# Federal Highway Administration University Course on Bicycle and Pedestrian Transportation

# Lesson 12: Midblock Crossings

July 2006



U.S. Department of Transportation Federal Highway Administration



APPROXIMATE CONVERSIONS TO SI UNITS           Symbol         When You Know         Multiply By         To Find         Symbol           in these         25.4         milimeters         mm           in these         25.4         milimeters         mm           if the         0.305         meters         m           if the         0.305         square milimeters         m           if and square field         0.033         square milimeters         m <sup>2</sup> if and square field         0.033         square milimeters         m <sup>2</sup> if and square field         0.033         square field         m <sup>2</sup> if and square field         0.033         square field         m <sup>2</sup> if and square field         0.033         square field         m <sup>2</sup> if and square field         0.033         square field         m <sup>2</sup> if and conces         2.39         square field         m         m           if and conces         2.37         millifters         mL         M           if and conces         2.37         millifters         mL         M           if and conces         2.35         grams         grams         grams	SI* (MODERN METRIC) CONVERSION FACTORS APPROXIMATE CONVERSIONS TO SI UNITS						
LENGTH         Formation           in choice         25.4         millimeters         mm           in choice         25.4         millimeters         mm           millimeters         0.305         meters         mm           millimeters         1.61         kilometers         km           in <sup>2</sup> square inches         645.2         square millimeters         mm <sup>2</sup> yd <sup>2</sup> square inches         645.2         square millimeters         m <sup>2</sup> yd <sup>2</sup> square millimeters         m <sup>2</sup> m <sup>2</sup> m <sup>2</sup> yd <sup>2</sup> square milles         2.59         square millimeters         m <sup>2</sup> gal         galons         3.785         tectares         ha           galons         3.785         cobic meters         m <sup>3</sup> yd <sup>3</sup> cobic feet         0.907         megagrams (or "metric ton")         Mg (or t")           value y with         NOTE: volumes greater min 1000 L shalb be shown in m <sup>3</sup> value y with y y y y y y y y y y y y y y y y y y y							
in cheels         25.4         millimeters         mm           yd         yards         0.014         meters         m           yd         yards         0.914         meters         m           miles         1.61         kilometers         km           ress         square feet         0.093         square meters         m <sup>2</sup> square feet         0.093         square meters         m <sup>2</sup> acres         0.405         hectares         had           acres         0.405         hectares         had           acres         0.405         hectares         had           gallons         3.785         itters         m <sup>2</sup> gallons         3.785         itters         m <sup>3</sup> yd         cubic feet         0.925         cubic meters         m <sup>3</sup> yd         cubic feet         0.9265         cubic meters         m <sup>3</sup> yd         cubic feet         0.927         meters         m <sup>3</sup> yd         pounds         28.35         prems         m <sup>2</sup> yd         pounds         9.454         hilograms         kg           thot nos (2000 ib) <th>Symbol</th> <th>When You Know</th> <th>Multiply By</th> <th>To Find</th> <th>Symbol</th>	Symbol	When You Know	Multiply By	To Find	Symbol		
feet         0.305         meters         m           min         miles         0.514         meters         kin           in²         square inches         645.2         square millimeters         m²           yd²         square inches         645.2         square millimeters         m²           yd²         square miles         2.59         square meters         m²           yd²         square miles         2.59         square meters         m²           m²         square miles         2.59         square meters         m²           gal galons         3.785         litters         mL           tit         cubic (ref         0.028         cubic meters         m³           ounces         28.35         grams         grams         grams           ounces         28.35         grams         grams         grams           ounces         0.454         kilograms         ''''''''''''''''''''''''''''''''''''							
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in 3         square inches         645.2         square millimeters         m <sup>2</sup> yd         square relies         0.336         square meters         m <sup>2</sup> yd         square relies         0.436         square meters         m <sup>2</sup> acces         0.405         hectares         ha           m <sup>2</sup> square miles         2.59         square kilometers         m <sup>3</sup> gal         galons         3.785         litters         m.           gal         galons         3.785         litters         m.           yd <sup>3</sup> cubic meters         m <sup>3</sup> dubic meters         m <sup>3</sup> yd <sup>3</sup> cubic meters         m <sup>3</sup> galons         square miles         galons         galons         yd <sup>3</sup> outbic yards         0.454         kilograms         galons         galons         yd <sup>3</sup> galons         galons         galons         yd <sup>3</sup> galons         galons <td>•</td> <td></td> <td></td> <td></td> <td></td>	•						
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yda ac ac ac 				square millimeters			
ac.         acros         0.405         hectares         ha           m <sup>2</sup> square miles         2.59         square kilometers         Kn <sup>2</sup> galons         3.785         liters         L           galons         3.785         liters         L           galons         3.785         liters         L           yd*         oubic feet         0.028         oubic meters         m <sup>3</sup> yd*         oubic feet         0.283         oubic meters         m <sup>3</sup> outo         yd*         pounds         0.454         megarams (or "metric tor")         Mg (or "1)           T         metroten (2000 lb)         0.454         kilograms         gd         %g           T         Fahrenheit         5 (F-32)/9         Celsius         rC         rC           fc         foot-candles         10.76         lux         xd         rC           fc         foot-candles         10.76         kilograms         xd         rC           fc         foot-candles         10.76         kilograms         xd         rC           foot <candles< td="">         10.76         kilograms         xd         rC           foot-candles&lt;</candles<>		•		•			
m <sup>2</sup> square miles         2.69         square kilometers         km <sup>2</sup> I oz         fluid ounces         29.57         milliliters         ml.           gallons         3.785         milliliters         ml.           gallons         3.785         oubic meters         m <sup>3</sup> yd <sup>3</sup> oubic facet         0.785         oubic meters         m <sup>3</sup> yd <sup>3</sup> oubic scool ounces         28.35         grams         kg           ounces         28.35         grams         kg           pounds         0.454         kilograms         kg           short tons (2000 lb)         0.907         megagrams (or "metrice")         Mg (or ")           T         F         Fahrenheit         5 (F-32)/B         Celus         Celus           T         foot-Lamberts         3.426         candela/m <sup>2</sup> Cd <sup>m</sup> T         foot-Lamberts         3.426         candela/m <sup>2</sup> Cd <sup>m</sup> Bufm <sup>2</sup> poundforce per square inch         6.89         kilopascals         kPa           Bufm <sup>2</sup> poundforce per square inch         8.89         feet         n           Bufm <sup>2</sup> square meters         1.09				•			
VoluMe         Volume           fl oz galtons         29.57 milliters         mL           galtons         3.785 liters         Liters         Liters           volubic feet         0.028 cubic meters         m <sup>3</sup> volubic yards         0.785 cubic meters         m <sup>3</sup> volubic yards         0.785 cubic meters         m <sup>3</sup> volubic yards         0.785 cubic meters         m <sup>3</sup> volubic feet         0.028 cubic meters         m <sup>3</sup> volubic feet         0.0108 cubic feet         0.454 kilograms         kg           pounds colubic         0.97 megagrams (or "metric ton")         Mg (or ")           ref         Fahrenheit         5 (f-32)/9 colubic celsus         "Colubic celsus         "Colubic meters           otoot-ambers         10.76         lux         cubic meters         Mg           tibrin*         poundforce per square inch         8.49         kilopascals         N           boto-tambers         10.76         lux         cubic         Mg	ac mi <sup>2</sup>				na km <sup>2</sup>		
