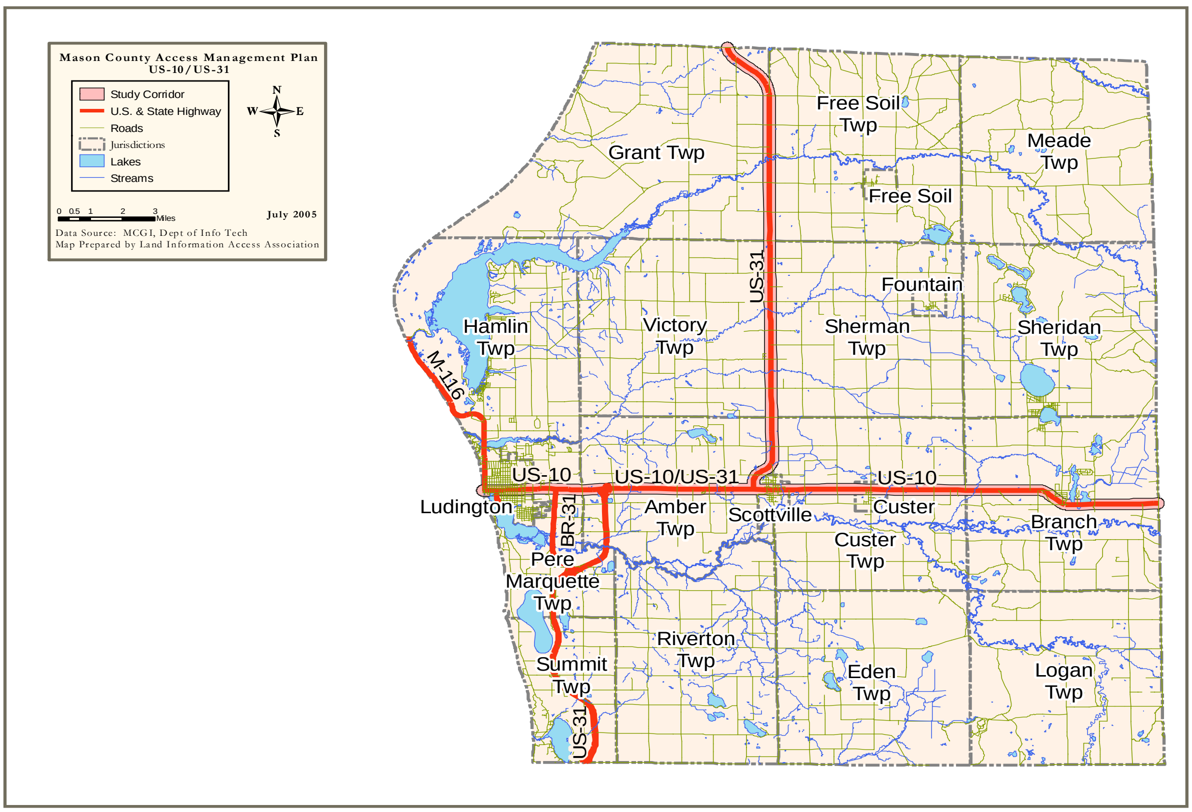
Chapter Three
TRAFFIC AND SAFETY INFORMATION, AND KEY ACCESS MANAGEMENT TECHNIQUES

INTRODUCTION

This Chapter gives an overview of the traffic and safety issues associated with the US-10/US-31 highway corridor in Mason County, and presents key access management concepts. The study area for this Plan begins at M-116 near Lake Michigan in the City of Ludington and proceeds east along US-10 to the county line with Lake County and then also north at the south junction of US-10/US-31 just west of Scottville to the County line with Manistee County. The corridor, which is approximately 38 miles in length affects the cities of Ludington and Scottville, the Village of Custer and the Townships of Pere Marquette, Amber, Custer, Branch, Victory, Sherman, Grant, Free Soil, and Mason County.

US-10 and US-31 are classified as U.S. Routes. They serve as primary highways for local citizens in the region, but also serve as a thoroughfare for those traveling across the Lower Peninsula. See Figure 3-1.

