3	14	30	54	-	-	-	-	-
25	6	18	37	-	-	-	-	-	-

Source: Geometric Design Guide for Canadian Roads, TAC, 1999

The criterion for bicycles on sag curves is comfort, which is expressed in terms of a vertical maximum radial acceleration of  $0.3 \text{ m/s}^2$ . However, it is important to consider non-illuminated cycling facilities, which might be used by cyclists after dark, by providing them with longer vertical curves. Table 4.7 provides minimum sag curvature values (K, metres) values corresponding to different design speeds based on the equation  $K=V^2/390$ .

Table 4.7: Crest Vertical Curve Lengths

Design speed, (v) km/h	25	30	35	40	45	50
Minimum sag curvature (K), m	1.5	2.5	3	4	5	6

Source: Geometric Design Guide for Canadian Roads, TAC, 1999



**Guidelines:**

- 4.12: *On roads where sight lines are an issue because of the horizontal or vertical curvature of the road, additional cautionary signs may be warranted to restrict passing manoeuvres.*
- 4.13: *On steep grades, provide cyclists the extra space needed to either make corrections to their trajectory at higher speeds going downhill, or to maintain balance at lower speeds heading uphill.*

### 4.2.2.3 Cross Slope

Cross slope is necessary to provide positive drainage of the cycling facility surface. A cycling facility may have a crown or continuous cross slope. It is preferable to use a balanced cross slope on two-way paths for drainage purposes, and also to direct cyclists to the right side of the cycling facility. Typical cross slopes depend on the surface type. Table 4.8 provides guidelines on typical cross slopes.

Table 4.8: Typical Cross Slopes

Surface	Range of cross slope
Concrete	1.5% to 2%
Asphalt	2% to 4%
Gravel, crushed stone, earth	2% to 4%

Source: Geometric Design Guide for Canadian Roads, TAC, 1999

**Guideline:**

- 4.14: *Bicycle routes should have a minimum 1.5% crown or continuous cross slopes. Balanced cross slopes for two-way paths should be used for drainage purposes and to direct cyclists to the right side of the cycling facility.*

## 4.3 Network Facility Types

In terms of public policy, it is important to recognize that the bicycle is formally recognized as a vehicle by the Province of Ontario, as outlined in the *Highway Traffic Act*. Cyclists, therefore, have the right to share all classes of roadways, including arterials, collectors and local streets, with the exception of controlled access highways.

The fact that cyclists have a right to use most municipal and provincial roadways leads to an important principle of roadway design, that “every road is a cycling road”. The City of Sault Ste. Marie should continue this “cycling-friendly” practice for all new roads, whether they are part of the cycling network or not. Cycling-friendly roadway features typically include, among other things, wide curb lanes plus drainage grates that are cycling friendly and located out of the desired path for cycling. Other features include traffic control devices that are programmed with bicycles in mind, particularly roadway vehicle detector loops that have their sensitivity adjusted to allow for bicycles to actuate a traffic signal.

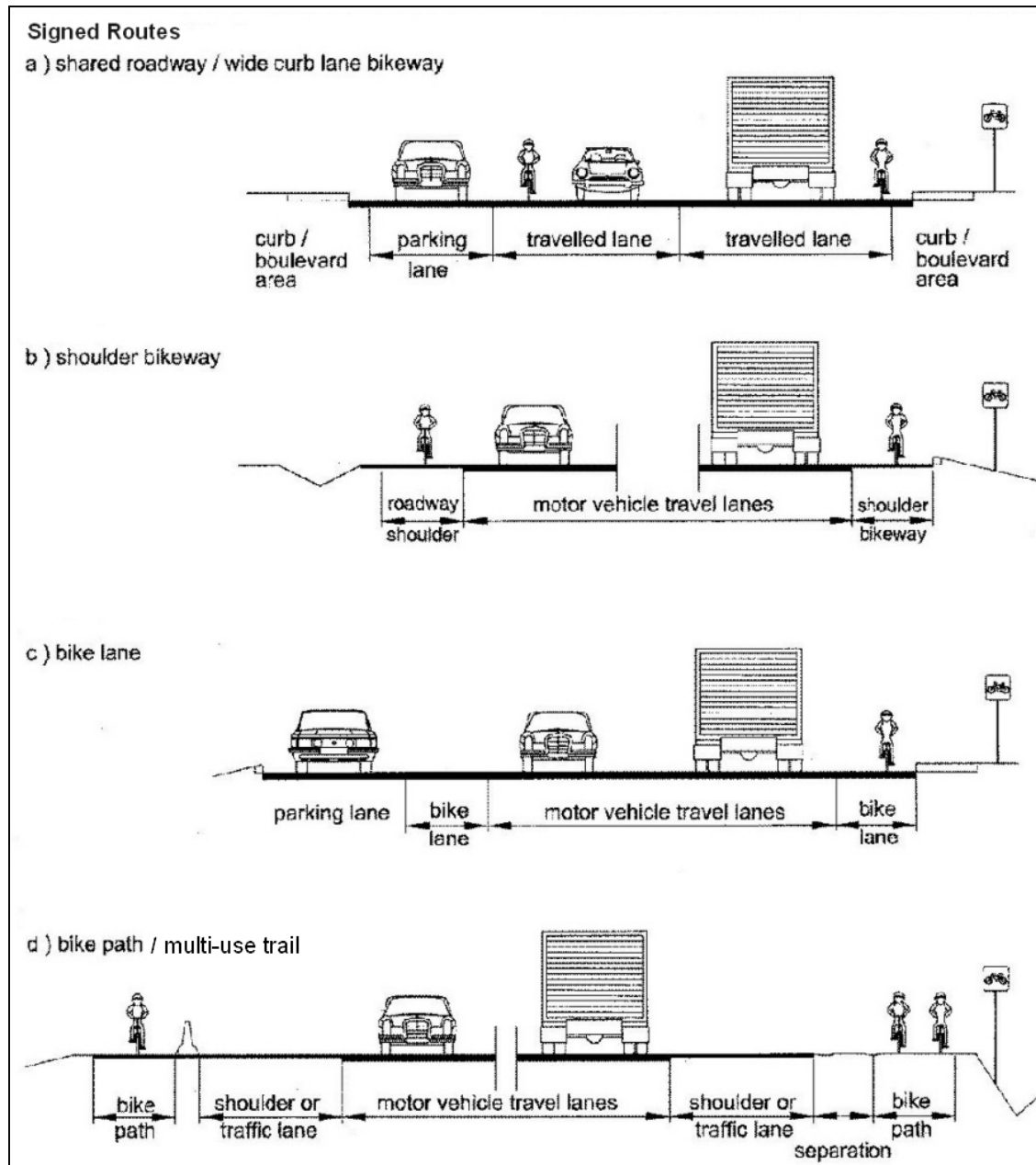
It is imperative that the City of Sault Ste. Marie and its partners recognize that providing an off-road multi-use pathway system to serve a community does not release it from an obligation to ensure that all roadways in a community are designed, updated and maintained in a way that provides a safe environment for bicycle use. No matter how extensive the on or off-road trail facilities are, some cyclists, especially experienced commuter cyclists, will choose to ride on the road with traffic in the motor vehicle travel lane. They have the right and, accordingly, should feel safe and comfortable in doing so. For any given route along a road right-of-way, consideration should also be given to the roadway operational characteristics in the route and facility type selection process. This includes consideration of such factors



as traffic volumes, truck percentages, posted speed limits, existing pavement and road platform width, right-of-way width, urban or rural cross-section, sight lines, collision history and other related elements.

Unless identified as a priority, implementation of an on-road cycling facility should occur at the same time a designated road is being improved through a pavement marking update, resurfacing or reconstruction. Figure 4.5 illustrates typical bicycle route facility types recommended for Sault Ste. Marie, modified from TAC's *Bicycle Route Functional Classification* in the *Manual of Geometric Design Standards for Canadian Roads* (1999).

Figure 4.5: Bikeway Facility Types



Source: Modified from the Manual of Geometric Design Standards for Canadian Roads, TAC, 1999





**Guidelines:**

*4.15: Continue the City of Sault Ste. Marie’s “cycling-friendly” roadway policy ensuring that all new roads constructed have sufficient rights-of-way for designated on-road cycling facilities, whether they are part of the cycling network or not.*

*4.16: Cyclists have the right to be present on all classes of roadways, including arterials, collectors and local streets, with the exception of controlled access highways or roads designated by the City that prohibit bicycles.*

**4.3.1 Bike Lanes**

A bike lane is defined as a facility located in the traveled portion of the street or roadway and is designed for one-way cyclist traffic. Bike lanes are defined on the road through pavement markings and signing. Bike lanes are recommended for parts of the cycling route spoke system of Sault Ste. Marie, however, they will also be used for portions of the connecting cycling links system when certain conditions are met. Bike lanes should be constructed on main segments of the network expected to experience high cyclist volumes and / or offer the most direct connections.

For routes that are served by bike lanes, it is expected that pedestrians and in-line skaters will be accommodated on sidewalks and off-road pathways respectively.

The minimum design width for a bike lane on a street with an urban cross-section without on-street parking should be 1.5 m from the face of the curb. A preferred width of 1.8 m is recommended, especially on roadways with higher AADT’s, speed limits, and commercial vehicle volumes (trucks / buses) such as those on busy arterial roadways. This is consistent with both *MTO and TAC guidelines*.<sup>6</sup> Bike lane widths of 2.0 m should be considered on roads with motor vehicle operating speeds or posted speed limits equal to or greater than 80 km/h. Bike lane widths should not exceed 2.2 m because the excess width may encourage motorists to drive in the bike lanes since they may be wide enough to accommodate a motor vehicle.

In constrained rights-of-way or for short segments, a reduced width of 1.2 m may be acceptable for bike lanes. However, this should not be considered along high-speed roadways with high AADT’s and commercial vehicle volumes. Lane widths less than 1.2 m should not be designated or signed as bike lanes. When the available lane width narrows below 1.2 m, bike lane signs and pavement markings should cease, and a *Bike Lane Ends* sign posted.<sup>7</sup> Table 4.9 summarizes the widths of bike lanes recommended for the City of Sault Ste. Marie.

Table 4.9: Bike Lane Widths

Classification	Minimum Width	Desired Width
Standard Bike Lane	1.5 m	1.8 m
Bike Lane Adjacent to On-Street Parking Aisle	1.5 m	1.8 m
Bike Lanes on Rural Roads with Posted Speed Limit between 60 - 80 km/h (a)	2.0 m	2.2 m
Bike Lanes in Constrained Right-of-way (b)	1.2 m	1.5 m

(a) On-road cycling facilities are not recommended on roadways with posted speed limits greater than 80 km/h

(b) Bike lanes in constrained rights-of-way are not recommended on high-speed roads (> 50 km/h) with heavy commercial vehicle or truck percentages (> 12%) and / or AADT’s (> 3,000).

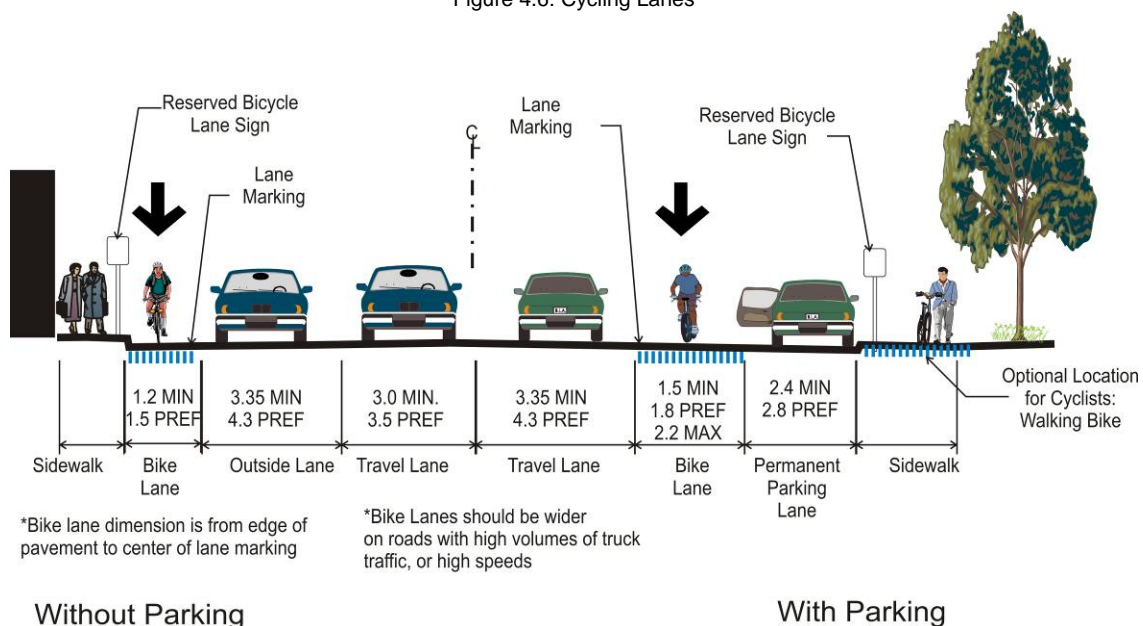
<sup>6</sup> MTO, Ontario Traffic Manual, Book 11 – Pavement, Hazard and Delineation Markings, 2000 (Figure 39) and TAC, Geometric Design Guide for Canadian Roads, 1999 (Table 3.4.6.2).

<sup>7</sup> TAC, Bikeway Traffic Control Guidelines for Canada, 1999.



Bike lanes should be clearly identified on roadways through bicycle route signing, edge lines, bicycle symbol pavement markings and bike lane signs. If the edge line continues along a roadway following the termination of a bike lane along with the cycling route, and the available lane width between the edge line and the shoulder / curb of the roadway is less than 1.2 m, *Bicycle Route* signs should be posted. Cyclists may attempt to ride in the space provided by the edge line even though it is less than 1.2 m in width. Cyclists should not be encouraged to ride in this minimal space as a cyclist who accidentally strikes a curb may “bounce” back into the motor vehicle travel lane and be struck by a passing motor vehicle. Therefore, curbed roadways with edge lines less than 1.2 m from the face of the curb should not be signed as bike lanes. However, if the bicycle route must be continued along a road with edge lines, signed bicycle route signs supplemented by “share the road” sign tabs should be implemented. Figure 4.6 illustrates a typical urban road cross-section standard modified to accommodate bike lanes.

Figure 4.6: Cycling Lanes



#### Guidelines:

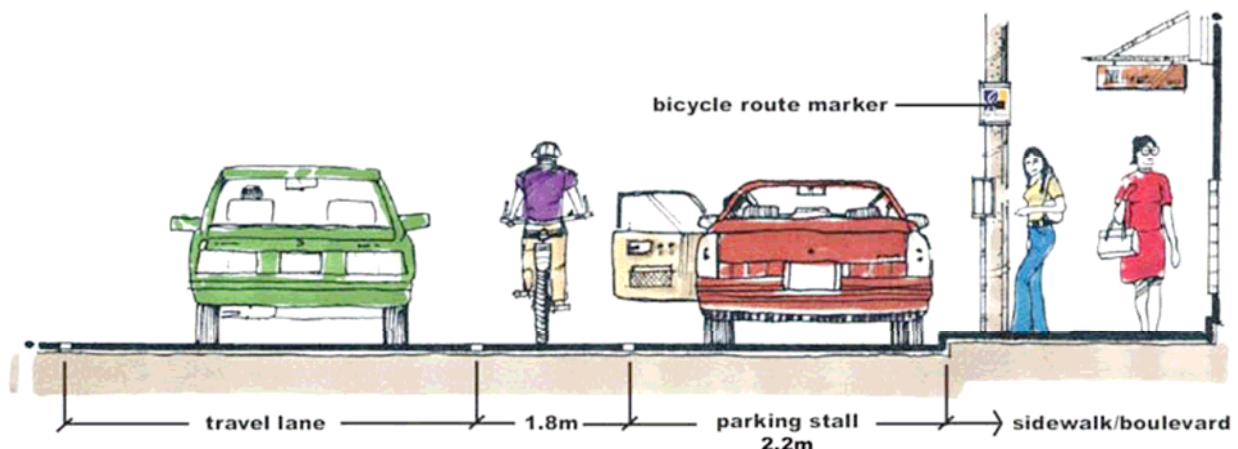
- 4.17: Design width for a bike lane in an urban area without on-street parking will be 1.2 m from the face of curb. Bike lanes that are 1.5 m wide are recommended as a standard, while a preferred width of 1.8 m should be considered on roadways with high AADT's, speed limits, and truck volumes such as those on busy arterial roadways.
- 4.18: Bike lanes should be clearly identified on roadways through bicycle route signing, edge lines, bicycle symbol pavement markings and bike lane signs.
- 4.19: Bike lanes are typically recommended where feasible for collector and arterial roads designated to have cycling facilities. In locations where a bike lane is not deemed feasible following a review, consideration should be given to providing a wide curb lane. If this is not possible, as a minimum, a signed-only route cycling facility should be provided if thresholds permit.
- 4.20: Bike Lanes are recommended on several spoke routes including North Street, Willow Street, Poplar Street, Pine Street, Lake Street, Third Line East and Queen Street east of Pim Street, as well as several connecting cycling links.



#### 4.3.1.1 Bike Lanes with On-Street Parking

Bike lanes on roads with on-street parking are typically located to the left of and adjacent to parked vehicles along the curb. Designing this type of cycling facility must take into consideration the potential hazard to cyclists of car doors opening into the traveled portion of the bicycle route (“dooring”). In order to allow clearance for vehicle doors, and to minimize collisions with cyclists, the combined width of the bicycle and parking lanes should be a minimum of 4.0 m. This width allows for a 1.8 m bike lane and a 2.2 m wide curbside parking stall. The extra distance added to the typical 2.0 m wide parking stall provides space for the opening of car doors, and encourages cyclists to travel a safe distance from the parked vehicles. As an alternative, the width of the bike lane may be reduced if the parking aisle is greater than 2.4 m wide. Figure 4.7 illustrates an example of bike lanes and on-street parking.

Figure 4.7: Typical Bike Lane with On-Street Parking



On existing roadways in Sault Ste. Marie where the road right-of-way and / or other factors limit the opportunity to provide a cycling facility along with on-street parking, an assessment should be undertaken to determine whether the parking can be relocated. However, if on-street parking is seen as a priority, parking stalls / bays should first be considered. The accompanying photo illustrates an example of parking bays which are employed to provide for permanent on-street parking adjacent to bike lanes. Permanent parking bays with bicycle lanes adjacent to them should be considered as a preferred design option for cycling routes on streets where the demand for on street parking is high and on-street parking is viewed as a priority. The installation of parking bays would further increase on-street parking priority to cyclists and automobile drivers and further define the right-of-way for all road users.



Example of Bicycle Lane adjacent to Parking Bay  
Victoria Avenue, Town of Lincoln, Region of Niagara



**Guidelines:**

- 4.21: *On existing or proposed cycling routes in Sault Ste. Marie where bike lanes are proposed and where on-street curb parking exists, undertake an assessment to determine whether the parking can be removed or relocated. In the event that on-street parking is seen as a priority, parking bays should first be considered as a preferred design.*
- 4.22: *Where the road right-of-way or other factors limit the opportunity to provide parking stalls / bays, standard on-street curb parking widths should be assumed. For both applications, the desired width of the parking lane should be a minimum of 2.2 m, with the adjacent bike lane 1.8 m.*

**4.3.1.2 Two-Way Bikeway Boulevards and Raised Bike Lanes**

**Two-Way Bikeway Boulevards** are constructed within a road right-of-way, typically adjacent to a sidewalk, however in some cases a sidewalk may be replaced with a boulevard bikeway.



Two-way Bikeway Boulevard, Percy Street

Two-way bikeway boulevards have been used extensively in the City of Montreal and in Europe and are typically located on one side of a roadway, side-by-side as illustrated in the accompanying photograph. Although constructed within the road right-of-way, boulevard bikeways should be separated from regular motor vehicle travel lanes through either a change in roadway elevation (a bikeway boulevard is usually placed at the same height as a sidewalk) and / or by concrete barriers, medians or bollards.

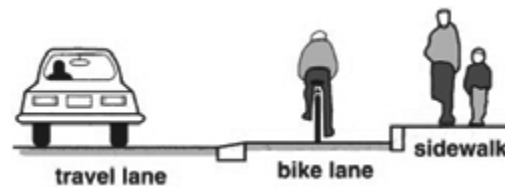
Though more costly than other cycling facility types to implement and maintain, the application of two-way bikeway boulevards is generally not recommended except for select locations where no other alternative is feasible or appropriate.

Appropriate signing at intersections where two-way bikeway boulevards are present is very important to warn and provide clear direction to both motorists and cyclists as to where they should proceed when traveling through an intersection.

**Raised Bike Lanes** can be best described as on-road sidewalks designated for cycling use. They are constructed at an elevation between that of the motor vehicle travelled portion of the roadway and the height of the curb. Figure 4.8 illustrates an application and schematic of a raised bike lane.



Figure 4-8: Example of a Raised Bike Lane - Eugene, Oregon



The application of raised bike lanes has caused confusion at intersections over proper rights-of-way. In many cases, the raised bike lane feeds into the pedestrian sidewalk at intersections and thus, directs cyclists to mix with pedestrians within a crosswalk. This practice is not only illegal, it is not encouraged either. Bicycles are defined as vehicles and therefore to reduce confusion over right-of-way, cyclists should remain on the road and in their own specifically designated facility if possible. This would help to reduce confusion over proper right-of-way for cyclists and pedestrians, especially at intersections. Therefore, the continued installation of Raised Bike Lanes is not recommended.