fi oz gal gallon gallons29.57 3.785 litersmL it it 		Square miles		square kilometers	NIII		
galons         3.785         liters         L           yd*         cubic feet         0.028         cubic meters         m*           yd*         cubic yards         0.765         cubic meters         m*           yd*         cubic yards         0.765         cubic meters         m*           yd*         cubic yards         0.765         cubic meters         m*           ources         28.35         grams         g           pounds         0.907         megagrams (or "metric tor)"         Mg (or ")"           "F         Fahrenheit         5 (F-32)/9         Celsius ("metric tor)"         Mg (or ")"           "F         Fahrenheit         5 (F-32)/9         Celsius         "C           "F         Fahrenheit         5 (F-32)/9         Celsius         "C           "G         foot-candles         10.76         lux         k         odm"           "It         foot-candles         10.76         lux         k         odm"           "It         poundforce per square inch         6.89         kilopascals         kPa           "It         poundforce per square inch         6.89         kilopascals         it         its           Symbol	floz	fluid ounces		milliliters	ml		
yd³         cubic yards         0.765         cubic meters         m³           NOTE: volumes greater than 1000 Lshall be shown in m³           ware         magagrams (or "metric ton")         mg           oz         ounces         28.35         grams (or "metric ton")         Mg (or "t)"           "F         Fahrenheit         0.454         kilograms (or "metric ton")         Mg (or "t)"           "F         Fahrenheit         5 (F-32)/18         Celsius         "C           ILLUMINATION           fc         foot-candles         10.76         lux         k           ft         foot-candles         10.76         lux         k           poundforce         4.45         endela/m2         cd/m2           poundforce per square inch         6.89         kilopascals         kPa           Bymbol         When You Know         Multiply By         To Find         Symbol           garars (or 300 inches         in           m         meters         0.039         inches         in           m         meters         0.039         inches         in           meters         0.036         square meters         in					L		
NOTE: volumes greater than 1000 L shall be shown in m <sup>3</sup> MASS           or measure in the term of the term of	ft <sup>3</sup>		0.028	cubic meters	m <sup>3</sup>		
MASS OUNCSWASS QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands QuandsQuands Colspan="2">Quands Colspan="2">Colspan="2">Quands Colspan="2">Quands Colspan="2">Colspan="2">Quands Colspan="2">Quands Colspan="2">Quands Colspan="2">Colspan="2">Quands Quands Quands	yd <sup>3</sup>	cubic yards			m <sup>3</sup>		
or         punces         28.35         grams         g           b         pounds         0.907         megagrams (or "metric ton")         Mg (or *t")           *         Fahrenheit         \$5 (F-32)/9         Celsius         °C           or (F-32)/1.8         or (F-32)/1.8         °C         °C           or (F-32)/1.8         it         Kg         Kg           ft         foot-candles         1.76         lux         kg           ft         foot-candles         1.76         lux         kg           ft         foot-candles         1.76         lux         kg           bf         poundforce         4.45         newtons         N           poundforce         4.45         newtons         N         N           bf(m <sup>2</sup> )         poundforce         4.45         newtons         N           poundforce         6.83         kilopascals         N         N           bf(m <sup>2</sup> )         poundforce         1.45         N         N           poundforce         0.039         inches         in         N           meters         3.226         feet         ft         N           m         meters		NOTE: v		be shown in m°			
b         pounds         0.454         kilograms         kilograms         kilograms         kilograms         kilograms         Mg (or "t)"           "F         Fahrenheit         5 (F-32)/9         Celsius         °C         °C           "for         foot-Lamberts         1.76         lux         k         k           "foot-Lamberts         1.076         lux         k         cd/m²         cd/m²           "bl/in"         poundforce         er square networs         N         N         N         N           "bl/in"         poundforce         Multiply By         To Find         Square nullimeters         0.039         inches         in           "m         meters         0.23         netes							
T         short tons (2000 lb)         0.907         megagrams (or "metric ton")         Mg (or "t")           TEMPERATURE (exact degrees)         °C           °F         Fahrenheit         °C         °C           ILLUMINATION         °C           ILLUMINATION         °C           ILLUMINATION         ×           ILLUMINATION         ×           FORCE and PRESSURE or STRESS           IDF opoundforce per square inch         6.89         ×           IDF opoundforce per square inch         8.8         N           IDF opoundforce per square inch         8.9         Notice           Symbol         When You Know         Multiply By         To Find         Symbol           Meters         0.039         inches         inches           Symbol         When You Know         Multiply By         To Find         Symbol           millimeters         0.039         inches <td cols<="" td=""><td></td><td></td><td></td><td>3</td><td></td></td>	<td></td> <td></td> <td></td> <td>3</td> <td></td>				3		
TEMPERATURE (exact degrees)         ""           "F         Fahrenheit         5 (F-32)/9 or (F-32)/1.8         Celsius         "C           ILLUMINATION           ILLUMINATION           "F         For-candles         10.76         lux         k           foot-Lamberts         3.426         candela/m <sup>2</sup> cd/m <sup>2</sup> FORCE and PRESSURE or STRESS           bf         poundforce         4.45         newtons         N           boundforce per square inch         6.89         kilopascals         KPa           Symbol         When You Know         Multiply By         To Find         Symbol           mm         millimeters         0.328         feet         t           m         meters         3.28         feet         t         t           mm         meters         0.039         inches         in?         t           mm         square meters         1.09         square feet         t*           mm         meters         0.034         fuid ounces         g         d           mm4         square meters         1.0764         square miles         mile							
°F         Fahrenheit         ° (F-32)/9 or (F-32)/1.8         ° Ceisius         ° C           fc         foot-candles         10.76         lux         k           fc         foot-candles         10.76         lux         k           fl         foot-candles         10.76         lux         k           fl         foot-candles         10.76         lux         k           fl         foot-candles         2.426         candela/m <sup>2</sup> cd/m <sup>2</sup> bf         poundforce         4.45         newtons         k           poundforce         4.45         newtons         k         k           bf         poundforce         4.45         newtons         k         k           spundforce         4.45         newtons         k         k         k           bf         poundforce         4.45         newtons         k         K           mm         meters         0.039         inches         in         in           m         meters         3.28         feet         ft         in           m         meters         0.0316         square inches         in <sup>2</sup> in           m <sup>2</sup>	1	· /			Ng (OF T)		
ILLUMINATION           ILLUMINATION           fc         foot-candles         10.76         lux         k           foot-Lamberts         3.426         candela/m²         cd/m²           FORCE and PRESSURE or STRESS           lbf         poundforce         4.45         newtons         N           https://doi.org/10.00000000000000000000000000000000000	°F				°C		