Figure 3-1
Location Map



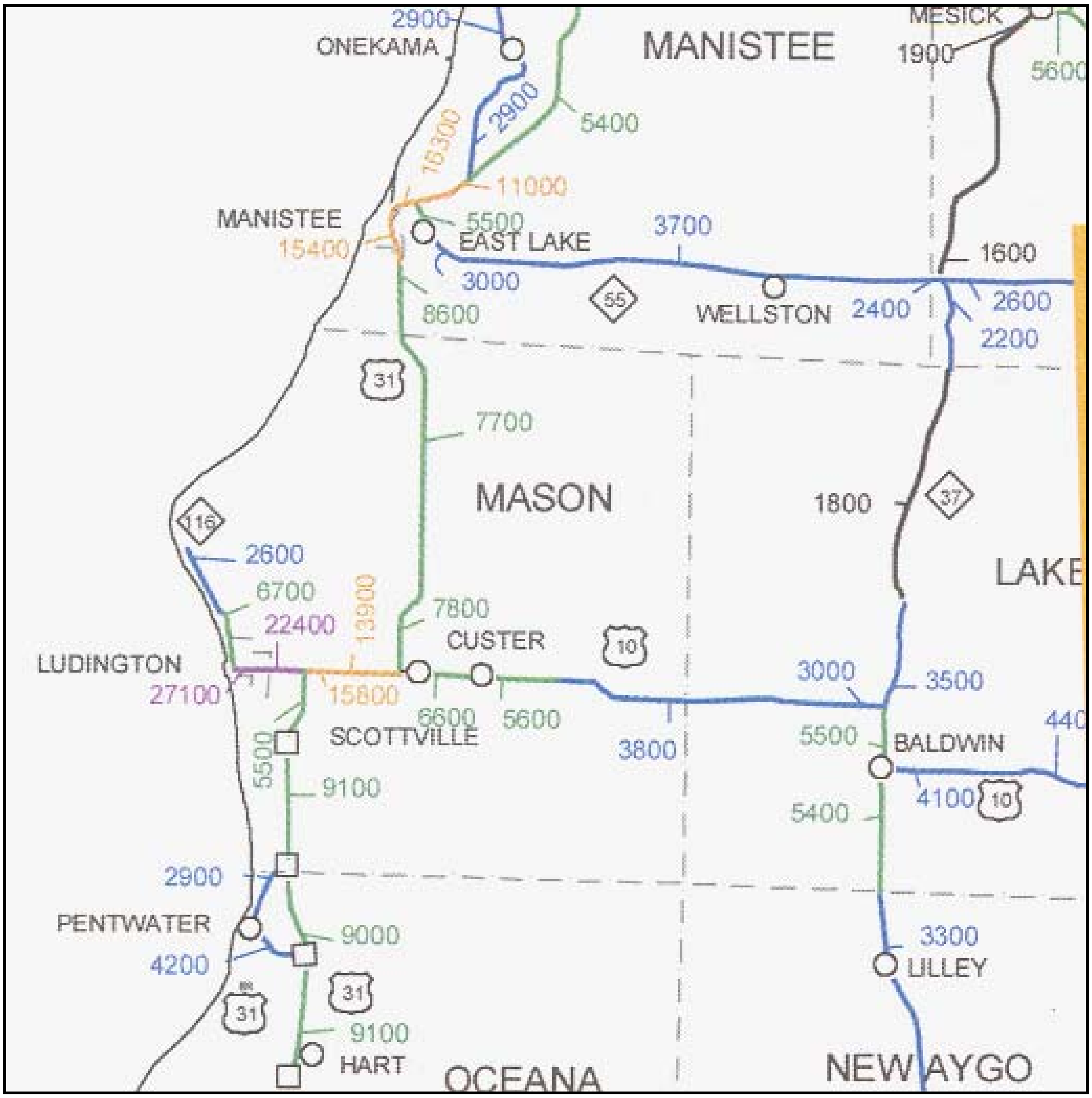
Source: Prepared by Land Information Access Association, 2005

TRAFFIC AND SAFETY ANALYSIS

Volumes

According to 24 Hour AADT (average annual daily traffic) volumes for 2004 provided by the Michigan Department of Transportation and illustrated for all vehicles on Figure 3-2 and just for commercial vehicles on Figure 3-3. The highest traffic volume in Mason County, with 27,100 vehicles a day is in downtown Ludington.