**Guidelines:**

*4.23: Bikeway boulevards must be separated from regular motor vehicle travel lanes through either a change in roadway elevation and / or by concrete barriers, medians or bollards. They are generally not recommended except in locations where there is no other alternative.*

*4.24: The installation of Raised Bike Lanes is not recommended for the City of Sault Ste. Marie due to the confusion caused over the proper right-of-way for cyclists and pedestrians at intersections.*

#### **4.3.2 Paved Shoulders**

##### **4.3.2.1 Paved Shoulders on Rural Roads**

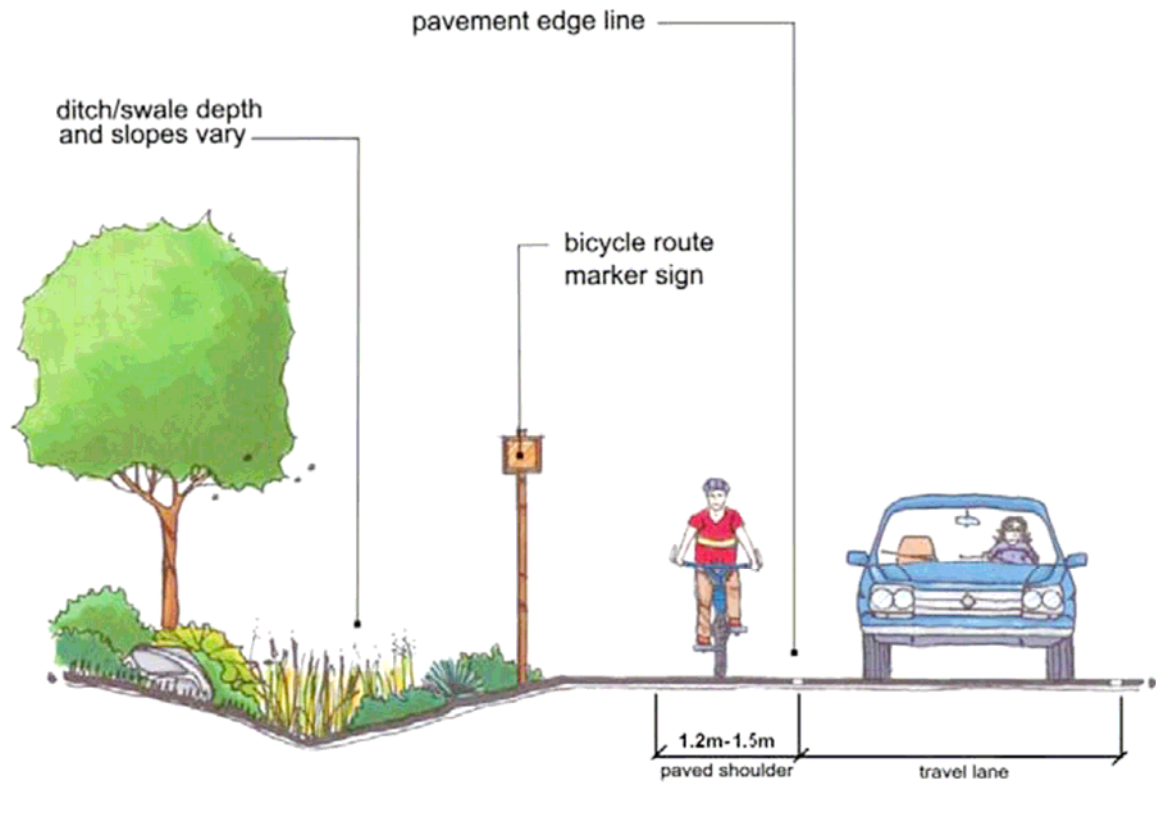
Paved shoulders are the paved portions of roads with rural cross-sections (no curb) adjacent to the regular traffic lanes. They may be designated as cycling facilities serving both recreational and utilitarian cyclists. Paved shoulders are usually delineated by an edge line, which separates the non-traveled portion of the road from the motor vehicle travel lanes.

Paved shoulders may provide key connections between adjacent systems and offer several advantages over wide curb shared lanes since they can provide a de facto separated space for cyclists. This leads to a higher level of comfort and can improve safety for cyclists since most of them will choose to ride on the paved shoulder and not with other motor vehicle traffic in the adjacent travel lane. Paved shoulders also reduce maintenance costs associated with the grading of gravel shoulders, serve as a refuge for disabled vehicles, accommodate emergency vehicles, are known to extend the life of the road by improving the lateral support for the roadway structure, and can reduce run-off-the-road collisions. For these reasons, the City of Sault Ste. Marie should make the paving of shoulders a priority for all roads with rural cross-sections that comprise part of the proposed cycling route network designated for paved shoulder cycling routes.

A marked edge line should designate a paved shoulder. Paved shoulders should only be signed as bicycle routes and not denoted as reserved bicycle lanes since they must still be used as a refuge for disabled vehicles. Figure 4.9 illustrates a typical paved shoulder bicycle route facility. The 1.2 m – 1.5 m width illustrated in Figure 4.9 should be accompanied by a 0.5 – 1.0 m granular shoulder for extra manoeuvring space or “recovery area” for a cyclist should they be inadvertently forced from the paved section by a passing vehicle.



Figure 4.9: Typical Paved Shoulder



The on-road facility design criteria for the City of Sault Ste. Marie is based on the road classification on which the cycling facility will be constructed, as well as right-of-way availability. Both MTO's *Geometric Design Standards for Ontario Highways* (GDSOH, 1994) and TAC's *Geometric Design Guide for Canadian Roads* (GDGCR, 1999) provide standards for shoulder widths for undivided rural highways that apply to Ontario and are based on design speed and AADT volumes. Although these standards are not specifically intended to incorporate on-road cycling facilities, the widths recommended by both are in some cases sufficient to accommodate a 1.2 m to 1.5 m paved shoulder bikeway and 0.5 m to 1.0 m for additional granular shoulder width. On rural roads with speed limits in excess of 60 km/h, a 2.0 m paved shoulder with an adjacent 0.5 m granular shoulder width is recommended. Table 4.10 indicates MTO's recommended shoulder widths for undivided rural roads. Figure 4.10 illustrates the shoulder of a typical roadway platform.



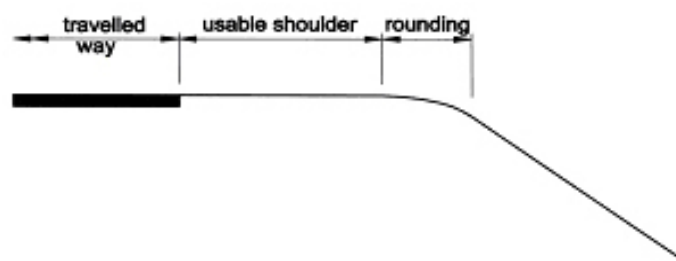


Table 4.10: Shoulder Width for Undivided King's Highways and Secondary Highways

Design Speed km/h	Traffic Volume for Design Year					
	AADT					
	>4000	3000-4000	2000-3000	1000-2000	400-1000	<400
	DHV					
	>600	450-600	300-450	150-300	60-150	<60
120	3.0	-	-	-	-	-
110	2.5	2.5	2.5	2.5	-	-
100	2.5	2.5	2.5	2.0	1.0	-
90	2.5	2.5	2.0	2.0	1.0	-
80	2.5	2.5	2.0	2.0	1.0	1.0
70	-	2.0	2.0	1.0	1.0	1.0
60	-	-	-	1.0	1.0	1.0
50	-	-	-	-	-	1.0

Source: Geometric Design Standards for Ontario Highways, MTO, 1994

Figure 4.10: Shoulder Component of Typical Road Platform (no bicycle route)



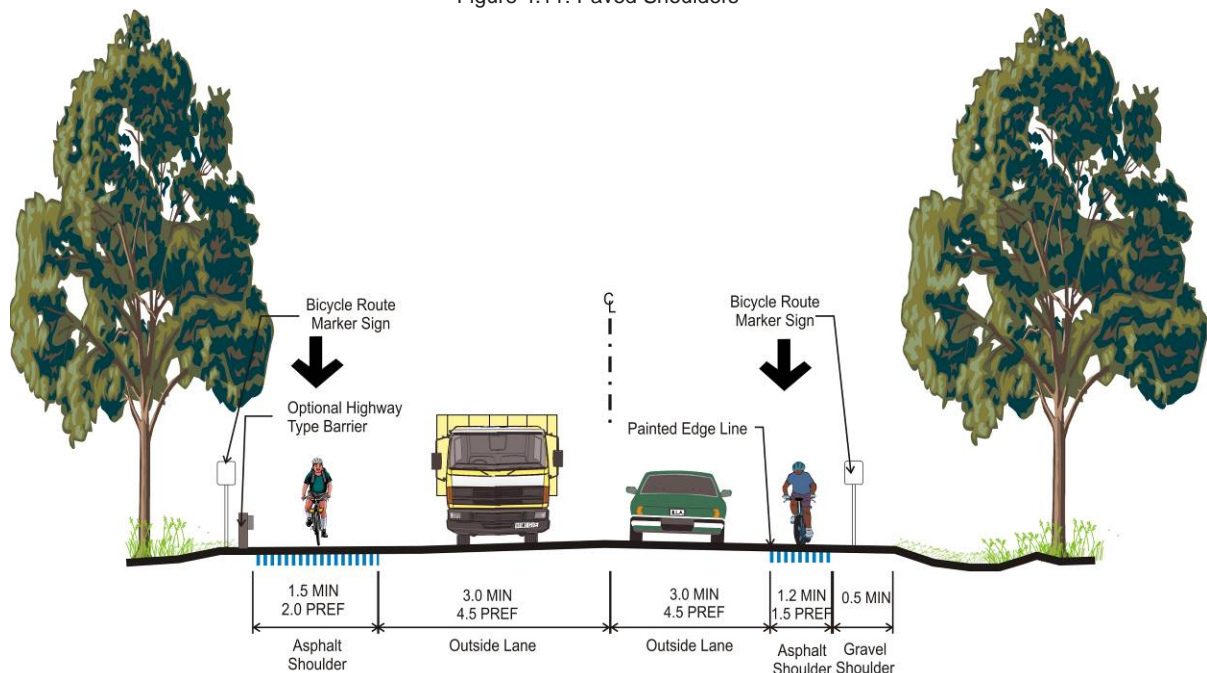
Implementing paved shoulders at the time a road is resurfaced or reconstructed often can be the best way to accommodate cyclists in rural areas, as well as benefiting motor vehicle traffic. Paved shoulders extend the service life of the road surface since edge deterioration is significantly reduced. Where funding is limited, adding or improving shoulders on uphill sections will give slow-moving cyclists needed manoeuvring space, and will decrease conflicts with faster moving motor vehicle traffic.

Paved shoulder cycling routes in the City of Sault Ste. Marie should have a preferred design width of 2.5 m, including 1.5 m – 2.0 m of paved section and 0.5 m - 1.0 m of gravel shoulder. In locations where 1.5 m paved section for a paved shoulder cannot be achieved, especially in constrained rights-of-way, a minimum paved shoulder width of 1.2 m with an adjacent granular shoulder of at least 0.5 m is a



reasonable compromise. If this cannot be achieved, any additional paved shoulder width is better than none at all. The decision on whether to sign a road with paved shoulders that is less than 1.2 m in width as a signed-only bicycle route should depend on the AADT volume and percentage of commercial vehicle traffic that the road experiences, as well as a number of other factors such as roadway geometry, gradients, horizontal / vertical curves and sight lines. Some roads that do not have adequate paved shoulder widths may be designated as signed-only cycling routes if the roadway characteristics permit. Figure 4.11 illustrates an example of a rural road cross-section reconfigured to accommodate a paved shoulder cycling route.

Figure 4.11: Paved Shoulders



Note: On Roads with posted speed limits over 60 km/h, the minimum recommended width is 2.0 m

In Sault Ste. Marie there may be segments of proposed cycling routes on roads with rural cross-sections (no curb) where it is difficult to accommodate even a minimum 1.2 m paved shoulder. In these cases, edge lines (pavement markings) may be provided to mark the 3.5 m vehicle lane width and to delineate as much additional shoulder width as possible for cyclists to use. This approach, however, is not recommended along urban roads with curbs due to the risk of cyclists striking the curb and “bouncing” back into the motor vehicle travel lane, potentially colliding with a motorist. Should edge lines be applied to a roadway primarily to support cycling, they should only be applied on roads with rural cross-sections.

Although not encouraged, if a paved shoulder width is significantly less than 1.2 m and a cyclist chooses to ride to the right of the edge line, an adjacent gravel shoulder would still provide a “recovery” area. In summary, paved shoulders are recommended on all arterial roads with rural cross sections designated for cycling facilities if exclusive bike lanes cannot be provided. Paved shoulders on rural roads should not be denoted as reserved bicycle lanes since they must still be used as a refuge for disabled vehicles. Paved shoulder cycling routes should only be denoted as signed-only bicycle routes. If a rural road is upgraded to an urban section (with curbs) the paved shoulders should be converted into bike lanes. This could be accomplished without the need for a cycling route feasibility assessment.



**Guidelines:**

- 4.25: Paved shoulders are the preferred facility for creating connections amongst rural areas, and between rural and urban areas.*
- 4.26: Paved shoulder bicycle routes in the City of Sault Ste. Marie have a preferred design width of 2.5m (including a gravel shoulder). In locations where this lane width for paved shoulders cannot be achieved, especially in constrained rights-of-way, provide a minimum paved shoulder width of 1.2 m with an adjacent granular shoulder of at least 0.5 m.*
- 4.27: Paved shoulder facilities should always be separated from the motor vehicle travel portion of the road by an edge line (pavement marking), and should be clearly identified through bicycle route signing. Edge lines should only be used on rural roads where there are no curbs, and should be a single line placed on the right side of the travel lane closest to the paved shoulder.*
- 4.28: Edge lines are only recommended for paved shoulders in rural areas as these roads typically have a gravel shoulder beyond the paved shoulder for a cyclist to recover should they be forced off of the paved section of the roadway.*
- 4.29: Paved shoulders on rural roads should not be denoted as reserved bicycle lanes since they should still be used as a refuge for disabled vehicles. Paved shoulder cycling routes should only be signed as bicycle routes.*

### **4.3.3 Shared Roadway Facilities**

This section focuses on all roadway facilities where a separate right-of-way (e.g. bike lane or paved shoulder) cannot be provided or is not necessary.

#### **4.3.3.1 Signed-Only Cycling Routes**

Signed-Only cycling routes are bicycle routes designated by bicycle route signing along a street. Road lanes signed as cycling routes may be accommodated on low volume roadways with limited truck traffic, good sight lines and physically constrained right-of-way's, where existing or outside lanes are used by motorists and cyclists. Signed-Only routes are typically installed on quiet, residential, local / collector streets. Apart from "bicycle route" signs, there are generally no changes made to the roadway. Although it is recommended that paved shoulders or bike lanes should be provided on all collector and arterial roads designated for cycling facilities, on lower volume roads or as an interim solution, cycling route segments can be implemented in the short term (0 – 10 years) by introducing signed-only routes and / or wide curb lanes.

In the longer term (10 + years), when a road that is designated as part of the Sault Ste. Marie cycling network is scheduled to be resurfaced or reconstructed, an assessment should then be undertaken to confirm whether the preferred cycling facility type can be accommodated. One potential outcome of such an assessment may be the decision that a signed-only route is sufficient for the purposes of the network at a particular location. Another potential outcome may be to upgrade a signed-only cycling route to a wide curb lane or a bike lane if possible.

Streets with signed-only cycling routes should typically only be signed as on-road bike routes if there is adequate pavement width to safely accommodate both motor vehicles and cyclists, and when adequate sight lines and acceptable AADT volumes exist. Otherwise, alternative routes should be investigated or paved shoulders / bike lanes implemented when the opportunity presents itself at a future date.



Existing roads that are recommended as part of the cycling network should not be prematurely signed or identified as part of the Sault Ste. Marie cycling network if the right-of-way available to cyclists is too narrow, AADT's are high, or if the roadway is in poor condition. Roads that are presently not suitable for on-road cycling facilities but are recommended for installation in the future should be upgraded to at least minimum standards before being signed as part of the cycling network.

Signed-only bicycle routes are especially appropriate for the connecting cycling links which consist of cycling routes that are “local” in nature and feed into the primary network. In many parts of Sault Ste. Marie, existing rural roads have narrow pavement widths of 6.1 m – 7.0 m with no edge line and narrow gravel shoulders. Some of these roads would be suitable for designation as signed-only routes because they have good sight lines and typically experience low to moderate automobile and truck volumes. However, it is recommended that “*Share the Road*” signs be erected along these sections of cycling routes to increase driver awareness of cyclists on the narrow roadway.

**Guidelines:**

- 4.30: Signed-only cycling routes are appropriate for the community system that consists of cycling routes that are “local” in nature and feed into the spine network.*
- 4.31: Streets with signed-only cycling routes should only be signed as on-road bike routes if there is adequate pavement width to safely accommodate both motor vehicles and cyclists, and when adequate sight lines and acceptable AADT volumes exist.*
- 4.32: On low volume rural roads with limited truck traffic, good sight lines and sometimes physically constrained ROW's, the existing travel lane may be designated as a cycling route, with cyclists and motorists expected to share the same lane. In these cases, “Share the Road” signs should be erected at strategic locations to communicate this message to all road users.*

#### **4.3.3.2 Signed-Only Cycling Routes on Wide Curb Lanes**

Signed-Only cycling routes within wide curb lanes are similar to signed-only cycling routes, with the exception that the travel lane shared by motorists and cyclists is wider than a standard motor vehicle travel lane (> 3.5 m). Wide curb lanes should have sufficient width to allow motorists to pass cyclists without encroaching on an adjacent travel lane (if one exists). Wide curb lanes should be encouraged for all road classifications to provide cycling friendly streets, whether they are designated as part of the cycling network or not.

Designation of signed-only cycling routes within wide curb lanes are recommended for curb lane widths ranging from 3.5 - 4.0 m. Research indicates that as lane widths begin to exceed 4.0 m, this tends to increase confusion and improper lane use by motor vehicles in congested urban environments, and may encourage unsafe passing manoeuvres in rural environments. In general, it has been concluded that a wider lane will provide a greater level of safety than a narrower lane. However, it must be recognized that there are existing roads in Sault Ste. Marie that have curb lane widths greater than 4.0 m.

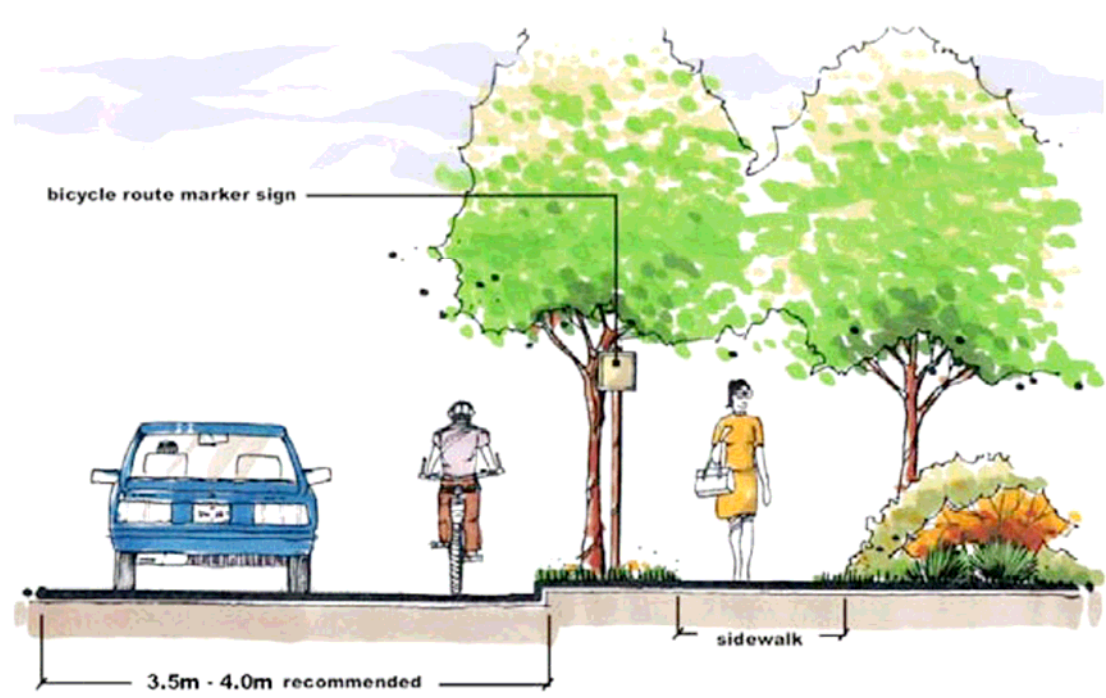


Wide Curb Lane, City of Ottawa



Signed-only cycling routes along wide curb lanes that are greater than 4.0 m in width should have pavement markings added to the curb lane, such as those illustrated in the photograph above, to help deter unsafe passing manoeuvres by motorists and increase driver awareness of cyclists on the road. Bicycle route signing should also be applied along the cycling route and may be supplemented with pavement markings such as the bicycle stencil and “*Shared Road*” text to indicate the presence of cyclists on the roadway to motorists. A schematic illustration of a typical signed-only cycling route in an urban area with a wide curb lane is provided in Figure 4.12.

Figure 4.12: Signed-Only Cycling Route along a Wide Curb Lane



There are locations throughout the City where edge lines have been applied to wide curb lanes as a traffic calming measure to slow motor vehicle traffic. As a result, motor vehicles travel lanes are narrowed between the centreline of the road and the edge line, and the remaining roadway width between the edge line and the curb is available for on-street parking. Cyclists riding along these streets tend to ride between the edge line and curb as this area acts as a makeshift bike lane, although it is not delineated as one (no arrows or bike stencil pavement markings).

It is recommended that streets like these be signed as signed-only bicycle routes, and not as bicyclelanes since motor vehicles are permitted to park within this makeshift area. The proper and legal location for a cyclist to ride would be with motor vehicle traffic in the narrowed motor vehicle travel lane. However, it should be expected that cyclists will continue to travel in the delineated space on the roadway between the edge line and curb, crossing into the motor vehicle travel lane to pass a parked vehicle on the left. The application of “*Share the Road*” signing along the cycling route would also benefit motorists as this would increase driver-awareness of cyclists riding in the motor vehicle travel lane.





**Guidelines:**

- 4.33: *The preferred width for a wide curb lane is 4.25 m with a minimum of 3.75 m.*
- 4.34: *In urban areas, proposed signed-only cycling routes should be implemented along roads with wide curb lanes (< 4.0 m) and bicycle route signs where possible.*
- 4.35: *Where the width of a wide curb lane exceeds 4.0 m along a designated cycling route, the application of pavement markings such as a bicycle stencil should be considered to indicate the presence of cyclists on the roadway to motorists.*
- 4.36: *Cycling routes along streets with edge lines applied to wide curb lanes should be signed as signed-only cycling routes and never as bike lanes.*

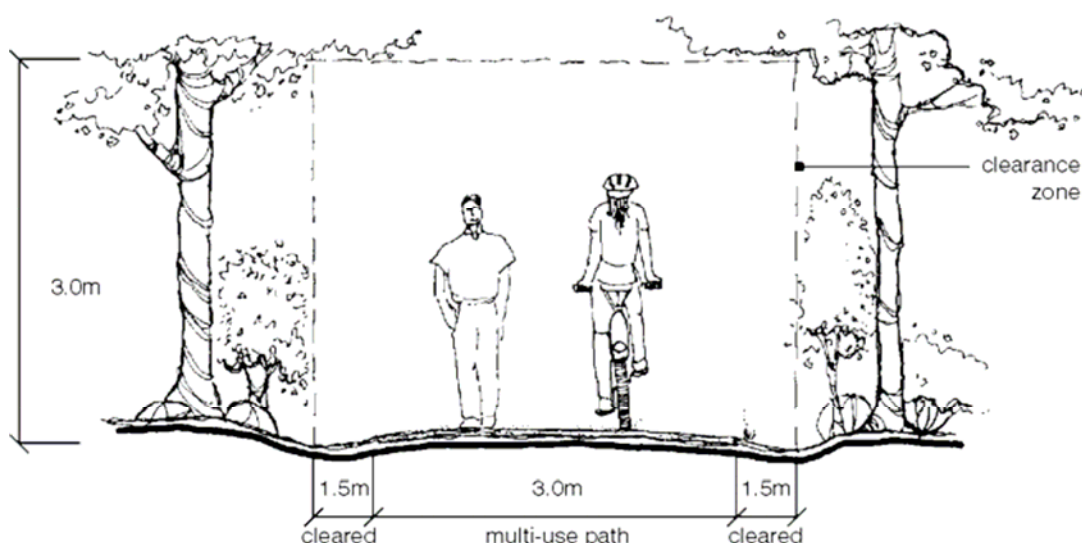
#### **4.3.4 Multi-Use Pathways**

##### **4.3.4.1 Multi-Use Trails**

Multi-use trails typically run through parklands, along the boulevards of major arterial roads ROW, and within hydro or rail corridors. Cyclists may choose, however, to remain on the road, even if a parallel route exists. Sault Ste. Marie currently possesses an off-road trail network that is enjoyed by residents and attracts tourists of all ages to the City. A significant part of off-road trails should be designed to accommodate a variety of user groups including cyclists, in-line skaters, pedestrians, wheelchair users, baby carriages and dogs. Cycling is one of the very broad range of uses that can be expected on multi-use trails. All off-road routes identified in the Sault Ste. Marie Cycling Route are expected to be designated as multi-use trails.