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If         foot-Lamberts         3.426         cad/m <sup>2</sup> cd/m <sup>2</sup> FORCE and PRESSURE or STRESS           buf opoundforce per square inch         4.45         newtons         N           buf opoundforce per square inch         6.89         kilopascals         N           Symbol         When You Know         Multiply By         To Find         Symbol           Symbol         When You Know         Multiply By         To Find         Symbol           IENGTH           mm         meters         0.039         inches         in           m         meters         0.021         miles         miles         vd           km         kilopaare inches         int         miles         miles         miles         miles           m         square meters         0.0016         square inches         int <sup>2</sup> f           m <sup>2</sup> square meters         1.0764         s	fc	foot-candles		lux	lx		
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APPROXIMATE CONVERSIONS FROM SI UNITS           Symbol         When You Know         Multiply By         To Find         Symbol           mm         meters         0.039         inches         in           m         meters         3.28         feet         ft           m         meters         3.28         feet         ft           km         kilometers         0.621         miles         mi           mm <sup>2</sup> square millimeters         0.0016         square inches         in <sup>2</sup> m <sup>4</sup> square meters         10.764         square feet         ft <sup>2</sup> m <sup>4</sup> square meters         1.764         square geet         gt <sup>2</sup> ha         hectares         2.47         acres         ac           km <sup>2</sup> square meters         0.386         square miles         mi <sup>2</sup> ML         millititers         0.264         galions         gal           m <sup>3</sup> cubic meters         3.5.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         1.307         cubic gets         jb           m <sup>4</sup> 0.035         ounces         oz         jb <tr< td=""><td>lbf</td><td></td><td></td><td></td><td>Ν</td></tr<>	lbf				Ν		
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Symbol         When You Know         Multiply By         To Find         Symbol           mm         millimeters         0.039         inches         in           m         meters         3.28         feet         ft           m         meters         1.09         yards         yd           km         kilometers         0.621         miles         mi           mm <sup>2</sup> square millimeters         0.0016         square inches         in <sup>2</sup> m <sup>2</sup> square meters         1.0764         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         1.195         square grads         yd <sup>2</sup> ha         hectares         2.47         acres         acres         ac           km <sup>2</sup> square kilometers         0.386         square miles         mi <sup>2</sup> ML         litters         0.264         gallons         gal           m <sup>3</sup> cubic meters         35.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         1.307         cubic yards         jb           m <sup>3</sup> cubic meters         1.307         cubic yards         jb           g         grams <th></th> <th></th> <th></th> <th></th> <th></th>							
LENGTH           mm         millimeters         0.039         inches         in           m         meters         3.28         feet         ft           m         meters         3.28         feet         ft           m         meters         1.09         yards         yd           km         kilometers         0.621         miles         mi           mm²         square millimeters         0.621         miles         mi           m²         square meters         10.764         square feet         ft²           m²         square meters         1.195         square yards         yd²           ha         hectares         2.47         acres         ac           km²         square kilometers         0.386         square miles         mi²           VOLUME         mi         mi²         gal         mi²           m³         cubic meters         3.5.314         cubic yards         yd³           m³         cubic meters         1.307         cubic yards         yd³           m³         cubic meters         2.202         pounds         lb           Mg (or "t")         megagrams (or "metric ton")         1.		APPROXI	MATE CONVERSIONS F				
m         meters         3.28         feet         ft           m         meters         1.09         yards         yd           km         kilometers         0.621         miles         mi           mm²         square millimeters         0.621         miles         mi           m²         square meters         10.764         square inches         in²           m²         square meters         10.764         square feet         ft²           m²         square meters         1.195         square geat         yd²           ha         hectares         2.47         acres         ac           km²         square kilometers         0.386         square miles         mi²           square kilometers         0.386         square miles         mi²           mL         millititers         0.034         fluid ounces         floid out           m3         cubic meters         35.314         cubic feet         ft³           m³         cubic meters         35.314         cubic feet         ft³           m³         cubic meters         3.307         cubic yards         jd           g         grams         0.035         ounces	Symbol				Symbol		
m         meters         1.09         yards         yd           km         kilometers         0.621         miles         mil           mm²         square milimeters         0.0016         square inches         in²           m²         square meters         0.0764         square feet         ft²           m²         square meters         1.0764         square feet         ft²           m²         square meters         1.195         square meters         yd²           ha         hectares         2.47         acres         acres         acres           km²         square meters         0.386         square miles         mi²           m²         square meters         0.344         fluid ounces         fl oz           km³         cubic meters         0.264         gallons         gal           m³         cubic meters         1.307         cubic feet         tf³           m³         cubic meters         35.314         cubic yards         jd²           g         grams         0.035         ounces         oz           klograms         2.202         pounds         bb         mi           Mg (or "t")         meagarams (or "metr	Symbol		Multiply By		Symbol		
km         kilometers         0.621         miles         mi           mm <sup>2</sup> square millimeters         0.0016         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         10.764         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         1.195         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         2.47         acres         ac           km <sup>2</sup> square kilometers         2.47         acres         ac           km <sup>2</sup> square kilometers         2.47         acres         ac           km <sup>2</sup> square kilometers         0.034         fluid ounces         fl oz           km         milliters         0.034         fluid ounces         fl oz           L         liters         0.264         gallons         gal           m <sup>3</sup> cubic meters         1.307         cubic yards         yd <sup>3</sup> m <sup>3</sup> cubic meters         1.307         cubic yards         bl           Mg (or "t")         megagrams (or "metric ton")         1.103         short tons (2000 lb)         T           Mg (or "t")         megagrams (or "metric ton")         1.802         short tons (2000 lb)         <		When You Know	Multiply By LENGTH	To Find	-		
mm <sup>2</sup> m <sup>2</sup> square millimeters         0.0016         square inches         in <sup>2</sup> m <sup>2</sup> square meters         10.764         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         1.195         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         1.195         square yards         yd <sup>2</sup> ha         hectares         2.47         acres         ac           square kilometers         0.386         square miles         mi <sup>2</sup> ML         milliliters         0.034         fluid ounces         floid           L         milliliters         0.264         gallons         gal           m <sup>3</sup> cubic meters         35.314         cubic yards         yd <sup>3</sup> L         liters         0.035         ounces         oz           m <sup>3</sup> cubic meters         2.202         pounds         jd           Mg (or "t")         megagrams (or "metric ton")         1.03         short tons (2000 lb)         T           Mg         celsius         1.8C+32         Fahrenheit         °F           C         Celsius         1.8C+32         Fahrenheit         °f           Cu/m <sup>2</sup>	mm m	When You Know millimeters meters	Multiply By LENGTH 0.039 3.28	To Find inches feet	in ft		