Figure 3-2
Average Annual Daily Traffic Volumes, 2004



Source: MDOT Annual Average 24-Hour Traffic Volumes, Michigan 2004

Figure 3-3
Average Annual Daily Commercial Volumes, 2004

Source: MDOT Annual Average 24-Hour Commercial Traffic Volumes, Michigan 2004

Volumes drop by almost half at the US-31 freeway intersection with US-10 (15,800 vehicles). They fall by more than half again just east of Scottville (6,600 vehicles) and are down to about 3,800 vehicles at the Lake County line. Just north of Scottville on US-31, volumes are 7,800 vehicles/day which remains steady to the Manistee County line where it starts to rise approaching the city of Manistee. Commercial traffic volumes are low throughout the County with the highest on the freeway portion of US-31 near the interchange with US-10 (910 vehicles). Generally, commercial volumes run about 500-650 vehicles/day on other parts of US-10 and US-31.

Crash Analysis

Crash analysis of the years 2002 to 2004 yielded 1,328 total crashes and 882 not involving animals on the corridor. The data was provided by MDOT. Table 3-1 summarizes the crashes during this three-year period. The highest concentration is from downtown Ludington to Brye Road just east of the US-31 interchange with US-10. Sixty-two percent (550 of 882) of the non-animal crashes were within this stretch of US-10. This is also where most of the driveways are. As one would expect, the overwhelming bulk of animal crashes involve deer and are on US-10 east of Custer and north of Scottville on US-31.

The higher the crash rate, the higher incidence of crashes based on the volume of traffic and presence of signalized intersections on that segment. Two of the three highest crash rates are in downtown Ludington where traffic volumes are highest and there is on-street parking with a 30 mph speed limit. The other is between Nelson and Jebavy in an area with a particularly large number of driveways close together.

Table 3-2 presents the details of this crash data by crash type and road segment from 2002-2004. The crash rate formula is presented at the bottom of the table. Maps 3-1 and 3-2 show the general location and type of crashes along the corridor from 2002-2004 (not including animal crashes).

Table 3-1
Mason County Traffic Crashes, US-10 and US-31, 2002-2004

Section	Crashes		
	Total	**w/o Animals**	**Crash Rate w/o Animals**
US-10 West to East			
Lake Shore Drive to Williams	5	5	115.2
Williams to E. of James St.	42	42	1,396.8
E. of James St. to E. of Lavinia	45	45	1,081.2
E. of Lavinia to Madison St.	31	31	561.8
Madison St. to W. of Jackson	22	21	357.4
W. of Jackson Rd. to W. of Nelson	53	52	699.7
W. of Nelson Rd. to E. of Nelson Rd.	53	53	713.2
E. of Nelson Rd. to E. of Jebavy Rd.	80	77	1,036.1
E. of Jebavy to E. of US-31BR	71	64	861.2
E. of US-31BR East 1/2 Mile	22	21	176.2
E. of US-10/31 to W. of Meyers Rd.	64	62	505.6
W. of Meyers Rd. to W. of US-31 West Jct.	12	8	65.2
W. of US-31 West Jct. to E. of Brye Rd.	74	69	631.1
E. of Brye Rd. to East of Dennis Rd.	18	12	138.5
E. of Dennis Rd. to W. of Stiles Rd.	3	3	34.6
W. of Stiles Rd. to Stiles Rd.	12	4	46.2
Stiles Rd. to W. of Quarterline Rd.	30	21	275.8
W. of Quarterline Rd. to W. of Amber	8	6	78.8
W. of Amber to W. of Gordon	18	12	157.6
W. of Gordon to E. of Gordon (intersection)	23	7	91.9
E. of Gordon to E. US-31 Jct.	21	11	144.5
US-31 E. Jct. to W. of Reinberg	4	3	84.6
W. of Reinberg to W. of Main	6	5	141.0
W. of Main to Columbia	20	20	759.5
Columbia to Bean	4	4	108.5
Bean to E. of Darr	38	10	162.5
E. of Darr to W. of Monroe	46	17	234.8
W. of Monroe St. to W. of Stephens	19	13	185.0
W. of Stephens to W. of Benson	63	19	77.8
W. of Benson to E. of Wever	25	16	383.0
E. of Weaver to Tyndall	53	18	115.4
US-31 South to North			
US-10 to N. of Main	54	36	351.8
N. of Main to N. of Dewey	103	32	98.7
N. of Dewey to N. of Freeman Rd. (N.B. PRL)	80	30	71.0
N. of Freeman Rd. to County Line Rd. (N.B. & S.B. PRL)	106	33	64.8
TOTAL CRASHES	**1,328**	**882**	**NA**