A review of various bicycle route and off-road trail design guidelines throughout North America indicates that standards vary depending upon the trail's location, the anticipated number of users and the permitted uses. The minimum width is typically 3.0 m, which allows for bi-directional flow. On popular multi-use trails, widths of 3.5 m – 4.5 m are recommended to allow for a wider variety and greater number of users. A schematic illustration of a typical off-road multi-use trail is provided in Figure 4.13.

Figure 4.13: Multi-Use Pathway







In areas with high levels of tourists or other active traffic, such as waterfront trails in highly urban settings, a suggested width of 3.5 m – 6.0 m should be considered depending on site characteristics. In all cases, a minimum clearance zone that is kept clear of brush, street furniture or other obstacles is recommended on both sides of the trail. Increasing trail width in certain circumstances, such as high density urban areas, in narrow valleys, constrained waterfront areas and/or other unique situations may be difficult to achieve. In some cases where there is very high demand, twinning or constructing of two parallel trail facilities may be more desirable than constructing one very wide trail. In such case, one trail would be designated by signage for pedestrians and another for wheeled users such as cyclists and in-line skaters.

Multi-use trails within urban areas typically have paved asphalt surfaces while trails in rural or environmentally sensitive areas typically have granular surfaces. Pavement markings should be applied to trails to indicate designated travel lanes and the directional flow that should be followed by means of arrows. Multi-use trails should include a solid yellow longitudinal centre line to distinguish separate lanes for opposing traffic direction, and encourage the practice of keeping to the right side of the trail unless wanting to pass. Table 4.11 shows recommended trail widths.

Table 4.11: Recommended Pathway Widths

Classification	Minimum Width	Desired Width
Two-way multi-use trail (shared with pedestrians)	3.0 m	4.5 m
Horizontal Clearance to rigid objects beside trail	0.5 m	1.0 m
Vertical Clearance	2.4 m	3.6 m

In rural areas, an on-road cycling facility such as a paved shoulder is the preferred cycling facility as it is a cost effective way to utilize existing shoulder space on rural roads for cycling facilities. Furthermore, frequent crossing of roadways are not common in rural areas as roads are generally spaced 1 – 2 km apart, therefore an on-road facility would be a more appropriate rural cycling facility rather than a multi-use pathway paralleling a rural road.

Multi-use trails in rural areas may only be appropriate to provide connections to other Regional trails and pathways that feed into the Sault Ste. Marie Cycling Route network. Multi-use trails would be appropriate in these locations to accommodate varying user groups expected on these trails such as pedestrians and hikers.

During implementation, some trail segments may need to be sub-standard along short sections due to physical or property constraints. Although implementing sub-standard bicycle route facilities is not advocated, it can be an appropriate solution to maintain bicycle route connectivity. At locations where a sub-standard design is being considered, the design considerations set out in this guide with regard to the operating characteristics of a bicycle should be carefully considered. Additional trail signing will typically be required to inform bicycle route users to take additional care (e.g. steep hill).

Implementing and maintaining the off-road components of the Sault Ste. Marie Cycling Route network will require the co-operation of the City and other public and private partners to achieve these off-road network components. All off-road facilities in Sault Ste. Marie should be designed and constructed where possible, based on the guidelines set out in this chapter for multi-use trails.

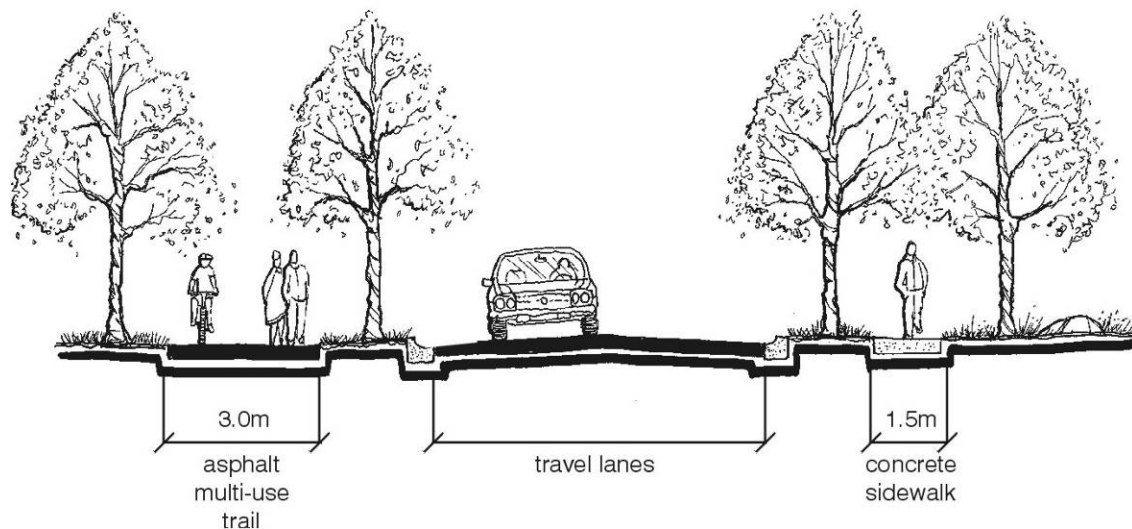
#### **4.3.4.2 Multi-Use Boulevard Trails**

Multi-use boulevard trails (also called in-boulevard trails) are bi-directional off-road trails and located within the boulevard of a road right-of-way and parallel to motor vehicle travel lanes. They are typically designed for a wide range of users including pedestrians, cyclists, and in-line skaters. Although



constructed within the road right-of-way, boulevard trails are separated from regular motor vehicle travel lanes through either a change in roadway elevation (a boulevard trail is usually placed at the same height as a sidewalk) and / or by barriers or medians. A schematic illustration of a multi-use boulevard trail is provided in Figure 4.14.

Figure 4.14: Multi-Use Boulevard Trail



Motorists tend to prefer boulevard trails because they get cyclists off of the roadway, but pedestrians tend not to like them because they place faster moving bicycle traffic into a space that is traditionally reserved for walking. Many cyclists who are uncomfortable operating in traffic believe that boulevard trails provide increased safety as cyclists are removed from the traffic stream on a roadway. However, safety professionals and experienced cyclists tend to disagree because collision statistics indicate that multi-use trail cyclists are more frequently involved in bicycle / motor-vehicle collisions at intersections.

Only when it has been determined that on-road improvements are not feasible along arterial streets, or when a primarily multi-use trail facility is preferred by a municipality over a sidewalk and on-street bicycle lanes to achieve a recreational facility objective, should a multi-use boulevard trail be considered as a primary cycling route. When this is the case, additional criteria should be considered to promote user safety.

These criteria include:

#### **Available Rights-of-Way**

To accommodate the minimum standard for a multi-use boulevard trail, there should be 6 m of available right-of-way. This is necessary to provide for a 1.0 m clear zone from obstructions, a 3.0 to 3.5 m wide trail, and a 1.5 m buffer / open space that separates the trail from the road. The American Association of State Highway Transportation Officials (AASHTO) standards suggest if there is less than a 1.5 m buffer width, a 1.4 m high physical barrier is required.

#### **Number of Street and Driveway Intersections**

Studies show that cyclists who ride on multi-use trails incur 1.8 times greater risk of being involved in a collision with a motor vehicle than those who ride on a roadway at intersections. The risk increases for trail users who are traveling against traffic – they have been found to be 4.5 times at risk than right-way



trail travelers because motor vehicle operators are not looking for cyclists or other traffic off of the roadway and / or coming from the opposite directions at intersections.

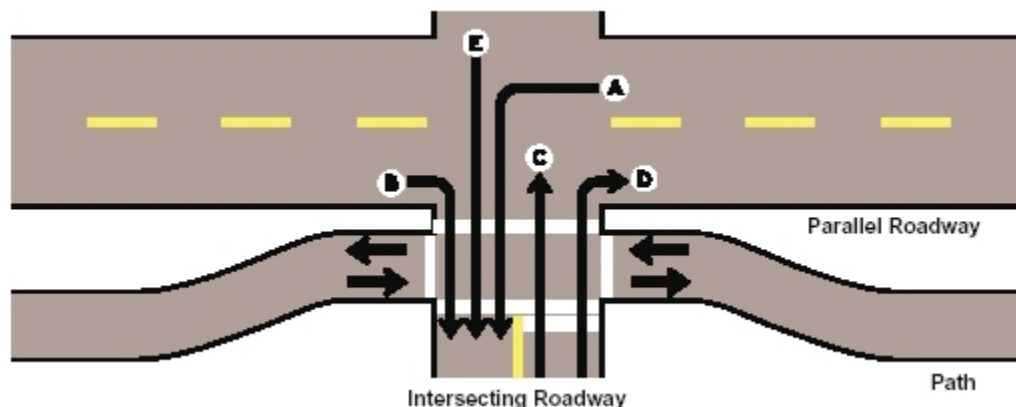
For this reason, consideration should be given to the number of driveways that the multi-use boulevard trail may cross in terms of safety and traffic flow. This can include commercial strips and other areas with heavy vehicular turning movements. Specifically, motorists may not be expecting cyclists or other traffic off of the roadway and / or traveling against traffic and, in cases where the number of crossings is high, cyclists will be required to make frequent stops. As a result, the safety and utility of the trail may be compromised. The following thresholds are recommended for driveway crossings as they relate to the provision of multi-use trails within roadway corridors in urban areas:

- > 0-3 crossings per km: An off-road multi-use pathway can be considered
- > 4-10 crossings per km: Consider substituting with on-street paved shoulders / bike lanes
- > 10 crossings per km: Substitute with on-street paved shoulders / bike lanes

#### Adjacent Trail Crossings at Intersections

An adjacent trail crossing refers to the situation where a trail “crosses a roadway at an existing intersection between two roadways, whether it is a T-intersection (including driveways) or a simple four-legged intersection.”<sup>8</sup> Figure 4.15 outlines the various possible traffic movements that can occur at an adjacent trail crossing amongst motorists and trail users. In such a situation, motorists and trail users should be cognizant of each others presence and each others traffic movements through the use of intersection design treatments, signage and / or pavement markings, alongside regulatory traffic controls.

Figure 4.15: Example of Adjacent Trail Intersection



Source: Guide for the Development of Bicycle Facilities, American Association of State Highway Transportation Officials (AASHTO), 1999

AASHTO (1999) provides the following suggestions with regards to Figure 4.15:

- In a Type A turning movement, it may be advisable to prohibit permissive left turns on a high-volume parallel roadway and high-use trail crossings;
- For turning movement Type B, as small as practical corner turning radius may be required to reduce the speeds of motor vehicles;
- For Type C and D movements, it may be advisable to prohibit right-turns-on-red and place a stop bar in advance of the trail crossing;
- To account for vehicle movement E, it may require an all-red phase to protect the trail users.<sup>9</sup>

<sup>8</sup> American Association of State Highway Transportation Officials (AASHTO), Guide for the Development of Bicycle Facilities, 1999, p.48.

<sup>9</sup> Ibid.



The application of boulevard trails as cycling facilities directly adjacent to a roadway should only be considered for cycling when an on-road facility is not feasible or when a municipality seeks to provide a primarily multi-use recreational boulevard trail and cannot or chooses not to provide a parallel on-road facility for cycling.

**Guidelines:**

*4.37: Off-road multi-use trails should be considered as part of the Sault Ste. Marie Cycling Network.*

*4.38: Construct off-road multi-use trails in Sault Ste. Marie to a minimum width of 3.0 m to accommodate two-way travel. On trails that may experience high demand or a significant percentage of pedestrian and / or in-line skating traffic, a width of 3.5 to 4.0 m is recommended.*

*4.39: Trail surface types are dependent on the requirements of the planned trail users (e.g. accommodating in-line skaters) and can vary from asphalt to granular surfaces (stone-dust).*

*4.40: In locations where a trail may intersect with more than four vehicle driveways or intersections per kilometer, consideration should be given to implementing an on-road bicycle facility. For road segments where 10 or more crossings of an off-road bicycle route could occur per kilometre, the preferred cycling facility for the network should be a Shared Road or Paved Shoulder / Bike Lane on-road cycling facility.*

#### **4.3.5 Retrofitting of Roadways**

The successful implementation of the Sault Ste. Marie Cycling Route will require balancing the desire to implement the preferred facility type and design with actual physical and environmental constraints, as well as the limited financial resources available. Although industry standard bicycle route designs are always preferred and are recommended for the City of Sault Ste. Marie, it must be acknowledged that they cannot always be implemented or accommodated. This is particularly true of retrofit situations.

#### **Retrofitting Guidelines**

The installation of new bicycle routes recommended in the Sault Ste. Marie Cycling Route may involve the retrofitting of existing City roads. In some cases it may be challenging for the City to implement the preferred design for a recommended cycling facility on part or all of certain roads designated in the Plan. Narrow rights-of-way, roadway platform and pavement widths as well as other geometric issues related to roadway design and drainage will impact both the feasibility and cost of implementing the recommended facility type and respective preferred design.

It is critical that the City of Sault Ste. Marie and its partners accept the need to be flexible and to introduce minimum cycling facility designs at locations where they are deemed appropriate. Without this flexibility, achieving a connected bicycle route network in Sault Ste. Marie within 10 years will not be realized. In addition, the costs of improving existing roadways to accommodate preferred paved shoulder and bike lane design could be prohibitive and therefore, little will be accomplished.

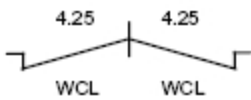
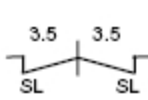
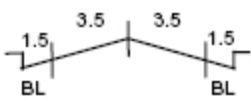
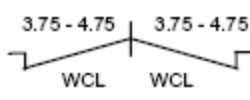
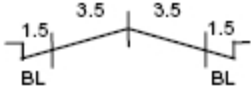
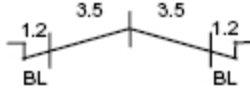
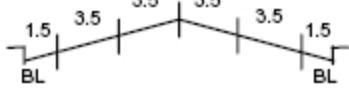
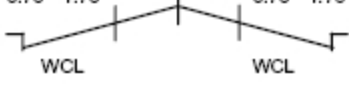
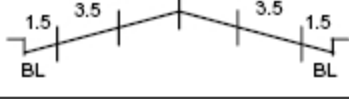
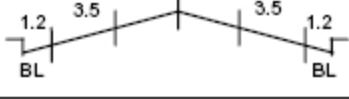
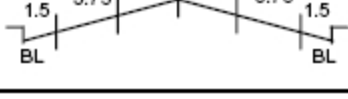
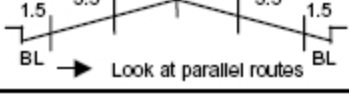
It is therefore important to establish thresholds for applying minimum bicycle route design standards or guidelines, although the preferred design should always be assumed for planning purposes and determining right-of-way policy. Tables 4.12 and 4.13 outline the recommended guidelines for retrofitting City roads having urban or rural cross-sections, to accommodate cycling facilities in both ideal and constrained conditions. The threshold values indicated in these tables are not meant to be prescriptive. Rather, they are meant to serve as a guide to assist bikeway planners and engineers in the decision-making process when attempting to retrofit existing roads for cycling facilities. Good engineering judgement should be used at all times during this process. The City of Sault Ste. Marie



should use the retrofitting guidelines identified in Tables 4.12 and 4.13 as a guide when installing cycling facilities on new and / or existing roads.

If a preferred cycling facility such as a bike lane, is not deemed as feasible for installation, then consideration should be given to installing a shared-roadway cycling facility and signed-only cycling route along a wide curb lane. If a wide curb lane is not available, then the route should be designated as a signed-only bicycle route at a minimum if the segment forms part of a continuous network and no other reasonable alternate routes are available.

Table 4.12: Retrofitting Urban Roads for Cycling Facilities in the City Sault Ste. Marie

Road Configuration and Characteristics	Preferred Standard	Minimum or Interim Solution (Constrained Projects)
a) 2 Lane Urban ≤ 3,000 AADT / Lane ≤ 60 km/h ≤ 6% Trucks Not CVR		
b) 2 Lane Urban > 3,000 AADT / Lane ≤ 60 km/h 6% ≤ 12% Trucks Not CVR		
c) 2 Lane Urban > 3,000 AADT / Lane > 60 km/h > 12% Trucks CVR		
d) 4 Lane Urban ≤ 10,000 AADT / Lane ≤ 60 km/h ≤ 12% Trucks CVR		
e) 4 Lane Urban > 10,000 AADT / Lane ≤ 60 km/h > 12% Trucks CVR		
f) 4 Lane Urban > 10,000 AADT / Lane > 60 km/h > 12% Trucks CVR		

BL = Bike Lane    WCL = Wide Curb Lane    SL = Shared Lane    CVR = Commercial Vehicle Route



Table 4-13: Retrofitting Rural Roads for Cycling Facilities in the City of Sault Ste. Marie

Road Configuration and Characteristics	Preferred Standard	Minimum or Interim Solution (Constrained Projects)
a) 2 Lane Rural ≤ 3,000 AADT / Lane ≤ 80 km/h ≤ 6% Trucks Not CVR Good Sight Lines		
b) 2 Lane Rural > 3,000 AADT / Lane ≤ 80 km/h 6% ≤ 12% Trucks Not CVR Good Sight Lines		
c) 2 Lane Rural > 3,000 AADT / Lane ≤ 80 km/h > 12% Trucks CVR Good Sight Lines		
d) 2 Lane Rural > 10,000 AADT / Lane ≤ 80 km/h > 12% Trucks CVR Good Sight Lines		
e) 4 Lane Rural ≤ 10,000 AADT / Lane ≤ 80 km/h ≤ 12% Trucks CVR Good Sight Lines		
f) 4 Lane Rural > 10,000 AADT / Lane ≤ 80 km/h ≥ 12% Trucks CVR Good Sight Lines		
PSL = Paved Shoulder Lane	SL = Shared Lane	CVR = Commercial Vehicle Route

**NOTES:**

1. On roads with poor sight lines, preferred standards should always apply. Consideration should also be given to an additional clearance width of 0.5 m in the paved shoulder.
2. Assumes paved shoulders have an adjacent granular shoulder, which are typically 1.0 m or more in width.
3. In very constrained situations and if supported by good engineering judgement, consideration may also be given to the use of edge lines as illustrated in “a)” above.
4. The values indicated in these tables are suggested thresholds and are not meant to be prescriptive. Rather, these thresholds are meant to serve as a guide to assist bikeway planners and designers in the decision-making process when attempting to retrofit existing roads for cycling facilities. A decision to select one cycling facility type over another will also be influenced by other factors. These may include the type and density of adjacent land uses, driveway frequency, collision information, municipal streetscape and/or urban design planning objectives for a particular road or road segment, and local community preferences.





**Guidelines:**

*4.41: Adopt the retrofitting guidelines recommended in Tables 4.12 and 4.13 of the Planning and Design Guidelines in Chapter 4 of the Sault Ste. Marie Cycling Plan.*

*4.42: If thresholds recommended in this Plan determine that the preferred standard for a cycling facility cannot be accommodated, then the minimum or interim solution should be considered. If a bike lane, for example, cannot be installed, then consideration should be given to installing a wide curb lane or at a minimum a signed-only cycling route if thresholds permit and no other alternate routes are available.*

## **4.4 Network Design Features**

### **4.4.1 Intersection Treatments**

#### **4.4.1.1 Pavement Markings**

Cycling related pavement markings are applied in various situations including paved shoulders, wide curb or shared lanes, as well as exclusive cycling lanes. The application of comprehensible pavement markings helps to direct both motorists and cyclists to safely manoeuvre through intersections as well as directing them along roads. The application becomes even more important at complex intersections or at locations where there is a significant amount of cyclist traffic.

In Ontario there are three primary references for bicycle route pavement markings: MTO's *Ontario Traffic Manual - Book 11* (OTM, 2000), TAC's *Geometric Design Guide for Canadian Roads* (GDGCR, 1999), and TAC's *Bikeway Traffic Control Guidelines for Canada* (1998). Although there are some minor differences, the bicycle route pavement marking guidelines from each of these references are similar with one exception. The OTM – Book 11, does not include the diamond reserve symbol in its recommended bike lane pavement markings. In place of the symbol, the OTM recommends the use of the word “ONLY”. However, *OTM – Book 5, Regulatory Signs* (2000) continues to require on-road lanes reserved for bicycles to be signed with Reserved Bike Lane signs (Rb-84). These signs include the diamond symbol on the top left corner of the sign.

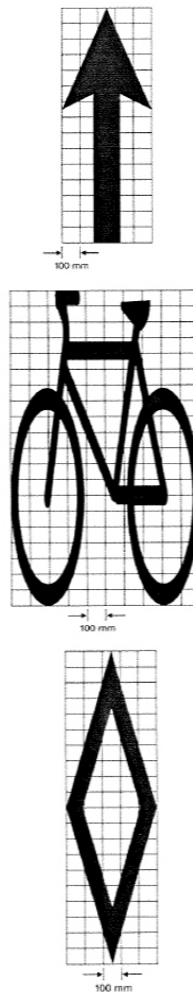
Since OTM – Book 5 requires the use of reserved lane signing for designated bike lanes, and TAC continues to recommend the use of the diamond pavement marking as a national standard for lanes reserved for bikes, it is recommended that the City of Sault Ste. Marie adopt the TAC pavement marking standard, including the diamond symbol, but excluding the “ONLY” lettering for new bike lanes in the City with the exception of those where parking is permitted as shown in the photo below. Figure 4.16 illustrates the TAC pavement marking standards that should be used for all future bike lanes constructed in the City of Sault Ste. Marie.



Example of bicycle lane pavement markings in Toronto (Source: MMM)



Figure 4.16: Bicycle Lane Pavement Markings



Source: Bikeway Traffic Control Guidelines for Canada, TAC, 1998

**Guideline:**

**4.43:** *Adopt the modified TAC pavement marking standard, including the diamond symbol and excluding the “ONLY” text, for new bike lanes in the City with the exception of those where parking is permitted.*

**4.4.1.2 Bike Lanes / Paved Shoulders at Intersections**

Bicycle lane lines delineate the edge of a travelled lane dedicated for bicycle use, where travel is permitted in the same direction on both sides of the line. Bicycle lane lines direct motor vehicles and bicycles into appropriate lanes, and provide for efficient and safe use of the road. TAC's *Bikeway Traffic Control Guidelines for Canadian Roads* (1998) suggests bicycle lane lines should be solid, white in colour, with a width of 100 mm. Edge lines used to delineate a curb lane from a paved shoulder bikeway should conform to the requirements of the OTM.