mm <sup>2</sup> square millimeters         0.0016         square inches         in <sup>2</sup> m <sup>2</sup> square meters         10.764         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         1.195         square yards         yd <sup>2</sup> ha         hectares         2.47         acres         ac           km <sup>2</sup> square kilometers         0.386         square miles         mi <sup>2</sup> km         milliliters         0.034         fluid ounces         fl oz           L         liters         0.264         gallons         gal           m <sup>3</sup> cubic meters         35.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         35.314         cubic rest         jd <sup>3</sup> m <sup>3</sup> cubic meters         30.35         ounces         oz           g         grams         0.035         ounces         oz           g(or "t")         megagrams (or "metric ton")         1.103         short tons (2000 lb)         T <sup>a</sup> C         Celsius         1.8C+32         Fahrenheit <sup>e</sup> F <sup>a</sup> C         Celsius         0.929         foot-candles         fc <i>cud</i>	mm m m	When You Know millimeters meters meters	Multiply By LENGTH 0.039 3.28 1.09	To Find inches feet yards	in ft yd		
m <sup>2</sup> square meters         10.764         square feet         ft <sup>2</sup> m <sup>2</sup> square meters         1.195         square yards         yd <sup>2</sup> ha         hectares         2.47         acres         ac           km <sup>2</sup> square kilometers         0.386         square miles         mil           km         square kilometers         0.386         square miles         mil           mL         milliters         0.034         fluid ounces         fl oz           L         liters         0.264         gallons         gal           m <sup>3</sup> cubic meters         35.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         35.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         35.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         0.035         ounces         oz           g         grams         0.035         ounces         oz         jb           Mg (or "t")         megagrams (or "metric ton")         1.103         short tons (2000 lb)         T           *C         Celsius         1.8C+32         Fahrenheit         °F	mm m m	When You Know millimeters meters meters	Multiply By LENGTH 0.039 3.28 1.09 0.621	To Find inches feet yards	in ft yd		
m <sup>2</sup> square meters         1.195         square yards         yd <sup>2</sup> ha         hectares         2.47         acres         ac           km <sup>2</sup> square kilometers         0.386         square miles         ml <sup>2</sup> mL         square kilometers         0.034         fluid ounces         floid           mL         milliliters         0.034         gluons         gal           m <sup>3</sup> cubic meters         35.314         cubic feet         ft <sup>3</sup> m <sup>3</sup> cubic meters         1.307         cubic yards         yd <sup>3</sup> FEMERST           g         grams         0.035         ounces         oz           kg         kilograms         2.202         pounds         lb           Mg (or "t")         megagrams (or "metric tor")         1.103         short tons (2000 lb)         T           °C         Celsius         1.8C+32         Fahrenheit         °F           ELLUMINATION           lx         0.0929         foot-candles         fd           candela/m <sup>2</sup> 0.2919         foot-Lamberts         fl	mm m m km	When You Know millimeters meters meters kilometers	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA	To Find inches feet yards miles	in ft yd mi		
ha         hectares         2.47         acres         ac           km²         square kilometers         0.386         square miles         ml²           mL         square kilometers         0.034         fluid ounces         gal           mL         milliters         0.034         fluid ounces         gal           m³         cubic meters         0.264         gallons         gal           m³         cubic meters         35.314         cubic feet         ft³           m³         cubic meters         1.307         cubic yards         yd³           g         grams         0.035         ounces         oz           kg         kilograms         2.202         pounds         lb           Mg (or "t")         megagrams (or "metric ton")         1.103         short tons (2000 lb)         T           °C         Celsius         1.8C+32         Fahrenheit         °F           °C         Celsius         1.8C+32         fot-candles         fc           uk         0.0929         foot-candles         fc           °C         Celsius         0.2919         foot-candles         fl           °C         Cendela/m²         0.2919         fo	mm m km mm <sup>2</sup>	When You Know millimeters meters meters kilometers square millimeters	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016	To Find inches feet yards miles square inches	in ft yd mi		
km²         square kilometers         0.386         square miles         mi²           mL         milliliters         0.034         fluid ounces         fl oz           L         liters         0.264         gallons         gal           m³         cubic meters         35.314         cubic feet         ft³           m³         cubic meters         35.314         cubic yards         yd³           m³         cubic meters         35.314         cubic yards         yd³           g         grams         0.035         ounces         oz           g(or "t")         megagrams (or "metric ton")         1.103         short tons (2000 lb)         T           %C         Celsius         1.8C+32         Fahrenheit         °F           °C         Celsius         1.8C+32         Fort candles         ft           kz         Luw         0.0929         foot-candles         ft           kz         Lux         0.0929         foot-candles         ft           kz         N         newtons         0.225         poundforce         Ibf	mm m km mm <sup>2</sup> m <sup>2</sup>	When You Know millimeters meters meters kilometers square millimeters square meters	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764	To Find inches feet yards miles square inches square feet	in ft yd mi in <sup>2</sup> ft <sup>2</sup>		
mLmilliliters0.034fluid ouncesfl ozLliters0.264gallonsgalm³cubic meters35.314cubic feetft³m³cubic meters1.307cubic yardsyd³MASSggrams0.035ouncesozklograms2.202poundslblbmegagrams (or "metric ton")1.103short tons (2000 lb)TILLUMINATION°CCelsius1.8C+32Fahrenheit°F°CCelsius0.0929foot-candlesfcLLUMINATION1.03foot-candlesfcIx cd/m²lux candela/m²0.2919foot-candlesfcFORCE and PRESSURE or STERSSFormationflNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> m <sup>2</sup> ha	When You Know millimeters meters meters kilometers square millimeters square meters square meters	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195	To Find inches feet yards miles square inches square feet square yards	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac		
L m³ cubic metersliters cubic meters0.264 35.314gallons cubic feetgal ft³m³cubic meters35.314cubic feetft³m³cubic meters1.307cubic yardsyd³MASSg kggrams0.035ouncesozkg(or "t")megagrams (or "metric ton")1.103short tons (2000 lb)TTEMPERATURE (exact degrees)°CCelsius1.8C+32Fahrenheit°FILLUMINATIONlx cd/m²lux candela/m²0.0929 0.2919foot-candles foot-LambertsfcFORCE and PRESSURE or STRESSNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> m <sup>2</sup> ha	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195 2.47	To Find inches feet yards miles square inches square feet square yards acres	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac		
m³ m³cubic meters35.314 cubic meterscubic feetff³ m³m³cubic meters1.307cubic yardsyd³MASSg kggrams0.035ouncesozkgkilograms2.202poundslbMg (or "t")megagrams (or "metric ton")1.103short tons (2000 lb)TTEMPERATURE (exact degrees)C C Celsius1.8C+32Fahrenheit°FILLUMINATIONlx cd/m²lux candela/m²0.0929foot-candles foot-Lambertsfc flFORCE and PRESSURE or STRESSNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> m <sup>2</sup> ha	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195 2.47 0.386	To Find inches feet yards miles square inches square feet square yards acres	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac		
m³cubic meters1.307cubic yardsyd³MASSggrams0.035ouncesozkgkilograms2.202poundslbMg (or "t")megagrams (or "metric ton")1.103short tons (2000 lb)T°CCelsius1.8C+32Fahrenheit°FILLUMINATIONlxlux0.0929foot-candlesfccandela/m²0.2919foot-candlesflFORCE and PRESSURE or STEESSNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> mL	When You Know millimeters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195 2.47 0.386 VOLUME 0.034	To Find inches feet yards miles square inches square feet square feet square yards acres square miles fluid ounces	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz		