Source: Michigan Department of Transportation

PRL – Passing Relief Lane

Table 3-2

Detailed Crash Type by Road Segment on US-10 and US-31 in Mason County, 2002-2004

US-10 West to East																
Speed Limit (MPH)	30		25		25-30		30		30-40		40		40		40	
# Lanes	4 Lane - BLVD		5 Lane		4 - 5 Lane		4 - 5 - 4 Lane		4 - 5 Lane		5 Lane		5 Lane		5 Lane	
Shoulder Type	Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb	
ADT	10984		10984		15204		20156		21465		27147		27147		27147	
Length (mi)	0.361		0.25		0.25		0.25		0.25		0.25		0.25		0.25	
On Street Parking	No		Yes		Yes		No		No		No		No		No	
	1. Lake Shore Dr. to Williams		2. Williams to E. of James St.		3. E. of James St. to E. of Lavinia		4. E. of Lavinia to Madison St		5. Madison St. to W. of Jackson		6. W. of Jackson Rd. to W. of Nelson		7. W. of Nelson Rd. to E. of Nelson Rd.		8. E. of Nelson Rd. to E. of Jebavy Rd.	
Crash Type	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate
Miscellaneous 1 Vehicle			1	33.3					1	17.0	2	26.9	2	26.9	8	107.6
Overturn																
Backing					1	24.0										
Parking			2	66.5	4	96.1										
Pedestrian			7	232.8	2	48.1	4	72.5								
Fixed Object			1	33.3			1	18.1	1	17.0	2	26.9	1	13.5	2	26.9
Other Object																
Animal									1	17.0	1	13.5			3	40.4
Bicycle					2	48.1	1	18.1								
Head-On									1	17.0						
Angle Straight			6	199.5	3	72.1	4	72.5	2	34.0	4	53.8	6	80.7	8	107.6
Rear- End Straight	1	23.0	7	232.8	13	312.3	16	290.0	11	187.2	25	336.4	25	336.4	25	336.4
Angle Turn	1	23.0	2	66.5	6	144.2	1	18.1	2	34.0	3	40.4	1	13.5	6	80.7
Side Swipe Same	2	46.1	13	432.3	12	288.3	3	54.4	1	17.0	4	53.8	5	67.3	5	67.3
Rear-End Left Turn																
Rear-End Right Turn											1	13.5	1	13.5		
Angle Drive			1	33.3							2	26.9	5	67.3	7	94.2
Rear-End Drive	1	23.0	1	33.3	1	24.0					4	53.8	5	67.3	4	53.8
Side Swipe Opposite			1	33.3	1	24.0	1	18.1	2	34.0	1	13.5	1	13.5	4	53.8
Head-On Left-Turn											4	53.8	1	13.5	7	94.2
Dual Right Turn															1	13.5
Total	5		42		45		31		22		53		53		80	
Total (-Animals)	5	115.2	42	1396.8	45	1081.2	31	561.8	21	357.4	52	699.7	53	713.2	77	1036.1
Condition and Injuries																
Icy	1		5		2				3		4		3		4	
Dark	1		10		8		5		3		5		10		19	
Wet			11		11		7		4		13		11		22	
Fatal																
Injury	1		11		7		11		3		10		15		19	