For paved shoulder bikeways, it is recommended that these facilities be marked using a standard edge line to separate the travel lane from the paved shoulder, complemented by bikeway route signing.

***Guideline:***

***4.44: Lane lines for bikeway facilities in Sault Ste. Marie should conform to the requirements of the Ontario Traffic Manual or the TAC Bikeway Traffic Control Guidelines for Canada.***

Cycling facilities at intersections should be carefully designed to encourage the safe and predictable movement of pedestrians, motorists and cyclists. Since intersections are the most likely area for conflict between various users of the roadway, care should be taken to design and mark the intersection approach such that all users understand and can anticipate the potential movements of other road users.

One of the most common conflicts at intersections occurs between right turning motor vehicles and cyclists proceeding straight through, since it is necessary for these two road users to cross paths. Pavement markings and appropriate signing should be installed at intersections to encourage such crossings in advance of the intersection, rather than within it (e.g. through the provision of an exclusive right-turn lane or an advanced stop bar for cyclists).

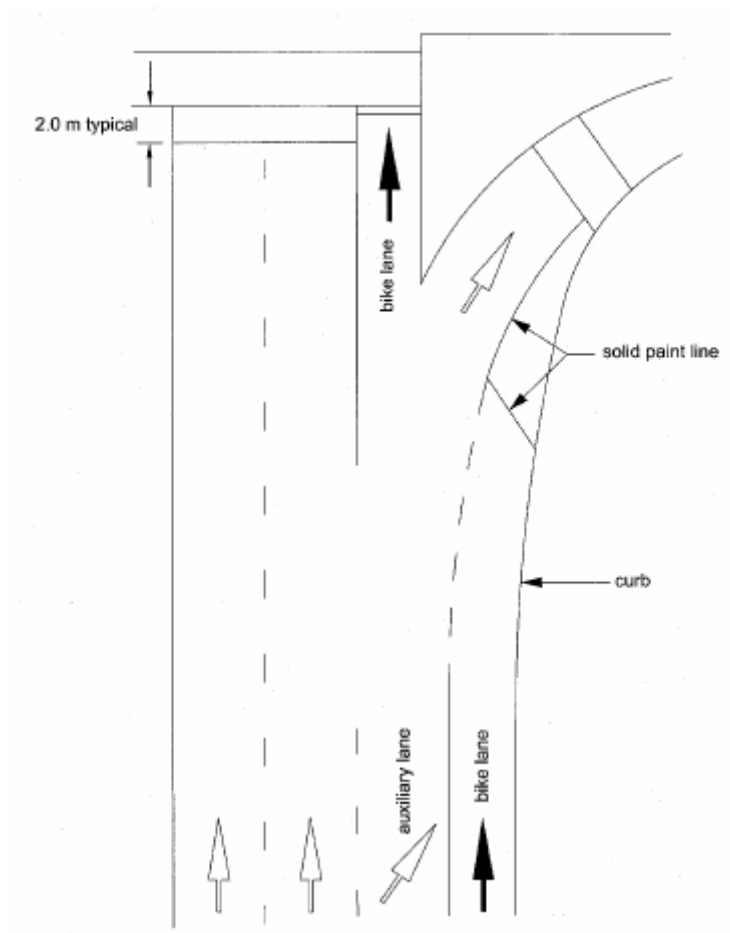
Left turning cyclists must also undertake a similar weaving manoeuvre through vehicular traffic. Cyclists may elect to undertake a “vehicular style” left turn by using the motor vehicle left turn lane, or they may choose to complete a “pedestrian style” turn by proceeding straight through the intersection, then turning left to cross again on the intersecting road.

In the case of both paved shoulders and bike lanes, pavement markings should change from a solid to a broken line on the approach to the intersection. Alternatively, though not preferred, the bike lane can be discontinued if there is insufficient pavement width. The bike lane or edge line markings should be discontinued at the start of the taper when right turn lanes or channelizations are provided, or otherwise a broken line should be used, a minimum of 30 m from a signalized intersection and 15 m from an unsignalized one. This allows cyclists to merge with other traffic and prevents right turning motorists from having to cross through a bike lane to make their turn, thereby cutting off cyclists at the intersection. By discontinuing the solid bike lane / edge line pavement marking, both the cyclists and motorists are made aware of the fact that they are sharing a common lane and should react accordingly.

Figures 4.17 to 4.19 illustrate a series of recommended intersection configurations with on-road bike lanes or paved shoulder cycling facilities. Figures 4.17 and 4.19 are from MTO’s *Ontario Traffic Manual – Book 11* (OTM, 2000) and TAC’s *Bikeway Traffic Control Guidelines for Canada* (1998). The TAC Guidelines include a series of 31 figures that illustrate typical bikeway applications at intersections.



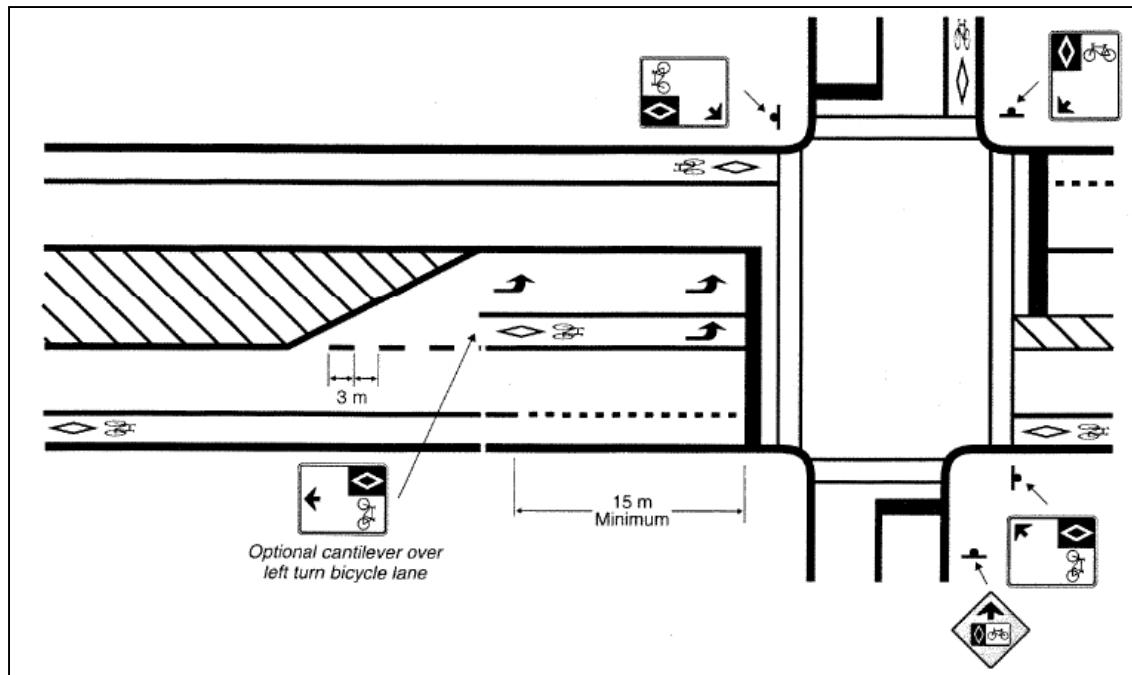
Figure 4.17: Typical Pavement Marking for Bicycle Lane at Right Turning Roadway



Source: Ontario Traffic Manual – Book 11, MTO, 2000

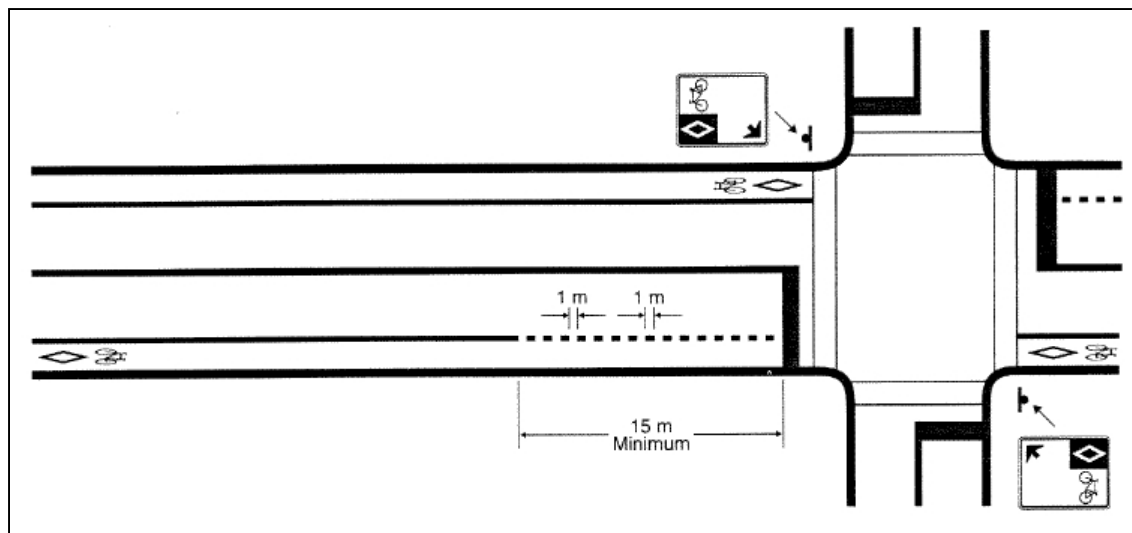


Figure 4.18: Left Turn Vehicle Lane



Source: Bikeway Traffic Control Guidelines, TAC, 1998

Figure 4.19: Bicycle Lane Adjacent to Through / Right Turn Lane



Source: Bikeway Traffic Control Guidelines, TAC, 1998



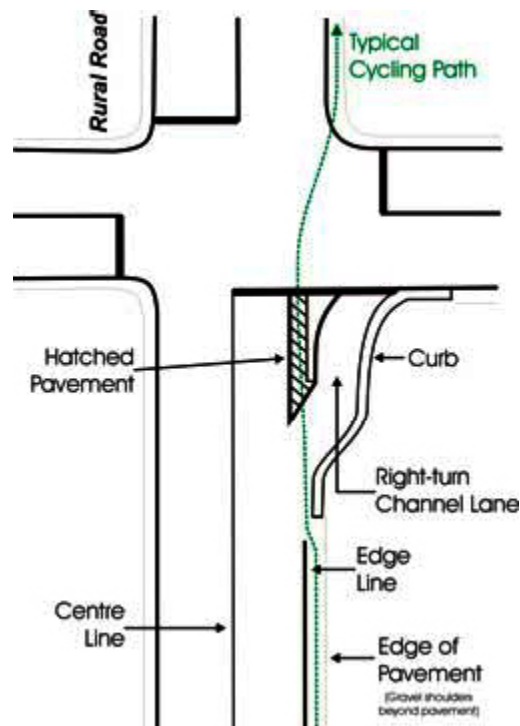
**Guidelines:**

*4.45: Design cycling facilities at intersections to encourage safe and predictable movement of pedestrians, motorists and cyclists.*

*4.46: Pavement markings and signing should be installed at intersections to encourage intersection crossings between right-turning motorists and cyclists proceeding straight through in advance of the intersection, rather than within it.*

In Sault Ste. Marie, there are currently paved shoulders that are not specifically designed for cyclists but are used by cyclists. Paved shoulders that are not designed, as specific cycling facilities either have no pavement marking treatment, or have pavement markings applied for other uses not related to cycling facilities. For example, where a rural road with a paved shoulder along its length gets a curb added on its approach to an intersection, and a right turn channelization lane is also present without a deceleration zone. What typically occurs in this situation is that the paved shoulder ends at the point where the right-turn channel begins. The remaining section of roadway leading to the stop bar is then marked with cross-hatching. Figure 4.20 illustrates this situation. Cyclists typically ride in this hatched section, but it is not designated as a cycling facility.

Figure 4.20: Hatched Pavement at Intersections on Rural Roads



This “hatched” pavement area typically forms a substandard cycling facility and is not intended for cycling use. However, cyclists use this area regardless. The implication, however, is that the City would not be responsible for cyclists using such shoulders since they are not designated cycling facilities, and this may be reflected in the design through the use of inappropriate pavement markings or inadequate width to deter cycling use. If the width of the hatched area is less than 1.2 m, it should not be designated as an on-road cycling facility. However, if the width of the hatched area is equal to or greater than 1.2 m, consideration may be given to removing the hatch striping and applying bicycle stencils, diamonds and





arrows to designate the area as a bike lane. This, however, is dependent on the type of cycling facility that is present on the approach to the intersection and on the far side.

If substandard cycling facilities were present on the approach and far side of this short bike-lane, it would not make sense to designate the “hatched area” as a bike lane since it would be a stand-alone segment that is not connected to any other formal cycling route. If the “hatched” segment forms part of a continuous cycling route and it is of sufficient width ( $> 1.2$  m), then it is recommended that the hatched area be designated as a formal cycling facility.

### **Guideline:**

*4.47: The “hatched” area along rural paved shoulders at intersections with right-turn lane curbs should not be designated as an on-road cycling facility unless it is greater than 1.2 m in width and it forms part of a designated cycling route.*

### **4.4.1.3 Coloured Pavement Surfaces**

The application of coloured surfaces and asphalt to indicate the presence of bike lanes on merge zones has been used in numerous cities around the world, especially in Europe. Red surfacing is used in the Netherlands and blue pavement colouring has been tested in Montreal and in Portland, Oregon. In the City of Portland, cyclist and motorist behaviour was observed before and after the application of “blue” bicycle lanes to determine which users, cyclists or motorists, yielded to the other at intersections. It was observed that 28% of cyclists yielded to motorists and 72% of motorists yielded to cyclists. After the application of the coloured bicycle lanes, 8% of cyclists yielded to motorists and 92% of motorists yielded to cyclists.<sup>10</sup>



Coloured Pavement, Montréal

The application of the coloured pavement helped to identify priority at intersections, as motorists were made more aware of the presence of cyclists. The blue bike lanes gave cyclists an increased feeling of safety when passing through intersections, resulting in fewer cyclists slowing, stopping or turning their heads when entering a “blue” area. Approximately 75% of the cyclists surveyed felt that the areas with the coloured pavement were safer than before, and 58% of cyclists stated that motorists were yielding more than they were before the blue bike lanes were installed.<sup>11</sup>

Results from a similar survey conducted in Montreal indicated a small decrease in motor vehicle / cyclist conflicts, an increase in motorists yielding, and a decrease in cyclists slowing or turning their heads when crossing through intersections.<sup>12</sup> The photo below illustrates an example of coloured pavement surfaces in the City of Montreal.

The application of coloured pavement has not been standardized in Canada, however, the application of coloured pavement may be beneficial at complex intersections with high conflict areas where cyclist priority is not respected and standard pavement markings do not suffice. It should also be noted that special signing is typically used at locations where coloured pavement is applied, indicating the priority movements at an intersection. Figure 4.21 illustrates an example of the signing used in Portland at intersections with blue bike lanes.

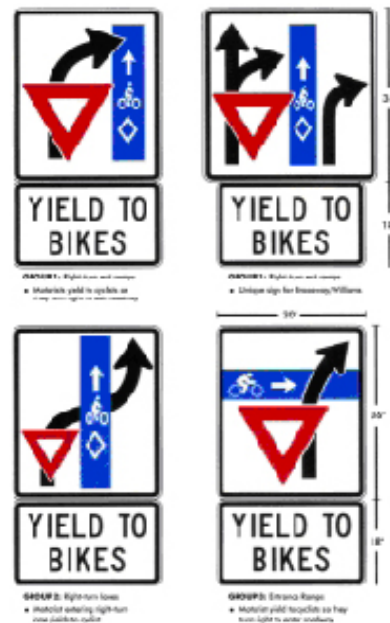
<sup>10</sup> City of Portland, Office of Transportation, Portland’s Blue Bike Lanes: Improved Safety through Enhanced Visibility, July 1, 1999.

<sup>11</sup> Ibid.

<sup>12</sup> Ibid.



Figure 4.21: Signing Used in Conjunction with Coloured Pavement



Source: City of Portland, Oregon

The cost of coloured pavement varies depending on the colour being selected for use. Based on a review of paving companies, blue pavement colouring is typically more expensive than red. However, the selection of blue coloured pavement tends to be the most sensible solution when compared to other colours such as red, yellow and green, some of which are used for bike lanes elsewhere around the world.

The colours red and green have specific meaning in regards to traffic engineering, where “red” implies stop, green implies “go” and yellow indicates an opposing traffic flow.<sup>13</sup> The colour blue is a “neutral” colour in the context of traffic engineering. Furthermore, the colour blue will show up in limited visibility conditions such as during fog, light rain and other wet conditions. Also, persons who are colour blind have difficulty identifying earth tone colours such as red and green. The cost of blue bike lanes using micro-surfacing techniques and a clear binder can range in the \$7 to \$11 / linear metre range while full depth coloured asphalt is approximately \$65 / linear metre. Should coloured bike lanes be considered for installation for segments of the Sault Ste. Marie cycling network, the colour blue is the recommended colour for application.

Another option to consider in the application of coloured pavement surfaces is micro surfacing. Currently, the Town of Richmond Hill, Ontario is experimenting with this treatment where colour pigment is mixed with asphalt when it is laid, resulting in a surface that is coloured, but has the same tactile features of bare asphalt. This method is significantly less expensive than traditional pavement colouring. Not much is known about micro surfacing’s long-term durability, although tests are currently underway. An application of micro surfacing is shown in the photo.



Microsurfacing, Town of Richmond Hill  
(Source: SGE Acres Ltd.)

<sup>13</sup> Portland Transportation, Bicycle, Blue Bike Lanes for Bicycle Safety, Bicycle Programs – Blue Bike Lanes, 2004. <http://www.trans.ci.portland.or.us/bicycle/bluebike.htm>



**Guidelines:**

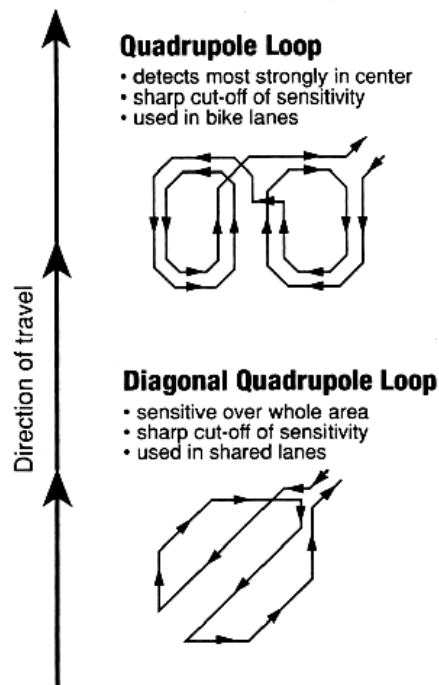
- 4.48: *Coloured pavement treatments should be considered at intersections with complex geometry or in areas with high conflict zones between cyclists and motorists.*
- 4.49: *Appropriate signing should be used in conjunction with the coloured pavement to identify to both motorists and cyclists the priority at an intersection.*
- 4.50: *Micro-surfacing should be considered by the City of Sault Ste. Marie as a possible option for the demarcation of bicycle lanes.*

#### 4.4.1.4 Cyclists Crossing at Traffic Signals

Many traffic signals in Sault Ste. Marie are activated by detector loops embedded in the roadway, which respond to the magnetic field induced by the metal in a motor vehicle. Bicycles can also be considered in the timing of traffic signals and in the selection, sensitivity and placement of vehicle detection devices. Since bicycles have much less ferrous metal than automobiles, the sensitivity of the detector loop is adjusted accordingly for greater responsiveness to bicycles.

The installation of detector loops with different configurations, such as a quadruple loops, detect more than just motor vehicles. Figure 4.22 illustrates the layout of Quadruple and Diagonal Quadruple loop detectors. The detection of bicycles at signalized intersections minimizes the potential for a cyclist to disobey the unchanged signal, and it is recommended that the City consider this practice.

Figure 4.22: Quadruple and Diagonal Quadruple Loop Detectors



Source: Traffic Signal Detection Study, City of San Diego, 1985

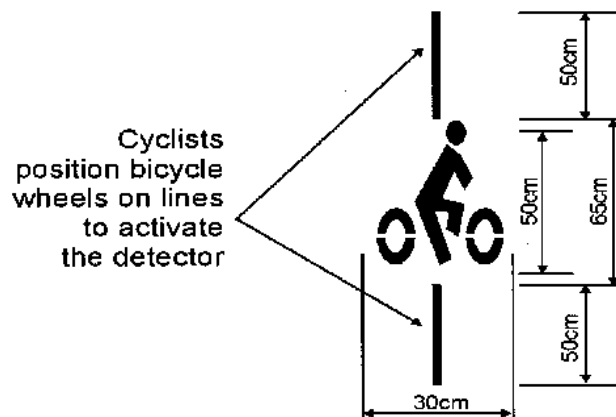


The application of three yellow or white dots on a road has been used in Ottawa and Toronto respectively, with the dots placed at the location where cyclists should position themselves at an intersection to be detected. Reviews of this application indicate that in some circumstances, cyclists are not aware of the purpose of the three dots, or even that they must be present in the zone of detection to initiate a signal change. The success of a bicycle actuating a signal is dependent on the cyclist not only knowing that there is a detection system, but also knowing how to use it. Even though the sensitivity of the detectors may be adjusted, the effectiveness of the detectors is limited if the cyclist is not properly located in the actuation zone. More distinct pavement markings such as a small bicycle symbol with a directional arrow and additional signing may be investigated to improve the effectiveness of this form of bicycle detection advisory system. Figure 4.23 illustrates an example of pavement markings that may be applied at intersections to help direct cyclists to the appropriate actuation zone.



"Three white dots" used for bicycle detection at intersections

Figure 4.23: Example of Detector Loop Pavement Markings



Another alternative is to utilize a pedestrian style push-button to actuate traffic signals for cyclists. These should be located on the curbside, separate from the pedestrian push-button. The Transportation Association of Canada (TAC) is currently developing traffic signal guidelines for bicycles (Project #226). The purpose of this project is to develop a guideline for the safe accommodation of bicycles at signalized intersections. The expected outcome is the acceptance of an exclusive "Bike Signal", similar to that in use in Quebec, the United States and throughout Europe.

Figure 4.24 illustrates a Bicycle Signal head that TAC is currently assessing as a potential national standard. It should be noted, however, that the bicycle traffic signal currently under development are not meant to be rigorously applied as a standard traffic signal that can be used to adequately accommodate cyclist movements through intersections. Therefore, the installation of bicycle traffic signals should only be considered in "extreme" situations, such as where a signalized intersection may not be standard in geometry, or where the right-of-way for a cyclist riding through an intersection may not be clear. Until traffic signal guidelines for cyclists are standardized, it is recommended that the City of Sault Ste. Marie adopt the three dot program.