MASSggrams0.035ouncesozkgkilograms2.202poundslbMg (or "t")megagrams (or "metric ton")1.103short tons (2000 lb)TTEMPERATURE (exact degrees)°CCelsius1.8C+32Fahrenheit°FILLUMINATIONlxlux0.0929foot-candlesfccandela/m²0.2919foot-candlesflFORCE and PRESSURE or STESSNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> L	When You Know millimeters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters liters	Multiply By           LENGTH           0.039           3.28           1.09           0.621           AREA           0.0016           10.764           1.195           2.47           0.386           VOLUME           0.034           0.264	To Find inches feet yards miles square inches square feet square yards acres square miles fluid ounces gallons	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz		
g kggrams0.035ouncesozkgkilograms2.202poundslbMg (or "t")megagrams (or "metric ton")1.103short tons (2000 lb)T°CCelsius1.8C+32Fahrenheit°F°CCelsius1.8C+32Fahrenheit°Flux0.0929foot-candlesfccd/m²0.2919foot-LambertsflFORCE and PRESSURE or STRESSNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> L mL L m <sup>3</sup>	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters liters cubic meters	Multiply By           LENGTH           0.039           3.28           1.09           0.621           AREA           0.0016           10.764           1.195           2.47           0.386           VOLUME           0.034           0.264           35.314	To Find inches feet yards miles square inches square feet square feet square yards acres square miles fluid ounces gallons cubic feet	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup>		
kgkilograms2.202poundslbMg (or "t")megagrams (or "metric ton")1.103short tons (2000 lb)TTEMPERATURE (exact degrees)°CCelsius1.8C+32Fahrenheit°FILLUMINATIONlxlux0.0929foot-candlesfccd/m2candela/m20.2919foot-LambertsflFORCE and PRESSURE or STRESSNnewtons0.225poundforcelbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> L mL L m <sup>3</sup>	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters liters cubic meters	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195 2.47 0.386 VOLUME 0.034 0.264 35.314 1.307	To Find inches feet yards miles square inches square feet square feet square yards acres square miles fluid ounces gallons cubic feet	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup>		
Mg (or "t")         megagrams (or "metric ton")         1.103         short tons (2000 lb)         T           TEMPERATURE (exact degrees)           °C         Celsius         1.8C+32         Fahrenheit         °F           ILLUMINATION         It         0.0929         foot-candles         fc           cd/m²         candela/m²         0.2919         foot-candles         fl           FORCE and PRESSURE or STRESS         N         newtons         0.225         poundforce         lbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> mL L m <sup>3</sup> m <sup>3</sup>	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters liters cubic meters cubic meters	Multiply By           LENGTH           0.039           3.28           1.09           0.621           AREA           0.0016           10.764           1.195           2.47           0.386           VOLUME           0.034           0.264           35.314           1.307           MASS	To Find inches feet yards miles square inches square feet square yards acres square miles fluid ounces gallons cubic feet cubic yards	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup> yd <sup>3</sup>		
TEMPERATURE (exact degrees)       °C     Celsius     1.8C+32     Fahrenheit     °F       ILLUMINATION     ILLUMINATION       Ix     lux     0.0929     foot-candles     fc       cd/m²     candela/m²     0.2919     foot-Lamberts     fl       FORCE and PRESSURE or STRESS       N     newtons     0.225     poundforce     lbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> L L m <sup>3</sup> m <sup>3</sup>	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters liters cubic meters cubic meters grams	Multiply By           LENGTH           0.039           3.28           1.09           0.621           AREA           0.0016           10.764           1.195           2.47           0.386           VOLUME           0.034           0.264           35.314           1.307           MASS           0.035	To Find inches feet yards miles square inches square feet square yards acres square miles fluid ounces gallons cubic feet cubic yards ounces	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup> yd <sup>3</sup> oz		
°C     Celsius     1.8C+32     Fahrenheit     °F       ILLUMINATION       Ix     lux     0.0929     foot-candles     fc       cd/m²     candela/m²     0.2919     foot-Lamberts     fl       FORCE and PRESSURE or STRESS       N     newtons     0.225     poundforce     lbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> mL L m <sup>3</sup> m <sup>3</sup> g kg	When You Know         millimeters         meters         meters         kilometers         square millimeters         square meters         square meters         hectares         square kilometers         milliliters         liters         cubic meters         grams         kilograms	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195 2.47 0.386 VOLUME 0.034 0.264 35.314 1.307 MASS 0.035 2.202	To Find inches feet yards miles square inches square feet square yards acres square miles fluid ounces gallons cubic feet cubic yards ounces pounds	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup> yd <sup>3</sup> oz lb		
ILLUMINATION         Ix       Iux       0.0929       foot-candles       fc         cd/m <sup>2</sup> candela/m <sup>2</sup> 0.2919       foot-Lamberts       fl         FORCE and PRESSURE or STRESS         N       newtons       0.225       poundforce       Ibf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> mL L m <sup>3</sup> m <sup>3</sup> g kg	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square kilometers milliliters liters cubic meters cubic meters grams kilograms megagrams (or "metric ton"	Multiply By  LENGTH  0.039 3.28 1.09 0.621  AREA 0.0016 10.764 1.195 2.47 0.386  VOLUME 0.034 0.264 35.314 1.307  MASS 0.035 2.202 ) 1.103	To Find inches feet yards miles square inches square feet square yards acres square miles fluid ounces gallons cubic feet cubic yards ounces pounds short tons (2000 lb)	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup> yd <sup>3</sup> oz lb		
Ix     Iux     0.0929     foot-candles     fc       cd/m <sup>2</sup> candela/m <sup>2</sup> 0.2919     foot-Lamberts     fl       FORCE and PRESSURE or STRESS       N     newtons     0.225     poundforce     Ibf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> mL L m <sup>3</sup> m <sup>3</sup> g kg Mg (or "t")	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square meters hectares square kilometers milliliters liters cubic meters cubic meters grams kilograms megagrams (or "metric ton"	Multiply By  LENGTH  0.039 3.28 1.09 0.621  AREA 0.0016 10.764 1.195 2.47 0.386  VOLUME 0.034 0.264 35.314 1.307  MASS 0.035 2.202 ) 1.103  FEMPERATURE (exact designment)	To Find         inches       feet         yards       miles         square inches       square feet         square yards       acres         acres       square miles         fluid ounces       gallons         cubic feet       cubic feet         cubic feet       cubic yards         ounces       pounds         short tons (2000 lb)       grees)	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup> yd <sup>3</sup> oz lb T		
cd/m <sup>2</sup> candela/m <sup>2</sup> 0.2919     foot-Lamberts     fl       FORCE and PRESSURE or STRESS       N     newtons     0.225     poundforce     lbf	mm m km m <sup>2</sup> m <sup>2</sup> ha km <sup>2</sup> mL L m <sup>3</sup> m <sup>3</sup> g kg Mg (or "t")	When You Know millimeters meters meters kilometers square millimeters square meters square meters hectares square meters hectares square kilometers milliliters liters cubic meters cubic meters grams kilograms megagrams (or "metric ton"	Multiply By LENGTH 0.039 3.28 1.09 0.621 AREA 0.0016 10.764 1.195 2.47 0.386 VOLUME 0.034 0.264 35.314 1.307 MASS 0.035 2.202 1.103 TEMPERATURE (exact deg 1.8C+32	To Find         inches       feet         yards       miles         square inches       square feet         square yards       acres         acres       square miles         fluid ounces       gallons         cubic feet       cubic feet         cubic feet       cubic yards         ounces       pounds         short tons (2000 lb)       grees)	in ft yd mi in <sup>2</sup> ft <sup>2</sup> yd <sup>2</sup> ac mi <sup>2</sup> fl oz gal ft <sup>3</sup> yd <sup>3</sup> oz lb T		
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\*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380. (Revised March 2003)