Crash Rate = # Crashes per 100 million vehicle miles of travel, Given by the equation:

$$\text{Rate} = \frac{\frac{\#\text{ Crashes}}{3\text{ Years}} \times 100{,}000{,}000}{\text{ADT} \times 365\text{ Days} \times \text{Length (mi)}}$$

Source: Michigan Department of Transportation

	US-10 West to East								US-10/31 West to East							
Speed Limit (MPH)	40		40-55		55		55		55		55		55		55	
# Lanes	5 Lane		5 Lane		5 Lane		5 Lane		5 Lane		5 Lane		5 Lane		5 Lane	
Shoulder Type	Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb	
ADT	27147		21774		22399		22399		19968		15824		15824		15824	
Length (mi)	0.25		0.5		0.5		0.5		0.5		0.5		0.5		0.5	
On Street Parking	No		No		No		No		No		No		No		No	
	9. E. of Jebavy to E. of US-31BR		**10. E. of US-31BR East 1/2 Mile**		**11. E. of US-10/31 to W. of Meyers Rd.**		**12. W. of Meyers to W. of US-31 West Jct.**		**13. W. of US-31 West Jct. to E. of Brye Rd.**		**14. E. of Brye to E. of Dennis Rd.**		**15. E. of Dennis to W. of Stiles Rd.**		**16. W. of Stiles to Stiles Rd.**	
Crash Type	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**
Miscellaneous 1 Vehicle	14	**188.4**	2	**16.8**	3	**24.5**	1	**8.2**	8	**73.2**	1	**11.5**			2	**23.1**
Overturn									1	**9.1**						
Backing									1	**9.1**						
Parking			1	**8.4**	1	**8.2**										
Pedestrian			1	**8.4**												
Fixed Object	3	**40.4**	3	**25.2**	2	**16.3**	1	**8.2**	1	**9.1**			2	**23.1**		
Other Object					1	**8.2**									1	**11.5**
Animal	7	**94.2**	1	**8.4**	2	**16.3**	4	**32.6**	5	**45.7**	6	**69.3**			8	**92.3**
Bicycle					2	**16.3**										
Head-On					3	**24.5**			1	**9.1**						
Angle Straight	8	**107.6**			6	**48.9**	2	**16.3**	12	**109.8**	3	**34.6**				
Rear- End Straight	21	**282.6**	4	**33.6**	18	**146.8**	1	**8.2**	18	**164.6**	5	**57.7**			1	**11.5**
Angle Turn	1	**13.5**			5	**40.8**			6	**54.9**						
Side Swipe Same	4	**53.8**			4	**32.6**	1	**8.2**	2	**18.3**	1	**11.5**				
Rear-End Left Turn			1	**8.4**	1	**8.2**			1	**9.1**						
Rear-End Right Turn					1	**8.2**			1	**9.1**			1	**11.5**		
Angle Drive	2	**26.9**	6	**50.3**	8	**65.2**	1	**8.2**	4	**36.6**						
Rear-End Drive	1	**13.5**	3	**25.2**	1	**8.2**			1	**9.1**	1	**11.5**				
Side Swipe Opposite	5	**67.3**			2	**16.3**	1	**8.2**	7	**64.0**	1	**11.5**				
Head-On Left-Turn	5	**67.3**			4	**32.6**			5	**45.7**						
Dual Right Turn																
Total	**71**		**22**		**64**		**12**		**74**		**18**		**3**		**12**	
Total (-Animals)	64	**861.2**	21	**176.2**	62	**505.6**	8	**65.2**	69	**631.1**	12	**138.5**	3	**34.6**	4	**46.2**
	Condition and Injuries															
Icy	3		5		8		1		5		4		1			
Dark	18		4		12		4		14		7				5	
Wet	17		1		13		4		14		2				1	
Fatal																
Injury	18		9		21		2		31		4		1		1	

Crash Rate = # Crashes per 100 million vehicle miles of travel, Given by the equation:

$$\text{Rate} = \frac{\frac{\#\ \text{Crashes}}{3\ \text{Years}} \times 100{,}000{,}000}{\text{ADT} \times 365\ \text{Days} \times \text{Length (mi)}}$$