Figure 4.24: Example of Bicycle Signal Head Currently Under Assessment



#### ***Vulnerable Road Users***

A Vulnerable Road User (VRU) is a term used to encompass many different groups who utilize a transportation network. Vulnerable road users include those who are not the occupants of a personal, commercial, transit, emergency or other common motorized vehicle.<sup>14</sup>

Vulnerable road users include:

- Pedestrians;
- Cyclists; and
- In-line skaters / Scooter riders / Skateboarders.

Since cyclists are classified as vulnerable road users, consideration and care must be given when designing facilities for their use. VRU conflicts can take many forms, have multiple contributing factors, and occur in different places within our transportation systems. Common cycling related conflicts with other road users include:

- Cyclist proceeding through an intersection past a stop sign conflicting with an approaching motor vehicle;
- Motorist proceeding through an intersection past a stop sign conflicting with an approaching cyclist;
- Motorist making a left-turn through an intersection conflicting with a cyclist proceeding straight across the intersection; and
- Motorists making a right turn conflicting with a cyclist proceeding straight across the intersection.

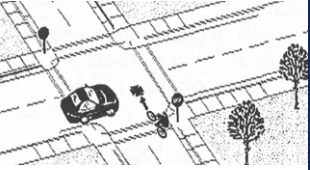
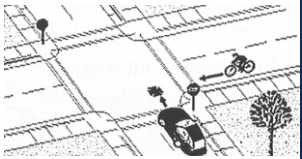
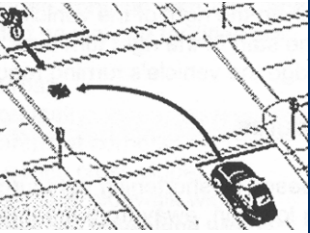
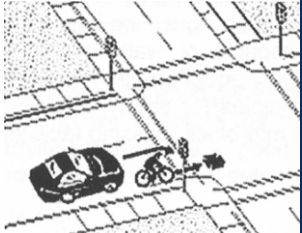
Table 4.14 identifies and illustrates these common cycling related collisions and provides preventative measures for minimizing their potential to occur.

---

<sup>14</sup> TAC, Safety Conscious Design for Vulnerable Road Users, McCormick Rankin Corporation for Transportation Association of Canada, 2004.



Table 4.14: Common Cycling / Motor Vehicle Collisions at Intersections

<b>Conflict</b>	<b>Possible Causes</b>	<b>General Countermeasures</b>
<p><i>Cyclist riding through intersection past a Stop Sign.</i></p> 	<ul style="list-style-type: none"> <li>▪ Cyclist ignores the traffic controls.</li> <li>▪ Cyclist incorrectly assumes there are not any vehicles on the road.</li> <li>▪ There are visual obstructions.</li> <li>▪ Cyclist is unable to stop.</li> <li>▪ Vehicles approach the intersection at high speeds.</li> <li>▪ The motorist has incorrect expectations.</li> <li>▪ The cyclist is unfamiliar with correct control procedures.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Enforce cyclist's compliance to traffic controls.</li> <li>▪ Improve sightlines for cyclists and motorists.</li> <li>▪ Educate cyclists on traffic control, bike maintenance and performance.</li> <li>▪ Educate motorists on common cyclist behaviours.</li> <li>▪ Provide <i>STOP</i> or <i>YIELD</i> pavement markings, advanced warning signs or pavement texturing.</li> </ul>
<p><i>Motorist driving into an intersection past a stop sign.</i></p> 	<ul style="list-style-type: none"> <li>▪ The intersection has a high incidence of driver stop violations.</li> <li>▪ The motorist stops beyond the stop bar, impacting cyclists on the sidewalk or in the nearest lane.</li> <li>▪ There are visual obstructions.</li> <li>▪ The cyclist is travelling facing traffic but beyond the motorist's primary viewing area.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reconfigure the intersection as a general roundabout.</li> <li>▪ Improve sightlines for cyclists and motorists.</li> <li>▪ Install "Stop Here" signs.</li> <li>▪ Install "Watch for Cyclists" signs.</li> <li>▪ Paint "Use Caution" on the sidewalk at hazardous locations.</li> <li>▪ Add a crosswalk and an adequate stop bar setback.</li> <li>▪ Provide cyclist and driver education programs.</li> </ul>
<p><i>Motorist making a left-turn – facing a cyclist.</i></p> 	<ul style="list-style-type: none"> <li>▪ Intersection has wide turning radius that encourages high speeds.</li> <li>▪ The motorist, coming to a stop, travels into the intersection.</li> <li>▪ The cyclist's travel path is outside the motorist's primary viewing area.</li> <li>▪ The cyclist incorrectly anticipates the motorist's left turning behaviour.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Tighten the left turn radii.</li> <li>▪ Channelize the intersection.</li> <li>▪ Reconfigure the intersection as a modern roundabout.</li> <li>▪ Improve sightlines for cyclists and motorists.</li> <li>▪ Prohibit permissive left turns.</li> <li>▪ Provide protected left turns.</li> <li>▪ Reroute pathways a minimum of 30 metres from the intersection.</li> <li>▪ Alert motorists with a "Yield to Approaching Cyclists" sign.</li> <li>▪ Alert cyclists with a "Watch for Turning Vehicles" sign and / or pavement markings in bike lanes or multi-use pathways.</li> </ul>
<p><i>Motorist making a right-turn at intersection beside a cyclist.</i></p> 	<ul style="list-style-type: none"> <li>▪ The vehicle approaches the turn at high speed.</li> <li>▪ The cyclist overtakes a slow moving vehicle.</li> <li>▪ The bicycle sign stops immediately to the right of the vehicle.</li> <li>▪ Weaving conflicts occur at the start of the right turn lane.</li> <li>▪ The motorist or cyclist misjudges the vehicle's turning requirements.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Reduce vehicle approach speeds by shortening right turn radii.</li> <li>▪ Provide a separate crossing location, away from the intersection, for bike lanes.</li> <li>▪ Place the vehicle stop line in advance of the bike lane stop line.</li> <li>▪ Educate cyclists and motorists.</li> <li>▪ Install a "Begin Right Turn, Lane, Yield to Bikes" sign.</li> <li>▪ Improve signing in general for cyclists and motorists.</li> </ul>

Source: Safety Conscious Design for Vulnerable Road Users, McCormick Rankin Corporation – Licensed to TAC, 2004





The design of cycling facilities must account for a number of facility types such as shared roadways, bicycle lanes, and off road cycling pathways. The main points to consider regarding safety conscious design for cyclists at intersections include:

**Heavy right turn cycling movements:** If the majority of cyclists are turning right, a bike lane can be placed to the right of the vehicle turn lane and wrapped around the corner;

**Tee Intersections:** If bike lanes are present on a T-intersection approach, the bike lane should be dropped early enough for cyclists to slide across into the proper turning lane;

**Dedicated bike lanes in high volume intersections:** Where there is a very high traffic volume, consideration should be given to providing dedicated left and right-turning bicycle lanes;

**Offset through lanes and pavement markings:** Where intersection through-lanes are offset, pavement markings should be clear enough to guide the driver and cyclist through safely;

**Provide cyclists options to walk or ride through:** For through-moving cyclists, the option should be available for cyclists to either navigate the intersection like a vehicle, or dismount at the curb and walk their bike over the crosswalk;

**Provide left-turning cyclists options to walk or ride:**

Cyclists making a vehicular-style left turn on a multi-lane roadway have to cross over one or more through travel lanes, which may intimidate inexperienced riders. Therefore, the option should be available for them to dismount and walk their bikes across two legs of the intersection to proceed.

**Guidelines:**

*4.51: Consider bicycles in the timing of traffic signals at intersections and in the selection, sensitivity and placement of vehicle detection devices wherever there is bicycle traffic.*

*4.52: The addition of pavement markings is recommended to increase the efficiency of bicycle detection at intersections to actuate either a mixed traffic or bicycle signal phase. These pavement markings could also help to direct cyclists to the actuation zone and to position themselves properly in the lane.*

*4.53: The general countermeasures indicated in Table 4.1 should be considered for minimizing common motor vehicle and cyclist collisions.*

#### **4.4.1.5 Advanced Stop Bars and Bike Boxes**

Advanced stop bars allow cyclists to stop closer to the intersecting roadway than other motor vehicles by placing the bicycle stop bar about 2 m closer to the cross street than the stop bar for other motor vehicles. This practice allows cyclists to be more visible to motorists that are queued at a traffic signal, and also to get a “head-start” or “queue-jump” over motorized traffic. The left photo below illustrates the application of an Advanced Stop Bar.



Advanced Stop Bar, Australia



Bike Box, Netherlands (Source: ITE Pedestrian and Bicycle Council)



Bike Box, Germany

Bike Boxes are used at locations where left-turning cyclist volumes may be very high approaching an intersection. In this situation, the motor vehicle stop bar is set back approximately 4 m, helping cyclists move from the curb lane and turn left by positioning themselves in front of the motor vehicles. The right photo above shows an application of a bike box at an intersection. It should be noted that the application of bike boxes restricts right turns on red displays for motor vehicles. Advanced stop bars and bike boxes may be considered at locations where cyclist volumes are high and measures are being considered to give cyclists more priority at intersections, for example by adjusting signal timings or phasing sequences.

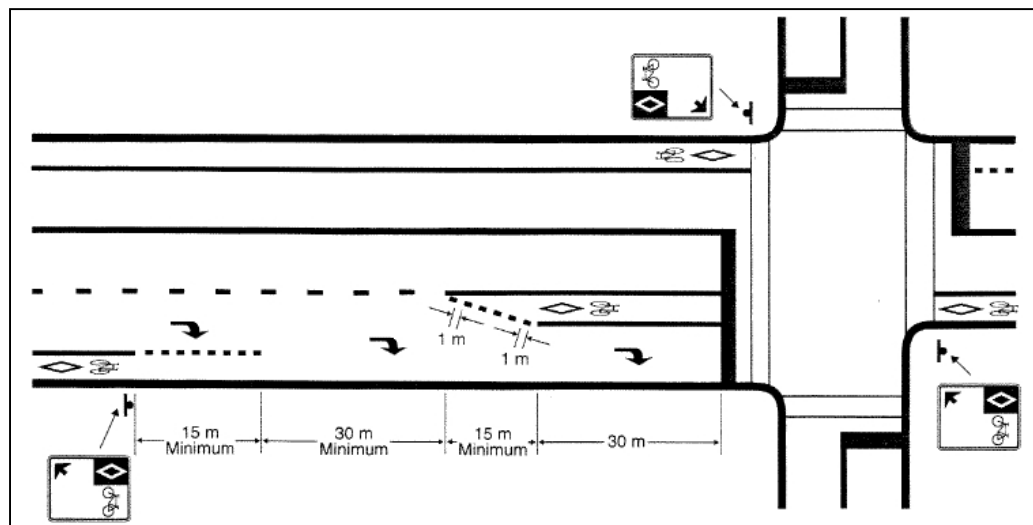
**Guideline:**

*4.54: Advanced stop bars and bike boxes should be considered at locations in the City of Sault Ste. Marie where cyclist volumes are high and measures are being considered to give cyclists more priority at intersections (e.g. adjusting signal timings or phasing sequences).*

#### 4.4.1.6 Bike Pockets

“Bike pockets” can be defined as a discontinuous dedicated space on the traveled portion of the roadway intended for use by cyclists that are delineated by pavement markings. An example of a bike pocket used in conjunction with a bicycle lane is illustrated in Figure 4.25.

Figure 4.25: “Bicycle Pocket” (Bicycle Lane Adjacent to Curb Lane Transition)



Source: Bikeway Traffic Control Guidelines for Canada, TAC, 1998



It should be noted that bike pockets have been effectively used in a variety of locations throughout Ontario such as the City of Ottawa where no bike lanes are present or where a bicycle lane ends. The most common use for a bicycle pocket is to show where cyclists should position themselves when adjacent to a right turn lane or a right turn channel. The critical dimension, as illustrated in Figure 4.25, is the 60 m segment between the end of the curbside bike lane and the beginning of the bike lane on the left side of the right turn lane. This minimum 60 m transition zone should be maintained between the curbside cycling facility and the bike pocket, left of the right turn lane / channel, whether the curbside facility is a bike lane, paved shoulder or signed-only route.

***Guidelines:***

*4.55: The use of bike pockets in the City of Sault Ste. Marie is recommended.*

*4.56: The minimum 60 m transition zone between the curbside cycling facility, and the bike pocket, left of the right turn lane / channel, should be maintained, whether the curbside facility is a bike lane, paved shoulder or signed-only route.*

#### **4.4.2 Bike Lanes Between Two Motor Vehicle Travel Lanes**

Very long ancillary lanes adjacent to the curb on arterial roads, notably merge / diverge lanes on arterial roads at expressway interchanges, can create a situation where a bike lane is “sandwiched” between two traffic lanes over a considerable distance. Locations where these situations occur typically take place on roadways with posted speed limits of 80 km/h with merging and diverging traffic. These conditions may not be comfortable for cyclists, and designers should consider limiting the maximum length for such a situation.

Based on the TAC *Bikeway Traffic Control Guidelines for Canada* (1998), the distance required to bring a cyclist from a curbside bike lane into a bicycle pocket on the left side of a right turn lane is 90 m as illustrated in Figure 4.25. As shown in Figure 4.25, the 90 m distance includes the length of the bicycle lane on the left side of the right-turn lane. In actuality, the 60 m merging distance between the curbside bike lane and the bike lane between the two travel lanes is the most critical since it is the merging area between cyclist and motor vehicle traffic. Doubling the 60 m distance to represent the total distance that a bike lane would be brought back across the right-turn lane on both ends of a roadway segment equates to a total distance of 120 m. If the roadway segment between two intersections is greater than 240 m (120 m x 2) and a bike lane is present between two motor vehicle travel lanes, consideration might be given to relocating the bike lane to the curbside of the roadway, and the application illustrated in Figure 4.25 applied at each end of the roadway.

If the roadway segment is less than 240 m in length, then it is recommended that a 2.0 m bike lane be placed between the two motor-vehicle travel lanes.

***Guideline:***

*4.57: When a bicycle lane situated between two motor vehicle travel lanes extends for a distance greater than 240 m, consideration may be given to relocating it to the curbside of the roadway with the applications recommended by TAC for a Bicycle Lane Adjacent to a Curb Lane Transition applied at each end of the roadway.*



#### **4.4.3 On-Road Cycling Facilities on Bridge Structures and Highway Interchanges**

The key consideration in designing bicycle facilities across bridges and through interchanges is the safety of cyclists. The separation of non-motor vehicle traffic from motor vehicle traffic, either through pavement markings or fully separated facilities, is often recommended to reduce the potential for conflict between these two types of road users, especially on arterial and collector roads.

The width of bridge structures tends to be significantly less than the right-of-way width of the abutting roadway, typically only providing sufficient width for the traveled lanes plus a raised sidewalk. Hence, these types of structures tend to constrict the flow of bicycle traffic. This section serves to review the needs of pedestrians and cyclists, and the design considerations associated with bridge structures.

It is an agencies duty to provide safe roadway conditions to all legal users, including cyclists unless they are prohibited from using the roadway. Therefore, provisions should be made to ensure that cyclists are accommodated on all structures, either through exclusive bike lanes or through the designation of a wide multi-use trail in place of the sidewalk.

##### **4.4.3.1 Current Bridge Standards**

###### ***Canadian Highway Bridge Design Code***

The design of new structures or the modification of existing bridges must now comply with the standards of the *Canadian Highway Bridge Design Code* (2002). The following is an excerpt relating to the structure geometry:

“Roadway and sidewalk widths, curb widths and heights, together with all other geometrical requirements not specified in the Code, shall comply with the standards of the Regulatory Authority (MTO Geometric Design Manual), or in their absence, with the *TAC Geometric Design Guide for Canadian Roads*.”

“Sidewalks and cycle paths shall be separated from traffic lanes by a barrier or guide rail, or by a curb having a face height of at least 150 mm and a face slope not flatter than one horizontal to three vertical. Sidewalks and cycle paths not so separated shall be designed as part of the roadway.”<sup>14</sup>

In Ontario, the current MTO *Geometric Design Standards for Ontario Highways* (GDSOH, 1994) does not provide guidelines on offsets (horizontal clearances) at bridges. In the past the *Ontario Highway Bridge Design Code* (OHBDC, 1991) was the guiding document, but this Code is no longer in force since it has been replaced by the Canadian Highway Bridge Design Code effective June 1, 2002. The Canadian Highway Bridge Design Code however, does not provide details on the side clearances required on bridge decks. Side clearances are the distance between the edge of the traveled way and adjacent curb or barrier. Where side clearances on a bridge are wider than the approach roadway shoulder width / side clearance, the bridge side clearance should match that of the approach roadway.<sup>15</sup>

Given that neither the Canadian Highway Bridge Design Code nor Geometric Design Standards for Ontario Highways prescribe current structure clearances and cross section dimensions, MTO in August of 2002 issued a “*Revision Information Sheet for Geometric Design Standards for Ontario Highways*”.

---

<sup>14</sup> CAN/CSA-S6-00 Canadian Highway Bridge Design Code, Section 1.6.2.1

<sup>15</sup> MTO, Revision Information Sheet for Geometric Design Standards for Ontario Highways, Section D.7.2.2.



*Section D.7.2.3* of this document, which now forms part of the *Geometric Design Standards for Ontario Highways*, provides the following direction with regard to curbs and bicycle routes on bridges:

Where required, the widths of sidewalks and bicycle routes on bridge decks should meet the following requirements:

- The edge of a sidewalk adjacent to the roadway on a bridge should match that of the approach sidewalk.
- Where the approach roadway is not provided with a curb, the sidewalk width should be at least 1.5 m.
- Paved bike lane and bicycle route widths should be in accordance with the Ministry's Ontario Bicycle Routes Planning and Design Guidelines. Bicycle routes should be at least 1.5 m wide for one-way traffic.
- The height of curbs should not be less than 150 mm above the adjacent roadway except to match the height of curbs on the approach roadway.
- Curbs should not be used in conjunction with barrier walls except where the curb and the barrier wall are separated by a sidewalk.<sup>16</sup>

*Section D.7.2.5* of the same source also states that:

- Where practicable, underpassing roadway cross-sections should match that of the approach roadway.
- Horizontal clearances from the edge of the through traveled way to the face of an abutment or pier should also meet or exceed the minimum clear zone widths specified in the Ministry's Roadside Safety Manual.

**Table 4.15** sets out the minimum side clearances at bridges prescribed by MTO.

---

<sup>16</sup> MTO, Revision Information Sheet for Geometric Design Standards for Ontario Highways, Section D.7.2.2.





Table 4.15: Minimum Side Clearances at Bridges

	Design Speed (km/h)	Urban Roads			Rural Roads		
		Left	Right		Left	Right	
			No Sidewalk	Sidewalk		No Sidewalk	Sidewalk
<b>FREEWAY 4-LANE DIVIDED</b>	100 to 120	2.5a	3.0 a		2.5a	3.0 a	
<b>FREEWAY MULTI-LANE DIVIDED</b>	100 to 120	2.5 a	3.0 a		2.5 a	3.0 a	
<b>ARTERIAL DIVIDED</b>	90 to 110	2.0 a	2.5 a	1.5	2.0	3.0 a	
	80	2.0 a	2.5 a	1.5	1.5	2.5 a	
<b>ARTERIAL UNDIVIDED</b>	90 to 110	-	2.0	1.5	-	3.0 a	2.5 a
	80	-	2.0	1.5	-	2.5 a	2.0 b
<b>COLLECTOR UNDIVIDED</b>	90 to 100	-	1.25 c	1.0	-	2.5 a	1.5 c
	70 to 80	-	1.25 c	1.0	-	1.5 d	1.25
	60	-	1.0	1.0	-	1.5 d	1.25
<b>LOCAL UNDIVIDED</b>	60 to 80	-	1.0	0.5	-	1.25	0.5 d
<b>Notes:</b> 1. If a barrier is to be placed between the sidewalk and roadway, then clearance should be the same as when there are no sidewalks. 2. All clearance should meet requirements for sight distance. 3. The width of a median on a bridge should match that of the approach roadway. 4. L = Length of bridge between centreline of abutment bearings. a - For bridges with L>50 m, consideration can be given to decreasing the clearances to 1.5 m. b - For bridges with L>50 m, consideration can be given to decreasing the clearance by up to 0.5 m. c - For bridges with L>50 m, consideration can be given to decreasing the clearance by 0.25 m. d - For bridges with L>50 m, consideration can be given to increasing the clearance by up to 0.75 m. e - The values of the clearances given above are the minimum values. Consideration may be given to providing more than the minimum if justification is provided.							

Source: Geometric Design Standards for Ontario Highways, Revision Information Sheet, MTO, February 8, 2002

Additional guidance is provided by MTO's *Ontario Bicycle Routes Planning and Design Guidelines* (1996). The following is an excerpt from this provincial guideline reference related to accommodating cyclists on existing bridges:

"To allow cyclists to cross an existing bridge safely, the structure may require alterations to provide adequate width for all bridge users. A bicycle route can be routed across the bridge in one of three ways:

- Creating a bike lane or shoulder bikeway on the traveled way;
- Reserving a sidewalk for cyclists only or for shared use with pedestrians if there is adequate width; or
- Widening the roadway to permit shared use of the right lane by motor vehicles and bicycles."





The creation of a bike lane on a bridge is an option if the bridge has shoulders, or if the traffic lanes are wide enough to permit the creation of a wide curb lane to accommodate bicycles on the traveled way.

***Guidelines:***

*4.58: The design of on-road cycling facilities on bridge structures should conform to the Canadian Highway Bridge Design Code, the Geometric Design Standards for Ontario Highways (revised as of 2002), and the Ontario Bikeways Planning and Design Guidelines.*

*4.59: The values indicated in Table 4.15 should be referenced for determining the minimum side clearances on bridges when the installation of cycling facilities on bridges is being considered.*

*4.60: The creation of a bike lane on a bridge may be considered if the bridge has shoulders, or if the traffic lanes are wide enough to permit the creation of a wide curb lane to accommodate bicycles on the traveled way*

#### **4.4.4 Accommodating Cyclists in Construction Zones**

During construction / rehabilitation of a roadway, the environment through the construction zone typically features rough pavement, narrow or restricted lanes and heavy machinery. This can be particularly uncomfortable for a cyclist.

When reconstructing a roadway section, especially one that has high bicycle volumes, it is important to maintain safe and convenient access for bicycles through the construction zone. If access is maintained for motor vehicles, then access should also be maintained for bicycles. Ideally, the contractor should provide a temporary facility for cyclists if space is available within the road allowance. While this is not always possible, alternatives to accommodate cyclists should always be considered. If the phasing of construction requires that access to the roadway is closed to vehicular and bicycle traffic at any time, a well-signed detour route should be provided. Similarly, separate detour routes may be required for motorists and cyclists.

Temporary road conditions through the construction zone that are compatible with motor vehicles may not be compatible with bicycles. For example, steel plates and timber decking are typically used to cover excavations in the roadway. Steel plates should be coated with a non-slip surface, and timber decking should be placed at right angles to the direction of travel to prevent a bicycle wheel from falling into the cracks. The edges of any road cut, whether for a resurfacing or for a utility cut, should be ramped to prevent falls or tire punctures by cyclists. This should be done immediately after the asphalt has been lifted.