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## LESSON 12

# MIDBLOCK CROSSINGS

### 12.1 Introduction

Designers often assume that pedestrians will cross roadways at established intersections. However, observation of pedestrian behavior clearly indicates that people routinely cross at midblock locations. Pedestrians will rarely go out of their way to cross at an intersection unless they are rewarded with a much improved crossing—most will take the most direct route possible to get to their destination, even if this means crossing several lanes of high-speed traffic.

Well-designed midblock crossings can actually provide many safety benefits to pedestrians when placed in proper locations. This chapter discusses those benefits and explains several basic design principles for midblock crossings. The major sections of this lesson are as follows:

- 12.1 Introduction.
- 12.2 Background.
- 12.3 Medians and Refuge Islands—Powerful Safety Tools.
- 12.4 Advantages of Medians.
- 12.5 Design Considerations for Medians.
- 12.6 Midblock Crossings by Roadway Classification.
- 12.7 Midblock Crossing Design.
- 12.8 Staggered Midblock Crosswalks.
- 12.9 Midblock Crossing and Detection Technology.
- 12.10 Midblock Signals.
- 12.11 Grade-Separated Crossings.
- 12.12 Student Exercise.
- 12.13 References and Additional Resources.

### 12.2 Background

For most of this century—since pedestrians and motorists began competing for space—safety campaigns have directed pedestrians to walk to intersections to cross roadways. This is helpful advice, especially in downtown locations where signalization is frequent, where cycle lengths are short, where blocks are short, and where intersections are small and compact. But with the advent of the modern suburb, blocks are much longer, signalization is less frequent, some intersections are very wide, and vehicle speeds are much higher than in downtown areas. Under these conditions, crossing at intersections becomes less practical and often more dangerous.

Today's designer is challenged to find workable crossing points to move pedestrians across high-speed roadways. When convenient and manageable crossing points are not identified, most pedestrians cross at random, unpredictable locations. In making random crossings, they create confusion and add risk to themselves and drivers.

This chapter addresses several ways to facilitate nonintersection crossings: medians and refuge islands, midblock crossings, and grade-separated crossings. By placing medians along multilane roadways, the designer helps channel pedestrians to the best locations: where gaps are more frequent; where lighting is improved; and where motorists have the best chance to search, detect, recognize, and respond to the presence of pedestrians (see figure 12-1). Where there are medians, the pedestrian still may cross at random locations, but because of the increased frequency of acceptable gaps and greatly reduced conflicts, the pedestrian is more likely to find a longer gap and then walk (not rush) across the roadway.

Midblock crossings are an essential design tool. All designers must learn the best placement, geometrics, and operations of midblock crossings.



Figure 12-1. Photo. Midblock crossings are easily located on low-volume, low-speed roadways such as short collectors through neighborhoods.

### 12.3 Medians and Refuge Islands—Powerful Safety Tools

A median or refuge island is a raised longitudinal space separating the two main directions of traffic. Median islands, by definition, run one or many blocks. Refuge islands are much shorter than medians, with a length of 30.5–76.2 meters (m) (100–250 feet (ft)). Medians and refuge islands can be designed to block side-street or driveway crossings of the main road, as well as block left-turning movements. Because medians reduce turning movements, they can increase the flow rate (capacity) and safety of a roadway.

Medians have become an essential tool in minimizing the friction of turning and slowing vehicles. Medians maximize the safety of the motorist and pedestrian. Medians have been extensively studied by the Georgia and Florida Departments of Transportation (DOTs). Based on more than 1609.3 centerline kilometers (km) (1,000 centerline miles (mi)) of conversion from two-way left-turn lanes (TWLTLs) to raised medians, motorist crashes were reduced dramatically. Florida DOT (FDOT) research has shown that pedestrians are at high risk while standing in TWLTLs.<sup>(1)</sup>

Midblock crossings can be kept simple and are easily located on low-volume, low-speed (40.2–48.3 kilometers per hour (km/h) (25–30 miles per hour (mi/h)) roadways such as short collectors through neighborhoods. When collectors are longer and handle more traffic and higher speeds, medians or refuge islands are helpful and sometimes essential (see figure 12-2). On multilane minor and major arterials, refuge islands or raised medians are essential. However, when used, crosswalks must be placed with great care in these locations, especially once travel speeds exceed 64.4 km/h (40 mi/h).

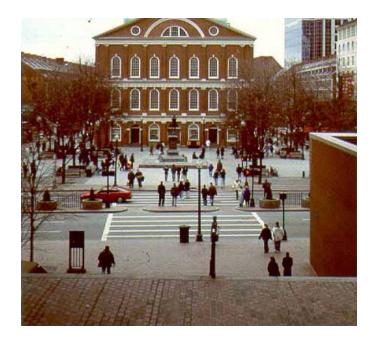


Figure 12-2. Photo. Refuge islands and visible crosswalks are essential on major arterials with higher traffic speeds.

### 12.4 Advantages of Medians

Medians separate conflicts in time and place. The pedestrian faced with one or more lanes of traffic in each direction must determine a safe gap in two, four, or even six lanes at a time. This is a complex task requiring accurate decisions. Younger and older pedestrians have reduced gap acceptance skills compared with pedestrians in other age groups. Pedestrians also typically have poor gap assessment skills at night. Many may predict that a car is 61.0 m (200 ft) off when, in fact, it is only 30.5 m (100 ft) away, far too close to attempt a crossing.

#### Medians Allow More Frequent Gaps

Not only do medians separate conflicts, but they also create the potential for acceptable gaps. On a standard-width, four-lane roadway with a center left-turn lane (19.5 m (64 ft) wide, with five 3.7-m (12-ft) lanes plus two 61.0-centimeter (cm) (24-inch) gutter pans), it takes an average pedestrian traveling 1.2 m/second (s) (4 ft/s) nearly 16 s to cross. Finding a safe 16-second gap in four moving lanes of traffic may be difficult or impossible. In any event, an attempt to cross may require a wait of 3–5 minutes (min). Faced with such a substantial delay, many pedestrians select a less adequate gap, run across the roadway, or stand in the center left-turn lane in hope of an additional gap. If a raised median is placed in the center, the pedestrian now crosses 7.9 m (26 ft) instead. This requires two 8-second gaps (see figures 12-3 and 12-4). These shorter gaps come more frequently. Based on traffic volume and the platooning effects from downstream signalization, the pedestrian may be able to find an acceptable gap in a minute or less.

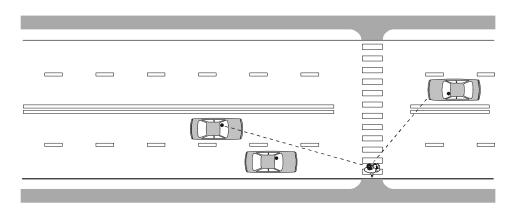
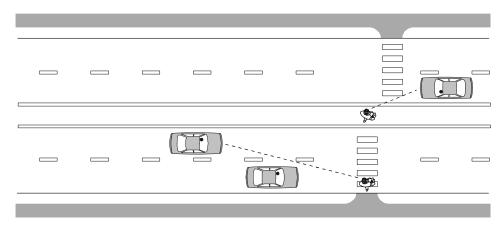


Figure 12-3. Photo. A midblock crossing without median refuge requires the pedestrian to look for gaps in both directions at once.



#### Figure 12-4. Photo. A midblock crossing with a median refuge allows the pedestrian to look for gaps in only one direction at a time.

#### Medians Are Less Expensive To Build

The reduced construction cost of a median versus a center left-turn lane comes as a surprise to many designers. Grass medians allow natural percolation of water, thus reducing drainage and water treatment costs. Medians do not require a base or asphalt. Curbing is essential in urban sections where medians are typically raised above the level of the street. In general, however, medians average a 5- to 10-percent reduction in materials and labor costs compared to a center left-turn lane.