	US-10/31 West to East										US-10 West to East					
Speed Limit (MPH)	55		55		55		55		55		40		30		30	
# Lanes	5 Lane		5 Lane		5 Lane		5 Lane		5 Lane		3 Lane		3 Lane		3 Lane	
Shoulder Type	Curb		Curb		Curb		Curb		Curb		Curb		Curb		Curb	
ADT	13908		13908		13908		13908		13908		12958		12958		9619	
Length (mi)	0.5		0.5		0.5		0.5		0.5		0.25		0.25		0.25	
On Street Parking	No		No		No		No		No		No		No		No	
	17. Stiles to W. of Quarterline Rd.		18. W. of Quarterline to W. of Amber		19. W. of Amber to W. of Gordon		20. W. of Gordon to E. of Gordon (intersection)		21. E. of Gordon to E. US-31 Jct.		22. US-31 E. Jct. to W. of Reinberg		23. W. of Reinberg to W. of Main		24. W. of Main to Columbia	
Crash Type	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate	# of Crashes (3 year)	Crash Rate
Miscellaneous 1 Vehicle	2	26.3	1	13.1	1	13.1	2	26.3	3	39.4	1	28.2			1	38.0
Overturn	1	13.1														
Backing																
Parking									1	13.1						
Pedestrian																
Fixed Object					3	39.4	1	13.1								
Other Object	2	26.3														
Animal	9	118.2	2	26.3	6	78.8	16	210.1	10	131.3	1	28.2	1	28.2		
Bicycle															1	38.0
Head-On					1	13.1										
Angle Straight	5	65.7	1	13.1			1	13.1	1	13.1			2	56.4	3	113.9
Rear- End Straight	4	52.5	1	13.1	2	26.3	1	13.1	5	65.7	1	28.2	1	28.2	12	455.7
Angle Turn	2	26.3	1	13.1	1	13.1	1	13.1								
Side Swipe Same	3	39.4	1	13.1	3	39.4	1	13.1			1	28.2	1	28.2	2	76.0
Rear-End Left Turn																
Rear-End Right Turn																
Angle Drive	1	13.1														
Rear-End Drive	1	13.1	1	13.1												
Side Swipe Opposite															1	38.0
Head-On Left-Turn					1	13.1			1	13.1			1	28.2		
Dual Right Turn																
Total	30		8		18		23		21		4		6		20	
Total (-Animals)	21	275.8	6	78.8	12	157.6	7	91.9	11	144.5	3	84.6	5	141.0	20	759.5
	Condition and Injuries															
Icy	3				3		1		2							
Dark	10		5		11		15		10				2		6	
Wet	4		2		3		7		3				1		2	
Fatal	1															
Injury	8		3		8		3		4		1		1		7	

Crash Rate = # Crashes per 100 million vehicle miles of travel, Given by the equation:

$$\text{Rate} = \frac{\frac{\#\ \text{Crashes}}{3\ \text{Years}} \times 100{,}000{,}000}{\text{ADT} \times 365\ \text{Days} \times \text{Length (mi)}}$$