Appropriate signing is also important in providing information to cyclists and drivers to ensure that the proper right-of-way for both user types is clearly defined. A review of this signing to determine both appropriate and consistent signing applications for construction projects across the City is required.

***Guidelines:***

*4.61: The City should provide measures to reduce risks to cyclists passing through construction zones, and to ensure access for cyclists during all road construction activities when practical. This should include, but not be limited to:*

- *Construction notices posted on the City's website;*
- *Advanced signing for construction activities;*
- *Temporary conditions that are compatible with bicycles such as non-slip surfaces, ramped utility cuts and timber decking placed at right angles to the direction of travel; and*
- *Bicycle specific detours where appropriate.*



#### 4.4.5 Railway Crossings

Railway crossings can be hazardous for all on-road cyclists and off-road trail users and, therefore, extra caution should be applied to assure their safe operation. It is strongly recommended that appropriate traffic control devices be installed at the intersections of railway tracks and bicycle routes. These include:

- Pavement markings;
- Signing;
- Rubber anti-slip pad inserts; and
- Lift gates.

The aforementioned traffic control devices should be designed and installed in accordance with TAC's *Bikeway Traffic Control Guidelines (1998)* and *Manual of Uniform Traffic Control Devices for Canada (1997)*, and Transport Canada's *Guidelines for At-Grade Rail Crossings*.

Careful consideration should be given to the design of at-grade bicycle route crossings of railways. Furthermore, it is recommended that bicycle routes be designed to cross railways at as close to right angles as possible. In many situations this may require widening of the cycling facility in advance of the crossing, thereby allowing cyclists to reduce their speed and position themselves for crossing at right angles. Rubber track guards are also recommended to assure better friction between bike tires and the pavement, and also to narrow the rail gaps. Figures 4.26a-d illustrate recommended options for skewed railroad crossings.

Figure 4.26a: Skewed Railroad Crossing Restricted Right-of-Way Width

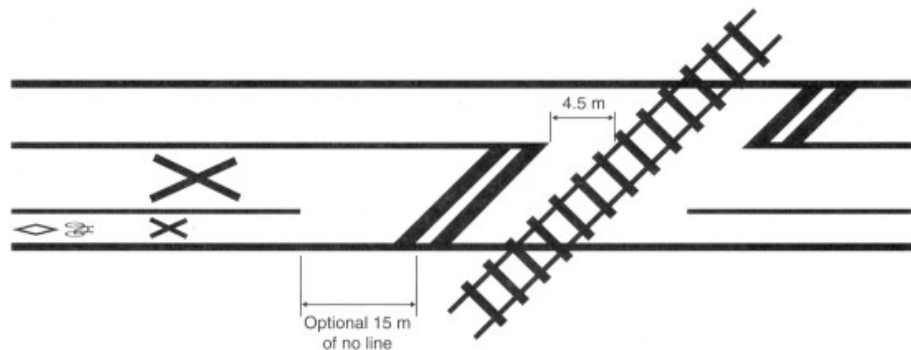


Figure 4.26b: Skewed Railroad Crossing Unrestricted Right-of-Way Width

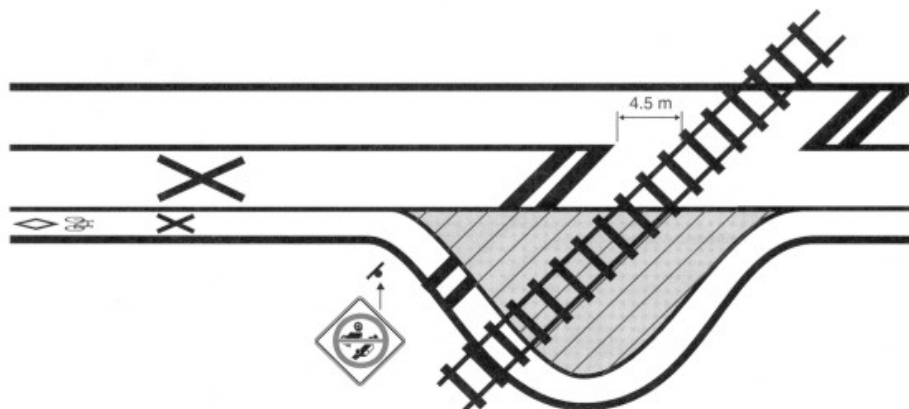




Figure 4.26c: Skewed Railroad Crossing Restricted Right-of-Way Width with Gate Control

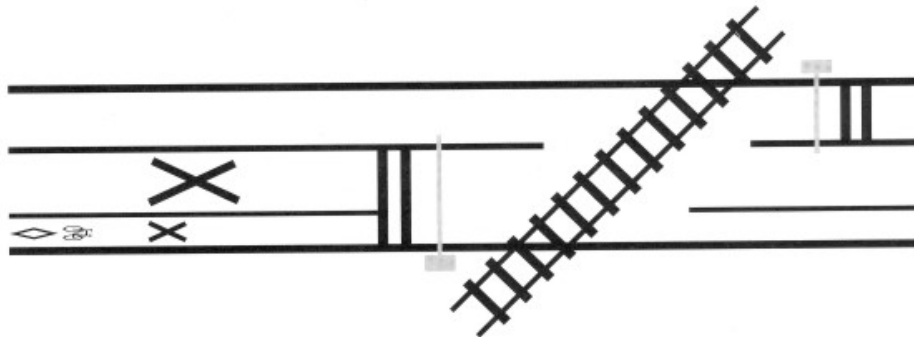
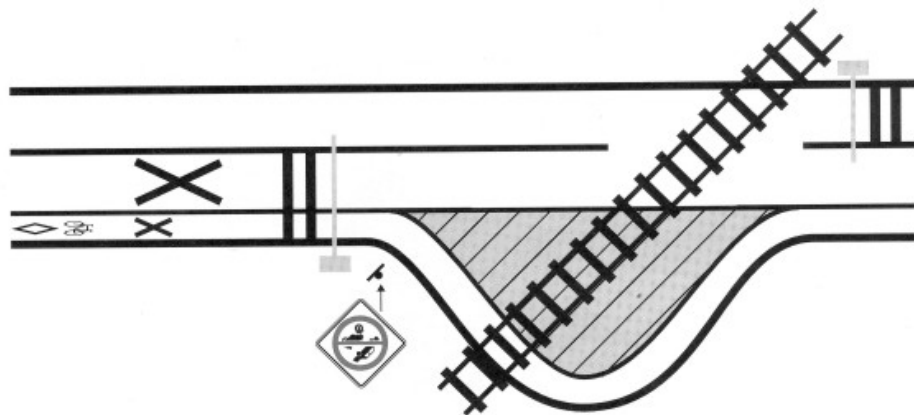


Figure 4.26c: Skewed Railroad Crossing Unrestricted Right-of-Way Width with Gate Control



Source: Bikeway Traffic Control Guidelines, TAC, 1998

**Guideline:**

*4.62: Bicycle route crossings of rail corridors and associated traffic control devices should be designed and installed in accordance with the Bikeway Traffic Control Guidelines (TAC, 1998)*

#### 4.4.6 Shared Parking / Bike Lanes

The application of shared parking / bike lanes in the City of Sault Ste. Marie is not recommended as they tend to lead to confusion between motorists and cyclists as to who has priority in these lanes. These lanes are typically located along roads that experience uncontrolled on-street parking, meaning parking along these streets is usually sporadic. As a result of these irregular parking patterns, cyclists typically travel within the parking / bike lane and cross into the adjacent motor vehicle travel lane on the left to pass a parked vehicle.

Motorists generally do not expect to see a cyclist travel outside of this lane (e.g. to pass a parked vehicle) even though cyclists are obviously permitted to do so. Motorists tend to believe that cyclists should “stay in their lane”, referring to the shared bike / parking lane, despite the fact that a cyclist has no obligation to remain there. Similarly, from a cyclist’s perspective, they may view the shared lane as a bicycle-only lane due to the lane’s resemblance to a bicycle lane. Thus, they may not expect to see a parked vehicle there, even though parking is permitted.



Due to the possibility for considerable misinterpretation on the intended use of the shared parking / bike lane, a clearer and more standard design is recommended. The following procedure is recommended for the application of cycling facilities along roadways with on-street parking. If there is sufficient roadway width and a substantial demand for on-street parking, the configuration detailed in *Section 4.3.1: Bike Lanes with On-Street Parking* in *Chapter 4* should be applied, if possible.

If there is insufficient roadway width to install separate bikelanes and parking lanes, then the parking demand along the particular roadway should be observed and assessed. If demand for on-street parking is low, then consideration should be given to prohibiting on-street parking and changing the parking / bike lane into a standard bicycle lane for cyclists only. If the on-street parking demand is high, or if there is a strong objection to the prohibition of on-street parking, then the edge line designating the parking / bike lane should be 2.0 m – 2.2 m from the face of the curb. This lane should then be designated as a parking lane, with the cycling route signed as a bicycle route (not a bike lane) with accompanying “Share the Road” signing.

***Guidelines:***

*4.63: The application of shared bicycle / parking lanes is not recommended for installation in the City of Sault Ste. Marie.*

*4.64: Consideration should be given to prohibiting on-street parking and designating the shared lane as standard 1.5 m bicycle lane if the demand for on-street parking is low.*

*4.65: Should there be a strong objection to the prohibition of on-street parking, then the road should be signed as a bicycle route with accompanying “Share the Road” signing, with the lane designated as a parking lane.*

#### **4.4.7 Transition from One Facility Type to Another**

The transition from one cycling facility type to another should ensure the continuity of the cycling route. Transitions between bike lanes to shared roadway or signed route facilities are typically straightforward, as a cyclists’ trajectory along the right side of the road should remain unchanged.

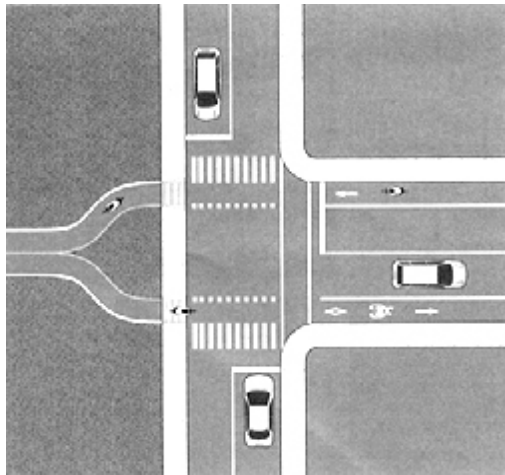
The role of a transition between cycling facility types is more important between on-road and off-road facilities since cyclists must transition between a route shared by motor vehicle traffic to a route that is not, or vice versa. In most cases, this would require a change in trajectory for a cyclist, whereas a pedestrian can simply follow crosswalks to change between facility types where an intersection is involved.

The trajectory change should be clearly indicated to a cyclist through the use of specific signing and / or pavement markings specific to that type of cycling facility. Figure 4.27 illustrates an example of a transition between an off-road pathway / multi-use trail and on-road bicycle lanes. In a situation where there is a single crosswalk, the small dashed markings shown in Figure 4.27, known as “elephant’s feet”, may also be applied on both sides of the crosswalk to provide a cycling area adjacent to the crosswalk, preventing cyclists from having to dismount to cross the road. In this case, the minimum width for the elephant’s feet markings is 1.2 m and the recommended width is 1.5 to 1.8 m.

Signing such as that indicated in the accompanying photograph should be installed on the motor vehicle approach to the intersection to warn right-turning motorists of cyclists who may be proceeding straight through the intersection to access the off-road trail, and to warn cyclists to watch for turning motorists.



Figure 4.27: Transition between On-Road Bike Lanes and Off-Road Trail



Example of sign warning cyclist of turning motorists and that they must yield to pedestrians

It should be noted that there are locations throughout the City of Sault Ste. Marie, such as Carmen's Way, where pathways terminate at sidewalks with no access provided to an immediate roadway. As a result, cyclists leaving a pathway are "dumped" onto a sidewalk and must navigate along a sidewalk, which is dangerous and illegal, to the nearest intersection for access onto a roadway or cycling facility. When pathways begin or terminate in such a manner, they do not provide a direct connection to other on or off-road cycling facilities. For a cyclist to avoid riding along a sidewalk, they would have to cross the sidewalk and then ride down a curb to access the adjacent roadway.

In order to provide connections to other cycling facilities, and to limit the potential for cyclists to ride along sidewalks, the following measures should be taken:

- On two-lane residential streets with low AADT's (< 3,000) curb-cuts should be provided to make a transition between the pathway down to the road level. Appropriate signing should be placed on the roadway at the curb cut and adjacent pathway warning motorists that cyclists may cross at this location. Additional signing should be placed at the pathway crossing to warn cyclists to yield to pedestrians, and pedestrians to watch for cyclists;
- If there is sufficient right-of-way, the pathway should be extended to the nearest intersection and / or location where they could make a proper, legal transition to another cycling facility or roadway;
- At existing locations where none of the above methods can be applied, signing should be placed at the terminus of the pathway indicating that cyclists dismount from their bicycles. Cyclists would have to "walk" their bicycles along the sidewalk to the nearest intersection or designated cycling-facility. Future pathways constructed should not terminate or begin in such a manner. Wherever possible, pathways should begin or terminate at intersections or other locations where a safe and legal transition between an on or off-road road cycling facility can be made.

**Guidelines:**

*4.66: Transitions between different cycling facility types should be applied between on and off-road facilities, to assist cyclists and motorists.*

*4.67: Appropriate signing and / or pavement markings should be installed to direct cyclists to the new cycling facility type.*



*4.68: Provide curb cuts at locations where pathways terminate at sidewalks on two-lane residential streets with AADT's below 3000. Signing should be installed warning cyclists to yield to pedestrians, and pedestrians to watch for cyclists.*

*4.69: Where possible, pathways should be extended to the nearest intersection or crossing location where cyclists can make a safe and legal transition to another cycling facility or roadway.*

*4.70: At locations where pathways terminate at sidewalks and no modifications can be made, signing should be installed indicating that cyclists should dismount from their bicycles when on a sidewalk.*

*4.71: Wherever possible, pathways should be directed to intersections or other locations where safe and legal transitions to other on or off-road cycling facilities can be made.*

#### **4.4.8 Multi-Use Trail Treatments**

##### **4.4.8.1 Mid-Block Crossings**

One of the key challenges for a municipality in implementing a connected on and off-road cycling network is how to accommodate a bicycle route crossing of a roadway. Ideally, a multi-use trail crossing of a roadway should occur at an existing signalized or stop controlled intersection or, if at a mid-block location, by way of a grade separated crossing, such as an underpass or bridge. Unfortunately, these ideal bicycle route crossing solutions cannot always be achieved. The location of the bicycle route and its existing or preferred alignment and desire line for cyclists may mean that crossing at an existing or future protected crossing is impractical. In addition, when retrofitting a roadway to accommodate a bicycle route crossing, constructing an underpass or bridge for cyclists is not always a feasible solution from both a design and cost perspective.

When a mid-block crossing is necessary, it should be designed in a way that provides advance warning to both motorists and cyclists of the impending crossing. The bicycle routes should be designed and signed to encourage cyclists to reduce speed and stop (unless bicycle signals are provided). Grade changes on the trails in advance of the crossing combined with adequate sight distances, signing, textural surface contrast, and bollards should be considered. Mid-block crossings of arterial or collector roads may warrant consideration of a separate traffic signal or a pedestrian crossover. Figure 4.28 illustrates one example of a typical mid-block trail crossing.

At mid-block crossings where there may be sight-line constraints for cyclists on a multi-use trail approaching a roadway, the following configuration for a mid-block crossing illustrated in Figure 4.29 is recommended. The sharp 90-degree turns on each approach to the mid-block crossing would force a cyclist to slow their speed at this location, allowing a cyclist to observe motor vehicle traffic approaching the crossing and wait for a suitable gap in traffic to cross. Consideration should also be given to changing the texture / colour / elevation of the roadway itself (in addition to the detail that is paid to the treatment of the approach) to provide drivers with a visual cue to exercise caution, such as an application of coloured pavement.

If a multi-use trail crossing is within a given distance of a signalized or stop-controlled intersection, or a formal pedestrian crossing, cyclists should be directed to cross at this location. The following are considered acceptable threshold distances for mid-block crossings:

- 2 Lane Roadway: More than 60 m from the nearest protected crossing
- 4 Lane Roadway: More than 120 m from the nearest protected crossing
- Mid-block crossings are not recommended for 6-lane arterial roadways.





Figure 4.28: Elements of Multi-Use Trail Crossings of Roadways

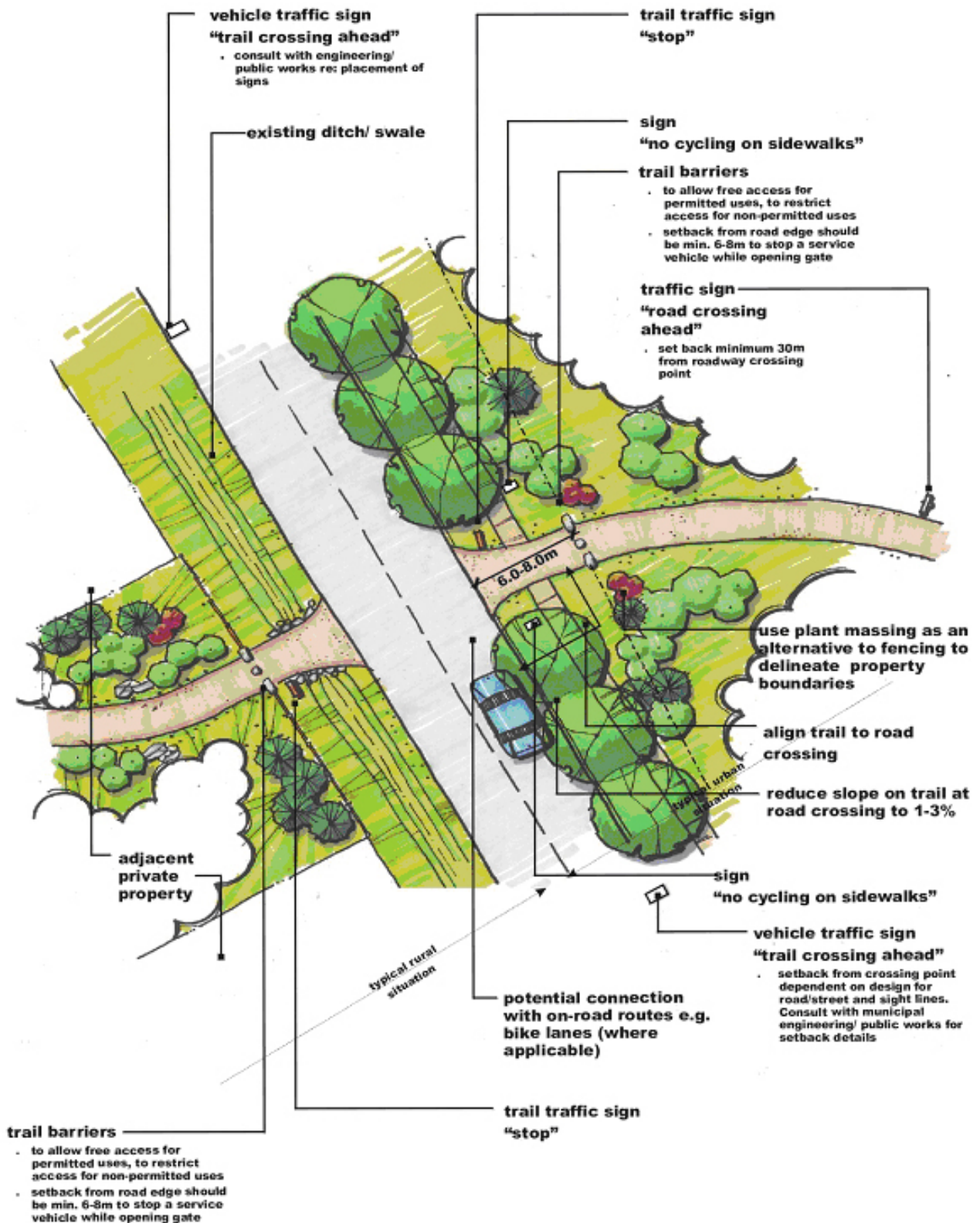
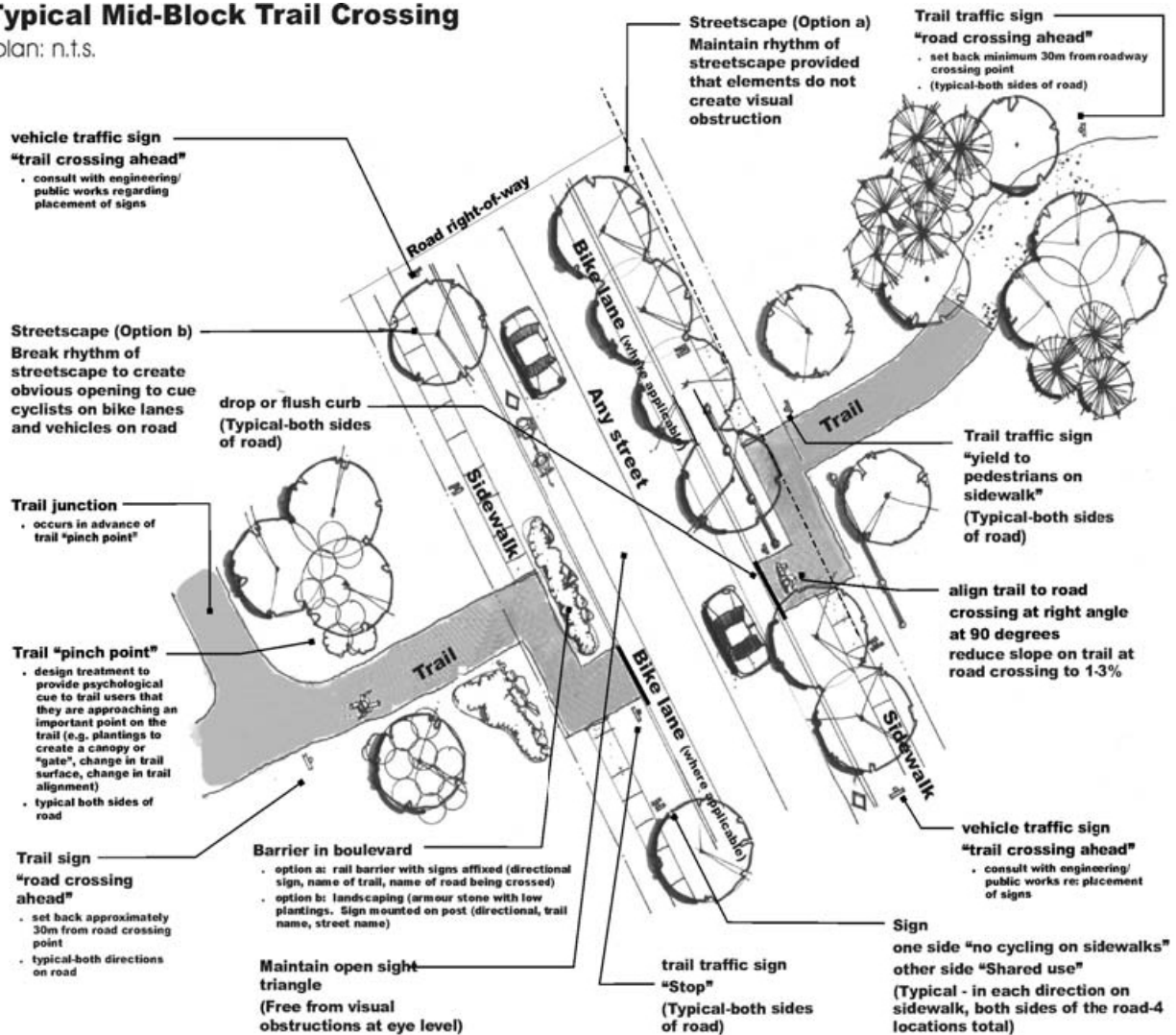