#### Medians Are Less Expensive To Maintain

While there is only a slight savings in cost to build a raised median versus a center left-turn lane, there is a substantial savings in maintenance. An FDOT study compared 6.4 km (4 mi) of median versus center left-turn lane maintenance costs and found that medians save an average of 40 percent on maintenance costs based on a 20-year roadway life. More frequent resurfacing, such as every 7 to 9 years, would show much greater savings. This, too, surprises many designers. During the full life of the roadway asphalt, a raised median saves costs associated with sweeping accumulated debris, repainting lines, replacing raised pavement markers, and resurfacing lanes.

### 12.5 Design Considerations for Medians

Ideally, a median should be at least 2.4 m (8 ft) wide to allow the pedestrian to wait comfortably in the center, 1.2 m (4 ft) from moving traffic. A wider median is necessary if it must also serve the purpose of providing a left-turn bay for motor vehicle traffic at intersections. If the desired 2.4 m (8 ft) cannot be achieved, a width of 1.8 m (6 ft), or 1.2 m (4 ft) will be sufficient. To find the needed width, especially in a downtown or other commercial environment, consider narrowing travel lanes to an appropriate width. In most locations, this reduction in travel lanes can only be made to 3.4 m (11 ft), but in many other locations, where speeds are in the 32.2–48.3-km/h (20–30-mi/h) range, the reduction to 3.0 m (10 ft) or even 2.7 m (9 ft) is possible, and may even be desirable.

Medians typically have an open, flat cut and do not ramp up and down due to the short width. If the island is sufficiently large, then ramps approved by the Americans with Disabilities Act (ADA) (1:12 grade) can be used. It is best to provide a slight grade (2 percent or less) to permit water and silt to drain from the area. Median cuts work best at midblock crossings.

### 12.6 Midblock Crossings by Roadway Classification

Midblock crossings are located and placed according to a number of factors, including roadway width, traffic volume, traffic speed and type, desired lines for pedestrian movement (see figure 12-5), and adjacent land use. Guidance for median placement on various types of roadways appears below.



Figure 12-5. Photo. Landscaping a median can block midblock access and divert pedestrians to adjacent intersections.

#### Local Roads

Due to their low traffic speed and volume, local roadways rarely have median treatments. Some exceptions may apply, especially around schools and hospitals, where traffic calming is desired, and in other unique locations.

#### Collector Roads

Two-lane collector roads occasionally have medians or refuge islands to channel pedestrians to preferred crossing locations. Used in a series, these refuge islands have a strong visual presence and act as significant devices to slow motorist travel through the corridor. A 16.1-km/h (10-mi/h) speed reduction (from to 64.4 to 48.3 km/h (40 mi/h to 30 mi/h)) has been achieved. Pedestrians crossing at these midblock refuge islands with marked crosswalks (who also make their intent to cross known) achieve a nearly 100-percent favorable response from motorists.

When collector roads are widened to four lanes (not recommended), raised medians may be essential. A boulevard-style street with tree canopies is recommended. This canopy effect helps reduce travel speeds.

#### Multilane Arterial Highways with Four Lanes

Suburban crossings of four-lane roadways are greatly improved when medians and midblock crossings are used. On lower-volume roadways, it is best not to use signalization.

Signalization may be helpful or even essential under the following conditions:

- On higher volume roadways.
- Where gaps are infrequent.
- In school zones.
- Where elderly or disabled pedestrians cross.
- Where speeds are high.
- When a number of other factors are present.

#### Multilane Arterial Highways with Six or More Lanes

On multilane arterials with six or more lanes, merging is occurring, lane changing increases, and there is a greater tendency for motorists to speed and slow. This creates highly complex conditions that must be interpreted by the pedestrian.

At midblock locations, where vehicle speeds are high, signalization may be the only practical means of helping pedestrians to cross unless as part of a signal coordination scheme. At high speeds and with infrequent signal calls, high numbers of rear-end crashes can be anticipated. It is best not to allow urban area roadways to achieve high corridor speeds. This is especially true in areas where land use supports higher densities. The higher the speed, the greater the engineering challenge to cross pedestrians safely.

If a pedestrian crossing is needed in such a location, the designer must increase the devices used to alert the motorist. The standard pedestrian crossing and advanced crossing symbols with signs measuring 91 by 66 cm (36 by 26 inches) are an absolute minimum for speeds of 64.4 km/h (40 mi/h) or greater. Pavement word symbols can be used as further enhancements. An enhanced crosswalk marking such as a zebra- or ladder-style crossing should be considered. Large overhead signs, flashing beacons, bulb-outs (see figure 12-6), and even flashing overhead signs have been successfully used in some locations.

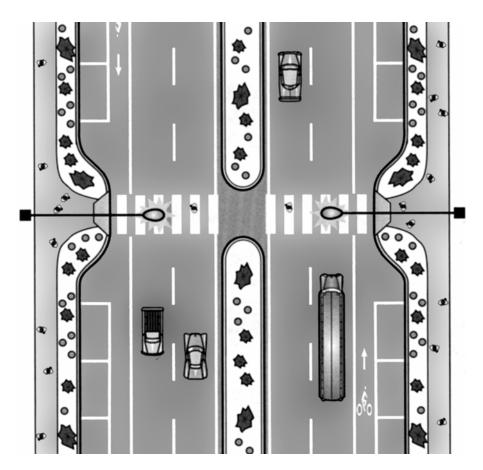


Figure 12-6. Illustration. Midblock crossing curb extensions provide better visibility for motorists and pedestrians.

### 12.7 Midblock Crossing Design

The design of midblock crossings makes use of warrants similar to those used for standard intersections. Stopping sight distances, effects of grade, cross slope, the need for lighting, and other factors all apply. The design considerations for medians are covered earlier in this lesson. However, there are a number of added guidelines that must be followed.

#### Connect Desire Lines

All other factors considered, pedestrians and bicyclists have a strong desire to continue their intended path of travel. Look for natural or existing patterns. Use of a high-angle, time-lapse video camera to map pedestrian crossings quickly paints this location, if it is not already well known.

#### Lighting

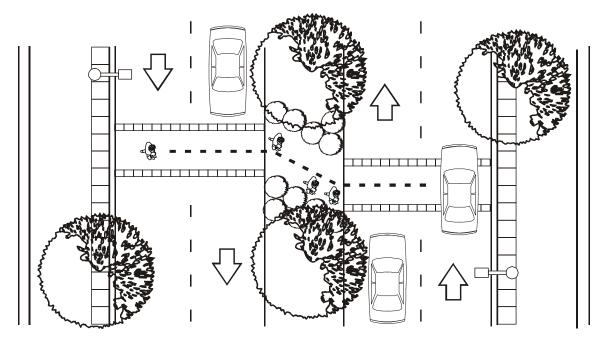
Motorists need to see both the pedestrians who stand waiting to cross and those who are already crossing. Either direct or back lighting is effective. Some overhead signs such as in Portland, OR, and Seattle, WA, use overhead lights that identify the pedestrian crossing and also shine down on the actual crosswalk.

Grade-separated crossings at midblock or intersection locations are effective in a few isolated circumstances (see section 12.11 for a further discussion of grade-separated crossings). However, because

of their cost and their potentially low use, engineering studies should be conducted by experienced designers. If given a choice, on most roadways, pedestrians generally prefer to cross at grade.