	US-10 West to East													
Speed Limit (MPH)	30-40		55		55-40		40-55		55		55		55	
# Lanes	3 Lane		2 Lane		2-3 Lane		3-2 Lane		2 Lane		2 Lane		2 Lane	
Shoulder Type	Curb		Shoulders		Shoulders and Curb		Curb and Shoulders		Shoulders		Shoulders		Shoulders	
ADT	9619		6613		6613		6417		5578		3815		3815	
Length (mi)	0.35		0.85		1		1		4		1		3.735	
On Street Parking	No		No		No		No		No		No		No	
	25. Columbia to Bean		***26. Bean to E. of Darr***		***27. E. of Darr to W. of Monroe***		***28. W. of Monroe to W. of Stephens***		***29. W. of Stephens to W. of Benson***		***30. W. of Benson to E. of Weaver***		***31. E. of Weaver to Tyndall***	
Crash Type	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**
Miscellaneous 1 Vehicle	1	**27.1**			3	**41.4**	1	**14.2**	3	**12.3**	2	**47.9**	3	**19.2**
Overturn							1	**14.2**	1	**4.1**	1	**23.9**		
Backing									1	**4.1**				
Parking														
Pedestrian														
Fixed Object			2	**32.5**	3	**41.4**	1	**14.2**	9	**36.8**	2	**47.9**	6	**38.5**
Other Object														
Animal			28	**454.9**	29	**400.5**	6	**85.4**	44	**180.1**	9	**215.4**	35	**224.3**
Bicycle														
Head-On	1	**27.1**									1	**23.9**	2	**12.8**
Angle Straight			2	**32.5**			2	**28.5**			2	**47.9**	1	**6.4**
Rear- End Straight	1	**27.1**	6	**97.5**	7	**96.7**	2	**28.5**	3	**12.3**	5	**119.7**	4	**25.6**
Angle Turn							1	**14.2**					1	**6.4**
Side Swipe Same					1	**13.8**	1	**14.2**	1	**4.1**	2	**47.9**		
Rear-End Left Turn					1	**13.8**								
Rear-End Right Turn							1	**14.2**	1	**4.1**				
Angle Drive					1	**13.8**	1	**14.2**						
Rear-End Drive	1	**27.1**					1	**14.2**			1	**23.9**	1	**6.4**
Side Swipe Opposite					1	**13.8**	1	**14.2**						
Head-On Left-Turn														
Dual Right Turn														
Total	**4**		**38**		**46**		**19**		**63**		**25**		**53**	
Total (-Animals)	4	**108.5**	10	**162.5**	17	**234.8**	13	**185.0**	19	**77.8**	16	**383.0**	18	**115.4**

Condition and Injuries

Icy	1	2	12	6	15	5	4
Dark		20	32	5	46	10	37
Wet		6	10	1	11	3	4
Fatal							
Injury	1	6	7	3	7	5	9

Crash Rate = # Crashes per 100 million vehicle miles of travel, Given by the equation:

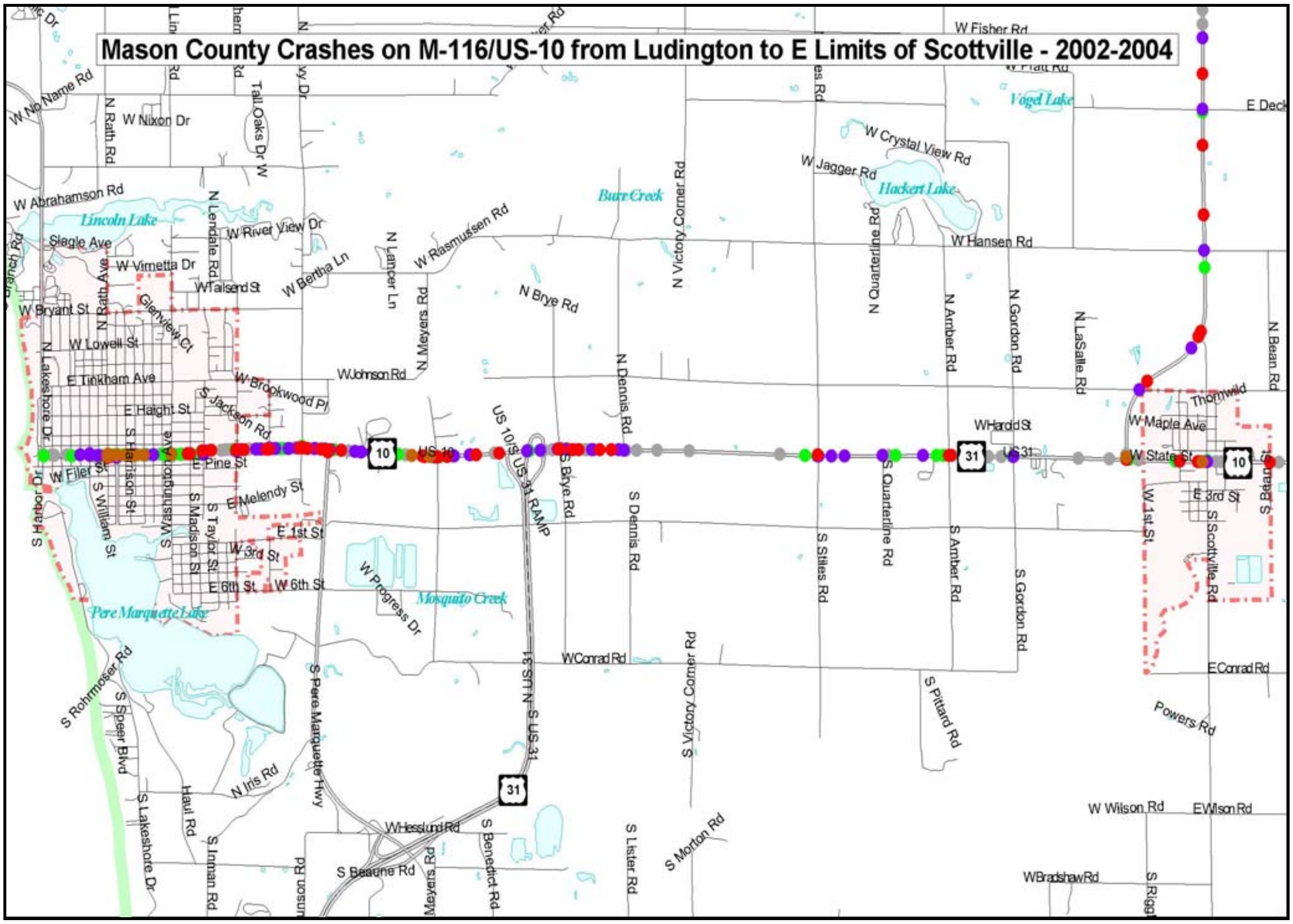
$$\text{Rate} = \frac{\frac{\#\ \text{Crashes}}{3\ \text{Years}} \times 100{,}000{,}000}{\text{ADT} \times 365\ \text{Days} \times \text{Length (mi)}}$$