Figure 4.29: Mid-Block Crossing (Application for Locations with Sight-Line Constraints)

## Typical Mid-Block Trail Crossing

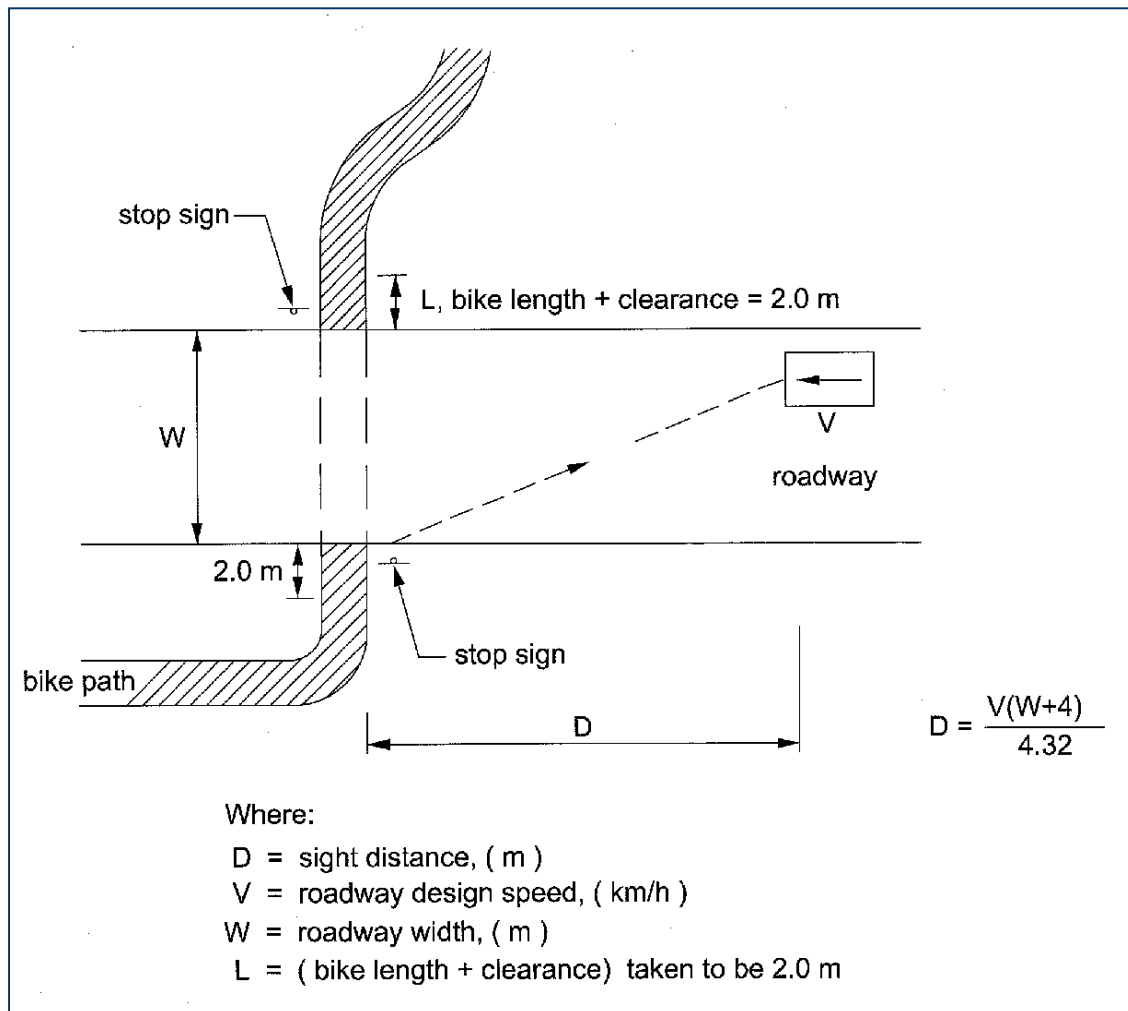
plan: n.t.s.



In addition, adequate sight distance along the roadway is required for a cyclist who has dismounted at the "stop" sign at a mid-block crossing, to be able to completely cross the entire roadway without impeding the progress of a vehicle approaching from the cyclists' right side. Figure 4.30 illustrates how sight distance is determined while Table 4.16 provides values for a range of widths and design speeds. For other widths and speeds, the formula on Figure 4.30 can be used.



Figure 4.30: Minimum Sight Distance for Bike Path Crossing



Source: Geometric Design Guidelines for Canadian Roads, TAC, 1999

Table 4.16: Minimum Sight Distance for Mid-Block Crossing (Bike Path Crossing)

Width of Roadway - W (m)	Minimum Sight Distance (D) to Approaching Vehicle (m)			
	Roadway Design Speed (km/h)			
	50	60	70	80
7.0	130	150	180	200
10.5	170	200	230	270
14.0	210	250	290	330
17.5	250	300	350	400
21.0	290	350	410	460

Note: Values for other roadway widths and / or design speeds may be derived from the formula in Figure 4.30



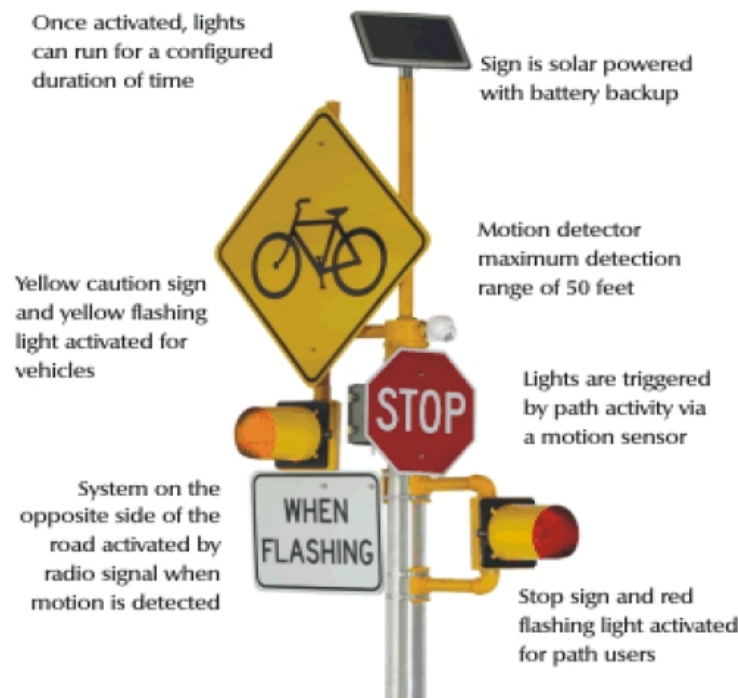
**Guidelines:**

- 4.72: *Bicycle routes should be designed and signed to encourage cyclists to reduce speed and stop prior to crossing a road via a mid-block crossing. Mid-block crossing design should consider grade changes and alignment of trails in advance of the crossing as well as sight distances, signing, textural surface contrast and bollards.*
- 4.73: *When recommended mid-block thresholds are met for 2 and 4-lane roadways, consideration should be given to implementing a formal traffic signal or a pedestrian crossover.*

**4.4.8.2 Motion-Activated Early Detection Systems (Cross-Alert System)**

Early detection motion-activated systems provide advanced warning to motorists of a user approaching on a trail. This motion activated system dubbed as the “Cross Alert system” is meant for use at intersections where signals to stop vehicular traffic are not indicated, but where an active warning system could provide enhanced safety where sight distances are poor or the view of the path is obstructed. An example of a motion-activated early warning “cross alert” system is illustrated in Figure 4.31.

Figure 4.31: Cross Alert System



The system does not alter the flow of vehicular traffic, but provides a forewarning to oncoming vehicles that trail users are near or at an intersection. The Cross Alert system consists of a red LED display and stop sign, which are presented to trail users, and a yellow LED display 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 trail 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 trail.

Solar power could be considered for installation, as this would reduce the installation costs required for the system and would eliminate the need for connection to the power grid. Radio linkage between the signs would eliminate the need for hanging or burying wires. This system is capable of running in a configuration with up to four sign poles, all of which can be triggered together by trail activity and can provide amber warning displays to oncoming vehicles up to 150 m of the intersection.

The standard cost for this installation at present is \$1,500.00 US. This installation is not intended to give trail users priority at mid-block crossings, rather, it is meant to reinforce the need for trail users to stop at mid-block crossings and wait for a suitable gap in traffic to cross the roadway. It also provides advanced warning to motorists that there are trail users at or near a trail crossing.

This system may be considered in Sault Ste. Marie at locations where sight lines for motorists and trail users are poor. It is also recommended that the yellow bicycle sign shown in Figure 4.31 be replaced with the “*Pedestrian and Bicycle Crossing Ahead*” sign (WC-46, TAC9) indicated in Figure 4.32 to indicate the presence of cyclists and pedestrians on the pathway to on-coming motorists. The W16-7p downward pointing arrow sign, also indicated in Figure 4.32 may also be considered for use on the Cross-Alert Systems to help identify the actual crossing location to motorists.

Upon approach to the crossing, the trail should be “doglegged” so that trail users are forced to angle themselves towards oncoming motor vehicle traffic in both directions. This is similar to the configuration illustrated in Figure 4.29 for a mid-block crossing. Setting up angles at the roadway edge may require curving the approaching trail ends so that they meet the street a few feet downstream with respect to the trail centreline before the approach. The approach curve, combined with the slightly angled junctions need to be re-oriented upon reaching the refuge, as this would cue trail users, especially children, not to cross the street without looking or assuming that they have priority.

It is recommended that a *STOP* sign be placed on the trail approach to the intersection. Since these stop signs would be positioned to only face trail users, the *Manual of Uniform Traffic Control Devices for Canada* (1997), permits them to be smaller than those located on-street. A solid yellow centreline should also be placed on the final approach of the trail to the street-crossing. A yellow-advanced yield line should be placed on the vehicle lanes.

Figure 4.32: WC-46 “Pedestrian and Bicycle Crossing Ahead” sign



Source: Cross Alert Systems Incorporated, Technology Solutions for Bike Path Safety, Warwick RI, 2004



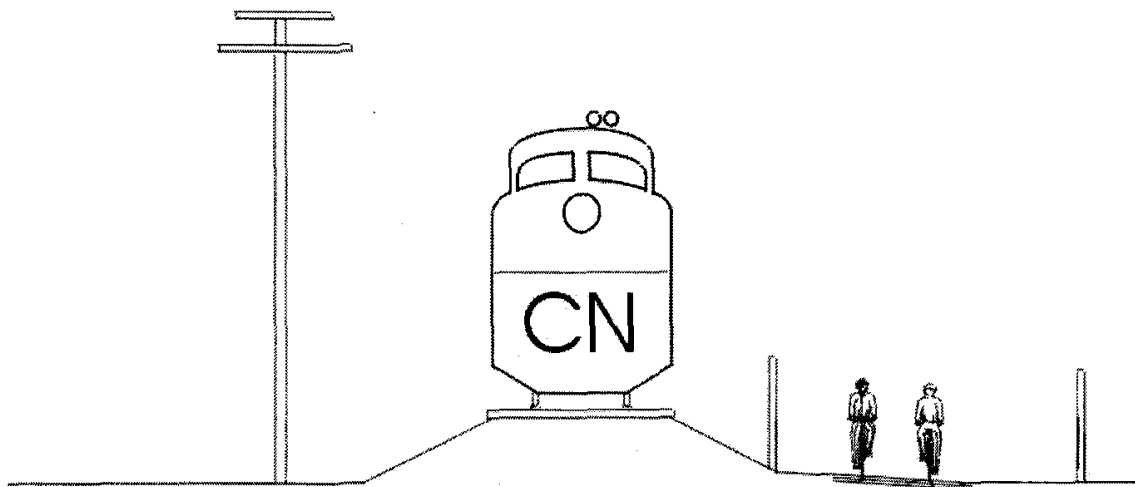
**Guidelines:**

- 4.74: *The cross alert system may be considered for installation at locations where a pathway crossing of a road occurs and when sight lines for motorists are poor.*
- 4.75: *The yellow bicycle stencil illustrated in the cross alert system should be replaced with the bicycle and pedestrian symbol to indicate the presence of cyclists and pedestrians on a pathway. This could also be used in conjunction with the W16-7p sign to better identify the crossing location to motorists.*
- 4.76: *Upon approach to the crossing, the pathway should be “doglegged” so that pathway users are forced to angle themselves towards oncoming motor vehicle traffic in both directions.*
- 4.77: *STOP signs, smaller than the MUTCD standard, should be placed on the pathway approach to the intersection.*
- 4.78: *A solid yellow centreline should also be placed on the final approach of the pathway to the street crossing. A yellow-advanced yield line should also be placed on the vehicle lanes.*

**4.4.8.3 Trails Adjacent to Rail Corridors**

The City of Sault Ste. Marie should consider installing cycling facilities along off-road rail corridors as part of a connected transportation network. Trails may be considered on under-utilized rail corridors such as railway lines used as sidings. Trails may also be considered on active rail lines where there is a wide enough right-of-way to safely accommodate a trail in addition to existing operations, such as the CP Railway line running east-west through the City. With this in mind, contact was made with CP Rail requesting that a trail be constructed on rail property parallel to the rail. The request was rejected in May 2007. Notwithstanding the City should continue to investigate the feasibility of implementing a trail adjacent to the rail corridor whereby the trail is shifted to run parallel to a rail facility on the edge of the corridor right-of-way. Fences would then be required to separate the cycling facility from a rail route. Figure 4.33 illustrates an example of a trail running adjacent to a rail corridor and separated by a fence.

Figure 4.33: Typical Cross-Section of a Cycling Facility Adjacent to a Rail Corridor Separated by a Fence



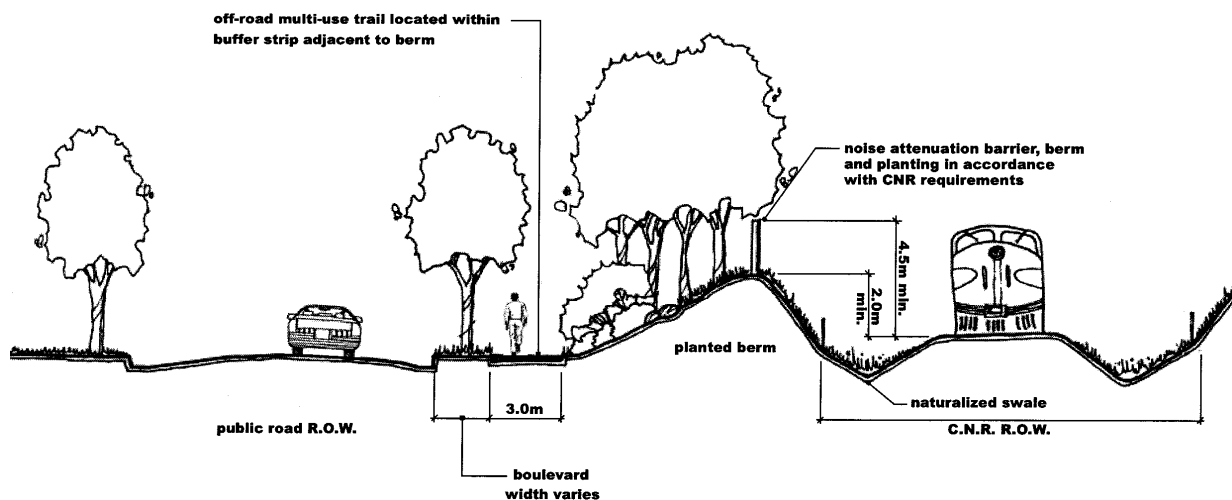
Source: Rails with Trails Feasibility Study: An example from Kelowna, British Columbia, G.D. Hamilton Associates Consulting Limited, 2003





All crossings of a rail facility should be grade separated, sharing the road with automobiles and cyclists. Cyclists should be directed to cross at signalized intersections. Trails adjacent to rail corridors should be physically separated from the cycling facility. This could be accomplished through the provision of a planted berm where sufficient right-of-way exists. In locations with constrained rights-of-way, a fence would be suitable to separate the two facilities. An example of a trail running adjacent to a rail corridor and separated by a planted berm is illustrated in Figure 4.34.

Figure 4.34: Typical cross section of a cycling facility adjacent to a rail corridor separated by a planted berm.



Source: Public Open Space Plan, Town of Whitchurch-Stouffville, Functional Servicing Study, Southeast Quadrant OPA 101 Secondary Plan, Stantec Consulting Ltd. (formerly ESG International) May 2002

#### **Guidelines:**

4.79: Railroads with wide enough rights-of-way can typically accommodate a multi-use trail.

4.80: Trails adjacent to active and / or under-utilized rail corridors should be separated from the rail line through the provision of a planted berm or fence.

#### **4.4.8.4 Off-Road Cycling Barriers**

Barrier protection may be required along a bicycle route for a number of reasons: to protect the trail, the user or the natural environment. Most commonly, fence or railing type barriers are provided to protect users from dangerous situations or to discourage access to sensitive areas. To prevent access by unauthorized users such as motor vehicles, barriers should be installed at trail entrances. Barriers should be clearly marked and visible, otherwise they can become a hazard to cyclists. Trailside or bicycle route signage alerting cyclists of the upcoming barriers should be appropriately located to provide adequate time to slow down and / or stop as required.

Suitable barriers associated with trails are bollards, rails, gates, fences and natural barriers. Materials suitable for this type of construction generally include wood, metal pipe and tubing and landscaping employing large stones. Bollards should be located at trail access points where vehicle access must be restricted. Where it is required that maintenance or emergency vehicles have access to trails, a collapsible or knockdown bollard is a suitable alternative. In a natural situation, timber bollards are preferred; metal



is suited to urban environments. Bollards should also have reflective surfaces facing a cyclist's direction for night time visibility.

Although not advocated, offset gates may be used as a bicycle traffic calming measure for cyclists traveling on off-road trails approaching busy intersections. If used, offset gates should be designed to provide uninterrupted through access for bicycles equipped with trailers. In addition, they should be removable by trail management staff to allow access for maintenance vehicles if required.



Offset Gates

Railings and fences are required to protect the cyclist from a hazardous situation, and should be constructed to conform to local building codes. Timber or stone construction is best suited to natural situations while metal or a combination of wood, metal and in some situations stone may be more appropriate for urban and heavy use areas. Landscaping treatments such as the strategic placement of stones, can provide a natural barrier that can successfully deter undesired access.

***Guideline:***

***4.81: Provide Barriers at off-road bicycle route / trail entrances to prevent access by unauthorized users such as motor vehicles, and to caution trail users that they are entering or exiting a trail environment.***

#### **4.4.8.5 Multi-Use Trail Bridges**

The trail system may require multi-use trail bridges that are designed for pedestrians and cyclists and not for motor vehicle traffic, with the exception of service vehicles. There are typically two basic types of pathway bridges, linear or ramped-type bridges. The approach paths of a flat or linear-type bridge do not ramp significantly. This type of bridge crosses over travel barriers such as waterways that are lower in elevation than the trail. The approach paths of a ramped-type bridge are sloped to gain elevation and cross barriers such as a railway that are at the same elevation or higher than the trail.

In general, a linear-type bridge is preferable because it is the simplest to build and has a flat runout, ensuring access for all trail users. Space limitations and increased bridge heights on ramped bridges may require ramp grades as steep as a maximum of 8 percent, which can cause excessive exit speeds. This is especially hazardous if the end of the bridge is located at an intersection. In these situations, curved ramps should be used. Wherever possible, ramps should be elliptical or circular rather than being interrupted by 180 degree turns at landings. In addition, bridge approaches should not be located near intersections, both road / trail and trail / trail, or where visibility is limited.



Example of a multi-use trail bridge

Bridges should be 0.6 m wider (0.3 m wider on each side) than the trails they are serving to provide adequate side clearance for the railings. They should also be wide enough and strong enough to support maintenance vehicles where required. An immovable bollard located at the centre of each approach can be used to prevent heavy vehicles from crossing a light duty bridge.

The bridge travel surface should be a non-slip material. Untreated wood or flat metal surfaces become slippery when wet or icy. Bridge slats made of self-weathering steel with raised dimples for traction have been used successfully. Open metal grating, on the other hand, is noisy and provides a less desirable riding surface for cyclists.

Warning signage and centre line bollards can be used to slow cyclists down and alert them to a constricted bridge crossing ahead. In some cases, it may be necessary to sign the bridge as a pedestrian only bridge and request that cyclists walk their bicycles.

Typically pre-fabricated bridges are recommended as a cost effective solution, except when crossing rails or highways. In Ontario there are a number of companies that provide these types of bridges. Key design considerations include:

- Surface type:
  - Applying stain grit to paint and using this to cover the wooden surface adds a “rough” texture. This however wears down over time and must be re-applied.
  - Apply asphalt shingles or Tar and Stone to the wooden surface of the bridge to increase the traction and “grip” on the bridge.
  - Place an open webbed rubber track on top of the wooden surface to provide more traction;
  - Metal grate surfaces are effective also, but they tend to be more expensive and are not as desirable for in-line skaters and cyclists.
  - Concrete surfaces are often used for major and more expensive crossing structures.
- Vertical railings should be located on the outside of the bridge structure to avoid damage by service and snow removal vehicles.
- Cover plates should be used to cover expansion joints.