#### 12.8 Staggered Midblock Crosswalks

Staggered crosswalks (or Z-crossings) are treatments in which the crosswalk is split by a median and is offset on either side of the median. This configuration forces pedestrians to turn in the median and face oncoming traffic before turning again to cross the second half of the crosswalk. Notice in figure 12-7 how, in either walking direction, the pedestrian must turn slightly toward traffic before crossing. In order to curtail shortcutting and force pedestrians to follow the intended path, some medians may also have attractive fencing to corral pedestrians in the correct direction (see figure 12-8). One problem with staggered crosswalks is that they may present a challenge for visually impaired pedestrians who are thrown off course by changes in the direction of the walkway leading to the road. A solution is to provide detectable warnings and/or railings to help realign the pedestrian perpendicularly to the roadway just before the crossing.



**Figure 12-7. Illustration. Diagram of a staggered crossing configuration.** Source: Southeast Neighborhood Traffic Management Plan<sup>(2)</sup>



Figure 12-8. Photo. Staggered crosswalk with fencing.

Source: Pedestrian and Bicycle Information Center (PBIC) Image Library, http://www.pedbikeimages.org<sup>(3)</sup>

### 12.9 Midblock Crossing and Detection Technology

Midblock crossings can be enhanced and made safer by the installation of some of the same crossing and detection technology found at intersections and other walkway locations. Refer to these previous sections for a discussion of these technologies:

- Pavement markings and signing (lessons 10.4–10.8).
- In-pavement flashers (lesson 10.9, "Intelligent Transportation Systems Technology").
- Automated detection devices (lesson 10.9, "Intelligent Transportation Systems Technology").
- Street lighting (lesson 9.5, "Ambience, Shade, and Other Sidewalk Enhancements").
- Pavement surfaces and detectable warning (lesson 9.3, "Basic Sidewalk Elements").
- Other crossing technologies (lesson 11.5, "Crossing and Detection Technology").

#### 12.10 Midblock Signals

The placement of midblock signals is called for in some locations. The warrants provided in the *Manual* on Uniform Traffic Control Devices (MUTCD) should be followed. But even more caution must be provided for signalized midblock locations. Pedestrians feel frustrated if a signal is holding them back from crossing when there is an ample gap. Many will choose to cross away from the crossing, while others will dutifully push the activator button, not get an immediate response, and cross when there is a sufficient gap. A few seconds later, the approaching motorists must stop at a red signal for no reason, which can encourage motorist disrespect for the signal in the future.

Thus, the best signal setup for a midblock crossing is a hot (nearly immediate) response. As soon as the pedestrian call actuator button is pushed, the clearance interval should be activated. This minimal wait

time is a strong inducement for pedestrians to walk out of their way to use the crossing. Hot responses can often be used if the nearby signals are not on progression, or else a hot response may be permitted in off-peak hours. Midblock signals should be part of a coordinated system to reduce the likelihood of rear-end crashes and double cycles (i.e., two pedestrian cycles per one vehicle cycle at intersections to reduce pedestrian delay).

If a midblock signal system is used, it is important to place pedestrian pushbuttons in the median. There will be times when some pedestrians start too late or when older pedestrians lack time to cross, even at 0.9 m/s (3 ft/s). In these rare instances, the pedestrian needs to reactivate the signal.

### 12.11 Grade-Separated Crossings

According to the North Carolina DOT (NCDOT) *Bicycle Facilities Guide*, a grade-separated crossing "provides continuity of a bicycle/pedestrian facility over or under a barrier."<sup>(4)</sup>

A grade-separated crossing such as a bridge/overpass or a culvert/underpass should be considered when a pedestrian facility meets a barrier like an active multitrack railroad, stream, or freeway (see figure 12-9).



Figure 12-9. Photo. An underpass continues this shared-use bicycle path beneath a four-lane highway with high traffic volume.

Source: Bicycle Facilities Guide: Types of Bicycle Accommodations<sup>(4)</sup>

Some principal planning concerns with grade-separated crossings are:

- This type of facility can be expensive and difficult to implement. For these reasons, advance planning, identification of a source of funds, and a compelling purpose and need are primary factors in obtaining approval for construction of bicycle/pedestrian bridges or underpasses.
- Bicycle/pedestrian grade separations to be included in State highway construction projects should already be identified in locally adopted bicycle or greenway master plans by the time a proposed highway improvement is in the early stages of development.
- Many bicyclists and pedestrians will not use an overpass that is inconvenient. Instead, pedestrians may choose a time-saving and sometimes more hazardous crossing. Fencing or other controls may be required to reinforce the safe crossing point.
- Grade crossings must be accessible; ramps, handrails, landings, etc., must be provided so the facility is accessible to all.

For a grade-separated crossing to be warranted, some of the following circumstances should be present:

- High pedestrian volumes at the location and a high demand to cross.
- A large number of young children who must regularly cross (particularly at locations near schools).
- High volumes of motor vehicles traveling at high speeds along the roadway.
- No convenient alternative crossing places nearby.
- Funding and a specific need for the overpass/underpass.
- An extreme hazard for pedestrians.

Section 7F.02 of the MUTCD states that "experience has shown that overpasses are more satisfactory than underpasses for pedestrian crossings, as overpasses are easier to maintain and supervise."<sup>(5)</sup> When deciding on the use of an overpass or underpass, be aware of the need to provide artificial lighting to reduce potential crime. Also, pay attention to the existing topography of the proposed site to "minimize changes in elevation for users of overpasses and underpasses and to help insure construction costs are not excessive."<sup>(6)</sup>

### 12.12 Student Exercise

Choose an urban site that would be a good candidate for a midblock crossing with a pedestrian refuge island. Document the reasons that people often cross at this site (or would cross, given the opportunity). Photograph the site and prepare a sketch design solution.

#### 12.13 References and Additional Resources

The references for this lesson are:

1. *Florida Pedestrian Planning and Design Guidelines*, Florida Department of Transportation, Tallahassee, FL, 1996, available online at http://www.dot.state.fl.us/Safety/ped\_bike/ handbooks\_and\_research/PEDHBTOC.PDF.

- "Chapter 5: Neighborhood Street Design Guidelines," Southeast Neighborhood Traffic Management Plan (NTMP), City of Vancouver, WA, 2003, available online at http://www.ci.vancouver.wa.us/transportation/ntmp/NTMTools/ TOOL%2012%20-%20Mid-Block%20Crossing%20for%20Arterial%20Streets.pdf, accessed May 18, 2004.
- 3. Image Library, Pedestrian and Bicycle Information Center (PBIC), available online at http://www.pedbikeimages.org, accessed May 6, 2004.
- 4. *Bicycle Facilities Guide: Types of Bicycle Accommodations*, North Carolina Department of Transportation, Raleigh, NC, June 2003, available online at http://www.ncdot.org/transit/bicycle/projects/project\_types/Grade\_Separated\_Crossing.pdf, accessed April 21, 2004.
- 5. *Manual on Uniform Traffic Control Devices*, Federal Highway Administration, Washington, DC, 2003, available online at http://mutcd.fhwa.dot.gov, accessed April 22, 2004.
- 6. "Grade Separation Worksheet," *Kane County Bicycle and Pedestrian Plan: Appendix J*, Kane County Division of Transportation, Geneva, IL, January 2003, available online at http://www.co.kane.il.us/DOT/COM/Bicycle/outline.asp, accessed April 21, 2004.

Additional resources for this lesson include:

- Design and Safety of Pedestrian Facilities—A Recommended Practice of ITE, Institute of Transportation Engineers (ITE), Washington, DC1998.
- Oregon Bicycle and Pedestrian Plan, Oregon Department of Transportation, Salem, OR, 1995.