***Guideline:***

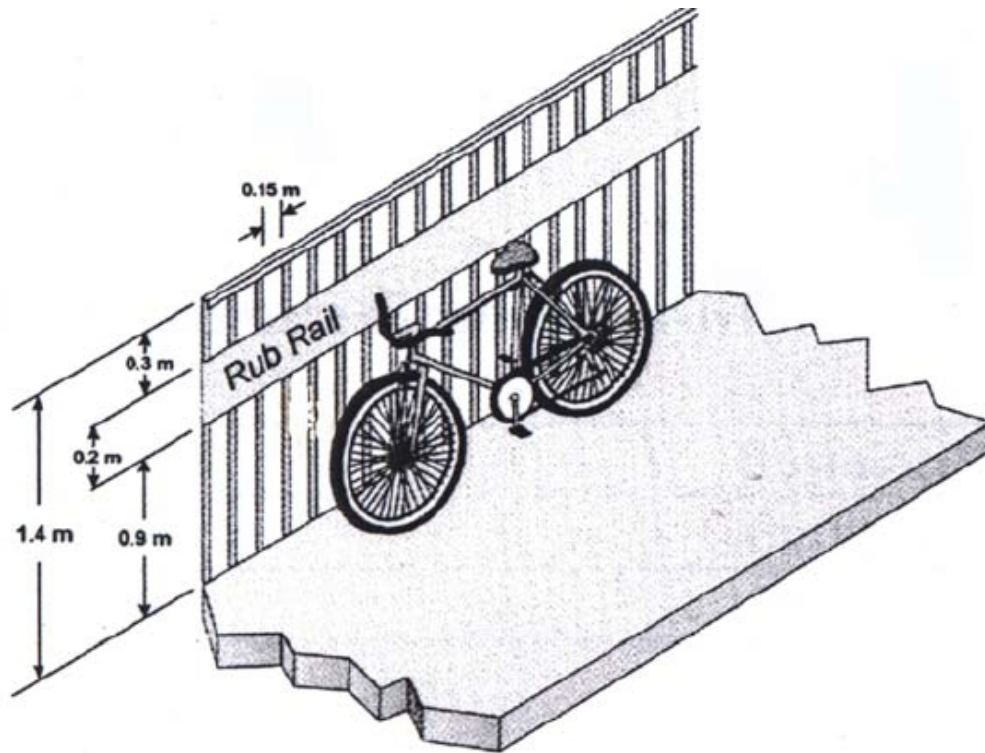
***4.82: Multi-use trail bridges should be designed with non-slip surfaces, have vertical railings attached to the outside of the structure and include cover plates over expansion joints.***



#### 4.4.8.6 Safety “Rub-Rails”

Along off-road bicycle pathways and multi-use trails with railings, a “rub-rail” should be provided to prevent cyclist’s handlebars from catching the vertical supports of the railing. Figure 4.35 illustrates a “rub-rail”. A rub-rail should be a minimum 20 cm strip of smooth surfacing along its length, placed at a height ranging between 0.90 m and 1.1 m.

Figure 4.35: Safety Rub Rail



Source: Bicycle Facility Design Guidelines, City of Nanaimo, 2003

#### **Guideline:**

4.83: Safety “rub-rails” may be considered along bicycle trails with railings to prevent a cyclist’s handlebars from catching the vertical supports of the railing.

#### 4.4.8.7 Crime Prevention Through Environmental Design

Crime Prevention Through Environmental Design (CPTED) is a pro-active crime prevention strategy that is used by planners, architects, police services, security professionals and everyday users of space. CPTED is defined as: “A proactive crime fighting technique in which the proper design and effective use of a building and its surroundings lead to a reduction in crime as well as an improvement in the quality of life for citizens of the community.”<sup>17</sup>

<sup>17</sup> Canadian Institute of Transportation Engineers (CITE), Crime Prevention Through Environmental Design (CPTED), Presentation, 2004.



The four main underlying concepts of CPTED are:

- Natural Access Control: deters access to a target and creates a perception of risk to the offender;
- Natural Surveillance: the placement of physical features and / or activities and people that maximizes natural visibility or observation.
- Territorial Reinforcement: defines clear borders of controlled space from public to semi-private to private, so that users of an area develop a sense of proprietorship over it.
- Maintenance: allows for the continued use of space for its intended purpose.

The concept of CPTED should be applied in the development of the Sault Ste. Marie Cycling Plan, especially in regards to off-road trail portions of the network and other areas that may be isolated or not heavily trafficked. It is important to design these facilities in such a way that a user would feel safe using a cycling facility and would not be deterred. Recommended CPTED features that should be considered for the design of new cycling facilities in Sault Ste. Marie include the following:

- Properly located entrances, exits, fencing, landscaping and lighting should direct both foot and automobile traffic in ways that discourage crime.
- To deter criminals, landscaping and lighting should be placed in strategic locations that promote and maximize natural surveillance and the ability for others to “see what’s going on” (e.g. from inside of a home or building, adjacent streets or from neighbours).
- Physical barriers such as bushes, sheds, or shadows, make it difficult to observe activity, therefore, consideration should be given as to how these items are placed.

**Guidelines:**

*4.84: The four main underlying principles of CPTED should always be considered when developing the Sault Ste. Marie Cycling Network:*

- *Natural Access Control;*
- *Natural Surveillance;*
- *Territorial Reinforcement; and*
- *Maintenance.*

*4.85: Properly located entrances, exits, fencing, landscaping and lighting should direct both foot and automobile traffic in ways that discourage crime.*

#### **4.4.9 Traffic Calming Measures**

When road reconstruction occurs, the City of Sault Ste. Marie will consider installing traffic calming measures to reduce the speed and volume of traffic on roadways that comprise the Cycling Route network, thereby helping to create a more cycling friendly environment. Traffic calming is the “combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior and improve conditions for non-motorized street users.”<sup>18</sup> The application of traffic calming measures affects the roadway facility through changes made to the roadway alignment, the installation of barriers and / or other physical means.<sup>19</sup>

---

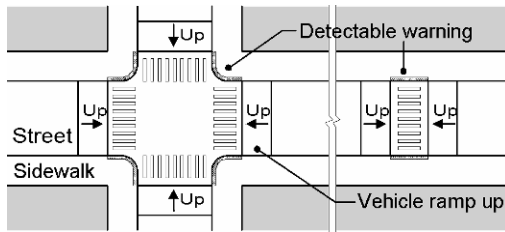
<sup>18</sup> G. Chartier and Diane G. Erickson, “Canada’s Guide to Neighbourhood Traffic Calming – Canadian Institute of Transportation Engineers (CITE) / TAC Project 208,” in *Compendium of Technical Papers for the 67th ITE Annual Meeting* (Boston, MA, 1997), Institute of Transportation Engineers (ITE), Washington, DC, 1997, CD-ROM.

<sup>19</sup> Ewing, R.H., Traffic Calming: State of the Practice, ITE / Federal Highway Administration (FHWA) Report RD-99-135, August 1999.





Figure 4.36: Raised Intersection



Source: www.access-board.gov



Speed Hump, Ottawa (Source: City of Kingston)

Examples of traffic calming measures include the creation of raised sections of roadway such as speed humps, speed tables or raised intersections (see Figure 4.36 and photo above); shifting the roadway alignment through installation of traffic circles, curb extensions, medians or diverters; and / or minimizing thru-way traffic through barrier mechanisms, or full or partial roadway closures. Traffic control devices such as crossing signage, signals, pavement markings and median refuges installed at mid-block crossings, or loop / cyclist activated traffic signals (refer to *Section 4.4.1: Cyclists Crossing at Traffic Signals in Chapter 4*) may also be considered traffic calming measures.



Speed Hump, Ottawa (Source: City of Kingston)



Mid-Block Crossing (Source: ITE - Institute of Transportation Engineers)

The aforementioned traffic calming measures should be designed and installed in accordance with TAC's *Canadian Guide to Neighbourhood Traffic Calming* (1998).

**Guideline:**

*4.86: For each reconstruction project, the road will be analysed for the opportunity to reduce speed. Traffic calming measures will be installed on major arterial roads, where the opportunity exists and where cyclists are expected to travel.*

## 4.5 Bicycle Parking

### 4.5.1 Bicycle Parking Facilities

The provision of bicycle parking facilities is essential for encouraging more bicycle use in the City of Sault Ste. Marie. The lack of adequate parking supply or type can deter many from considering using their bicycle as a basic mode of transportation.

Bicycle racks are made up of the following four main components:

- The rack element
- The rack
- The rack area
- The rack area site





Generally, optimum bicycle parking devices / facilities should:

- Enable the bicycle to be securely locked to the device without damaging the bicycle;
- Be placed along commercial arterials, employment centres and other destinations where cyclists are expected to frequent;
- Be placed in public view, where they can be viewed by passers-by, station attendants, fellow workers, etc;
- Present no hazard to pedestrians;
- Be easily accessible from the road or cycling network;
- Be arranged so that parking manoeuvres will not damage adjacent bicycles;
- Be as close as possible to the cyclist's destination;
- Have appropriate security lighting, where possible;
- Be sheltered from inclement weather, where possible;
- Be located in areas that are optimal for deterring theft and vandalism; and
- Be easy to use without detailed instructions.

This following lists guidelines on the basic elements of a bicycle parking rack, site and location that the City should refer to when installing new bicycle parking facilities.

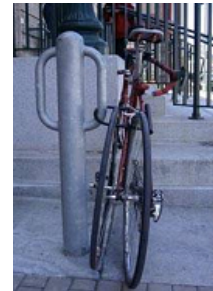
#### **4.5.2 The Bicycle Rack Element**



Spiral Rack



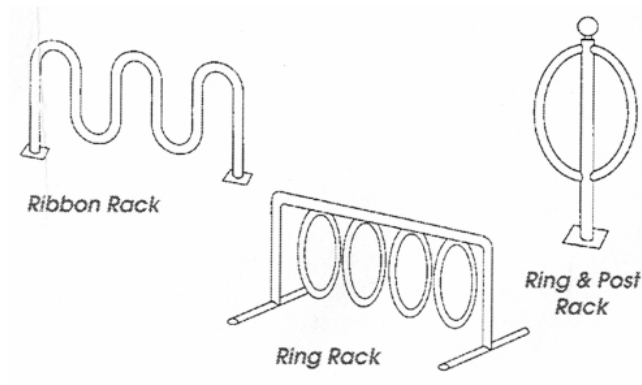
Triangle Ring Rack



Ring and Post Rack

The bicycle rack element is the portion of a bike rack that supports the bicycle. Bicycle rack elements can be joined on any common base or arranged in a regular array and fastened to a common mounting surface. The racks may be used to accommodate a varying number of bicycles securely in a particular location. The above photographs show the various types of bicycle rack designs that are used. Figure 4.37 shows the “Ribbon” rack, the “Ring” rack and the “Ring and Post” rack.

Figure 4.37: Sample Bicycle Rack Designs





The bicycle rack element should:

- Support the bicycle upright by its frame in two places;
- Prevent the wheel of the bicycle from tipping over;
- Enable the frame and one or both wheels to be secured;
- Support bicycles without a diamond-shaped frame with a horizontal top tube;
- Allow front-in parking: a U-lock should be able to lock the front wheel and the down tube of an upright bicycle; and
- Allow back-in parking: a U-lock should be able to lock the rear wheel and seat tube of the bicycle.

Bicycle racks should not only allow for a secure lock between the bicycle and the rack, but should also provide support for the bicycle frame itself. The rack element should also be designed to resist being cut or detached by common hand tools such as bolt and pipe cutters, wrenches and pry bars, which can be concealed in backpacks.



Welle Series Bike Rack (Source: [www.bikeparking.com](http://www.bikeparking.com))

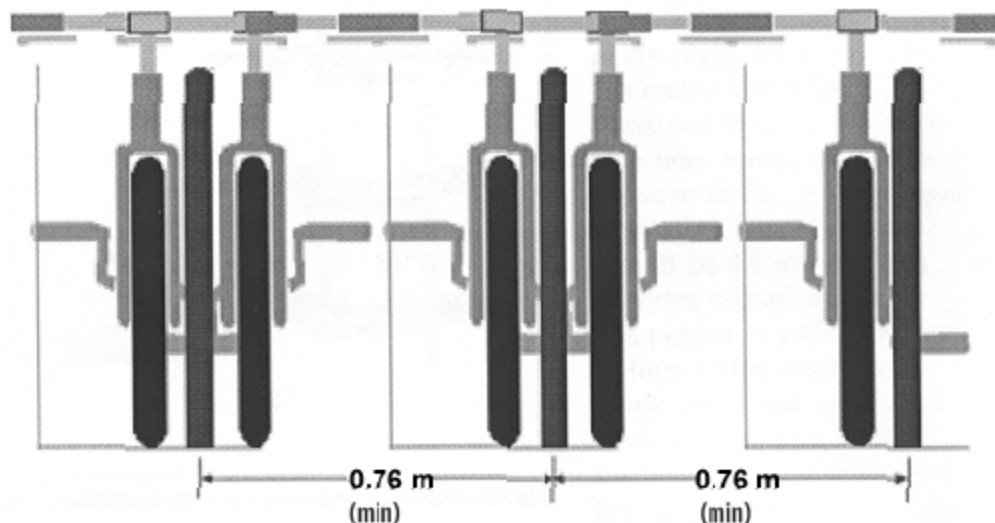
It was determined that the Welle Series Bike Rack designed by Palmer Group, a California firm, will provide the best opportunity to integrate with other street furnishings while providing various methods of orientation. As shown in the accompanying photographs, the bicycle rack can be direct buried in concrete, or fastened with bolts to existing concrete.

#### **4.5.3 The Bicycle Rack**

Bicycle racks should consist of a grouping of the rack elements either by attaching them to a single frame or allowing them to remain as single elements mounted in close proximity to one another. Racks, whether as single units or grouped together, should be securely fastened to a mounting surface to prevent the theft of a bicycle attached to a rack. Another alternative is to create a bicycle rack that is so large that it cannot be easily lifted or moved from its position with bicycles attached. Figure 4.38 illustrates a bicycle rack made up of three rack elements.



Figure 4.38: Bicycle Rack



A rack is one or more rack elements joined on a common base or arranged in a regular array and fastened to a common mounting surface.

Source: Revised from Bicycle Parking Guidelines: The Association of Pedestrian and Bicycle Professionals  
[www.apbp.org](http://www.apbp.org)

Easy and independent bike access should be provided to the bicycle rack. Inverted “U” rack elements should be mounted in a row and placed on 750 mm (approximately 30”) centres to allow enough room for two bicycles to be secured to each rack element. Bicycle racks should be arranged in a way so that is quick, easy and convenient for a cyclist to lock and unlock their bicycle to or from a rack.

#### 4.5.4 The Bicycle Rack Area

The rack area is essentially the “bicycle parking lot” and refers to the area where more than one bicycle rack is installed. Bicycle racks are separated by aisles much like a typical motor vehicle parking lot. The recommended minimum width between aisles should be 1.2 m to provide enough space for one person to walk with one bicycle. Aisle widths of 1.8 m are recommended in high traffic areas where many users may retrieve their bicycle at the same time, such as after a school class. A 1.8 m depth should be provided for each row of parked bicycles since conventional bicycles are just less than 1.8 m long and can be accommodated in that space.



Bicycle Parking at Niagara College

Large bicycle rack areas with a high turnover rate of arriving and departing cyclists should have more than one entrance to help facilitate user flow. If possible, the rack area should be sheltered to protect the bicycles from the elements by placing awnings and overhangs above the rack area.



#### **4.5.5 The Rack Area Site**

Bicycle racks should be placed as close as possible to the entrance that it serves, but not in a location where they would inhibit pedestrian flow in and out of the building. Rack areas should be no more than 15 m from an entrance, and should be clearly visible along a major building approach line. Bicycle rack areas that are hard to find or that are located far from a building entrance are generally perceived as vulnerable to vandalism and will generally not be used by cyclists. To encourage use of a bicycle rack by cyclists, the rack site should be clearly visible and well lit.

Multiple buildings in an area should not be served by one distant bike rack. Rather, smaller bike racks should be placed in a convenient location at each building, but not in a manner that would obstruct utility access openings, garbage disposal bins, doorways or other building access points. Bicycle racks can be placed on concrete, asphalt or brick surfaces. Bicycle racks should be securely fastened to the surface to prevent shifting or removal. If they cannot be fastened to the surface, then they should be large and heavy enough so that they cannot be easily moved.

Bicycle racks placed on grass surfaces typically cannot be securely fastened to the ground, therefore they should also be heavy enough so that they cannot be moved. To avoid excessive bicycle riding on the grass, bicycle racks should only be placed on grass surfaces located within close proximity to a paved cycling route, such as on off-road multi-use pathway, or an on-road route. Bicycle racks on grass surfaces should be considered temporary, and every effort should be made to relocate them to a permanent, hard surface area.

Bicycle racks should not be placed within the following areas:

- Bus loading areas;
- Goods delivery zones;
- Taxi zones;
- Emergency vehicle zones;
- Hotel loading zones;
- Diplomatic loading zones;
- Within 4.0 m of a fire hydrant;
- Within 2.5 m of a driveway or access lane; and
- Within 10.0 m of an intersection.

#### ***Guidelines:***

*4.87: Bicycle parking should be provided along major arterial roads, employment centres and other destinations where cyclists are expected to frequently visit.*

*4.88: Bicycle racks should be designed to provide lateral support to the parked bicycle and should be made from materials that can resist being cut by common hand tools such as bolt and pipe cutters, wrenches and pry bars. As such, the Welle Series Bike Rack has been identified as the preferred choice.*

*4.89: Racks, whether as single units or grouped together, should be securely fastened to a mounting surface to prevent the theft of a bicycle attached to a rack.*

*4.90: Bicycle racks should be placed adjacent to the entrance that it serves without inhibiting pedestrian flow in and out of the building. Rack areas should be no more than 15 m from an entrance and should be clearly visible along a major building approach line.*

*4.91: The City of Sault Ste. Marie should encourage their partners and the private sector to provide secure bicycle parking at key destinations, including public buildings. Modify Site Planning guidelines to require the provision of one bicycle parking space for every 50 parking spaces.*



#### **4.6 Network Amenities**

The provision of network amenities is a key and sometimes overlooked element of bicycle route system design. Developing and maintaining a comprehensive network of on and off-road cycling facilities does not automatically mean people will use the network. The network has to be promoted, users need to feel comfortable and safe in using it, and they should have access to adequate trip-end facilities at strategic locations. This section outlines many of the amenities that should be considered during the design and implementation of the bicycle route network.

##### **4.6.1 Bicycle Friendly Catchbasin Covers**

Sewer grates, catchbasins and utility covers with slot openings parallel to the roadway or that leave a gap between the frame and the grate can trap the front wheel of a bicycle causing loss of steering control, and potentially serious damage to the bicycle wheel and frame, as well as injury to the cyclist. A preferable solution is to adopt a safe grate type with openings perpendicular or at least angled to the flow of traffic.



Bicycle friendly catchbasin cover

All on-road cycling facilities of the proposed cycling network in urban areas with curb, gutter and storm drains should be made bicycle friendly through the provision of bicycle friendly catchbasin covers with openings perpendicular to the flow of traffic. The current City of Sault Ste. Marie standard for on-road drains are bicycle friendly and work well. Their continued use is encouraged where feasible. The accompanying photograph shows the catchbasin cover employed in the City of Sault Ste. Marie. The rectangular cover can be bicycle friendly because the slots are angled to the direction of travel. The City of Sault Ste. Marie may choose to adopt this in areas where the current standard may not be applicable.

***Guideline:***

***4.92: The City of Sault Ste. Marie should use bicycle friendly catchbasin covers only.***

##### **4.6.2 Rest And Staging Areas**

Rest areas should be provided along off-road and rural bicycle route systems. Areas where cyclists tend to stop, such as interpretative stations, lookouts, restaurants, museums and other attractions / services, are logical locations for rest areas. Ideally, there should be a rest area every 5 km on a recreational trail. Typical furnishings to be considered include benches or tables, washrooms, drinking fountains, trashcans, information signing complete with mapping, plus bicycle parking facilities. Additional services may include an air pump, shelter and telephones.

Staging areas were proposed in the Hub Trail report. They will provide for access to the bicycle route system. Potential amenities at staging areas may also include picnic facilities and automobile parking for recreational cyclists and “Park and Bike” commuters. Should parking at a rest or staging area be requested, the number of parking spaces required should be determined on a site-specific basis, and should account for factors such as supply and demand of automobile parking elsewhere throughout the network.

***Guideline:***

***4.93: Rest and staging areas proposed in the Hub Trail should be provided to serve the bicycle route system. The City of Sault Ste. Marie and its partners including the private sector should work together through the Sault Trails Advocacy Committee (STAC) to identify and implement other rest and staging areas.***





### **4.6.3 Gateways**

Gateways are a key element of a cycling network that provide identity and character. It is suggested that a hierarchy be established that represents citywide and local level contexts.

#### ***City Gateways***

These features are intended to “set the tone” for the system. They introduce Sault Ste. Marie as a community oriented place and are intended to create a sense of welcome, arrival and safety. They are recognized by their usually appealing plaza design. They are also an opportunity to establish trail use conventions, introduce sites of historic and cultural significance and introduce themes that reflect the character of different areas in the City. It is also important to offer people amenities such as benches, trash receptacles and information / directional kiosks at gateways.



Gateway trail information sign, City of Niagara Falls

#### ***Local Gateways***

Local gateways primarily reaffirm city-wide conventions and introduce locally significant themes. They are often paired with information and way-finding signs. They will become a recognizable feature in the Sault Ste. Marie landscape and are important to both tourists and local residents. These sites should become an integral part of the marketing initiative and should be identified on the city map.

#### ***Guidelines:***

- 4.94: Establish a hierarchy of City and Local Gateways that represents city-wide and local level contexts through a request for proposals.*
- 4.95: Gateways should become a recognizable feature in Sault Ste. Marie’s landscape to both tourists and residents alike. Locations are suggested at Trunk Road near Fournier Street and near Hiawatha Park at Fifth Line.*
- 4.96: Gateways should become an integral part of the marketing initiative and should be identified on the city map.*

### **4.6.4 Cycling and Transit**

#### **4.6.4.1 Bike and Ride / Rack & Roll Programs**

Bike-and-Ride programs allow cyclists to park their bicycles at transit stations and take the train or bus, and includes bicycle lockers. The Rack-and-Roll program has been initiated on key bus routes in Toronto, Windsor and Ottawa by providing bike racks on buses so that cyclists can take their bikes with them on the bus. It is recommended that these programs be promoted, with the ultimate goal of providing Rack & Roll service year-round by emphasizing the Cycling Route network spine during winter months.

When transit buses are equipped with bike racks, the length of the bus is increased. This increase in the bus length limits the space available in bus garages to store buses indoors. In the future, when bus garages are renovated, the City should take advantage of this opportunity and expand the bus garages so that they can accommodate the entire bike-rack-equipped fleet and adopt a winter “Rack & Roll” program.





Bike rack on bus (Source: Toronto Transit Commission)



Bike rack on bus, City of Windsor

Building cycling-transit connections is an important part of making cycling a part of daily life in Sault Ste. Marie. Linking cycling with buses will overcome such barriers as lengthy trips, personal security concerns and riding at night or in poor weather. Providing a transit link also enables cyclists to reach more distant areas across the City, and increases transit ridership on weekends and holidays.

***Guidelines:***

*4.97: The City of Sault Ste. Marie should promote a Rack-and-Roll program to cover all transit routes. Quality bicycle parking facilities should also be provided at transit centres throughout the City.*

*4.98: In the future when bus garages are renovated, the City should take advantage of this opportunity and expand the bus garages so that they can accommodate the bike-rack-equipped fleet and make a winter "Rack & Roll" program feasible.*

#### **4.6.4.2 Trip-End Facilities for Commuters**

Installation of showers and lockers at workplaces and educational institutions help to promote the use of the cycling network for utilitarian purposes. Lockers can be used to store personal belongings such as cycling accessories and a change of clothing. Businesses or institutions with employees who commute by bicycle and / or in-line skates should be encouraged to offer these facilities.

***Guidelines:***

*4.99: Provide trip-end facilities for employees and visitors to City of Sault Ste. Marie public buildings; the private sector should be encouraged to do the same.*

*4.100: Require that site plan approval be subject to providing cycling parking and distinct or signed access.*