	US-31 South to North							
Speed Limit (MPH)	55		55		55		55	
# Lanes	2 Lane		2 Lane		2 Lane		2 Lane	
Shoulder Type	Shoulders		Shoulders		Shoulders		Shoulders	
ADT	7788		7788		7718		7718	
Length (mi)	1.2		3.8		5		6.025	
On Street Parking	No		No		No		No	
	1. US-10 to N. of Main		**2. N. of Main to N.of Dewey**		**3. N. of Dewey to N. of Freeman Rd. (N.B. PRL)**		**4. N. of Freeman Rd. to County Line Rd. (N.B. & S.B. PRL)**	
Crash Type	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**	**# of Crashes (3 year)**	**Crash Rate**
Miscellaneous 1 Vehicle	4	**39.1**	3	**9.3**	2	**4.7**	5	**9.8**
Overturn			1	**3.1**	1	**2.4**	5	**9.8**
Backing								
Parking								
Pedestrian	1	**9.8**					1	**2.0**
Fixed Object	2	**19.5**	6	**18.5**	6	**14.2**	8	**15.7**
Other Object	1	**9.8**	2	**6.2**	4	**9.5**	1	**2.0**
Animal	18	**175.9**	71	**219.1**	50	**118.3**	73	**143.4**
Bicycle								
Head-On	2	**19.5**	2	**6.2**			1	**2.0**
Angle Straight	2	**19.5**	4	**12.3**	4	**9.5**	2	**3.9**
Rear- End Straight	16	**156.4**	5	**15.4**	7	**16.6**	4	**7.9**
Angle Turn			2	**6.2**				
Side Swipe Same			2	**6.2**	2	**4.7**	2	**3.9**
Rear-End Left Turn	1	**9.8**						
Rear-End Right Turn	4	**39.1**	2	**6.2**			1	**2.0**
Angle Drive								
Rear-End Drive							1	**2.0**
Side Swipe Opposite			1	**3.1**	3	**7.1**	1	**2.0**
Head-On Left-Turn	1	**9.8**	2	**6.2**	1	**2.4**	1	**2.0**
Dual Right Turn	2	**19.5**						
Total	**54**		**103**		**80**		**106**	
Total (-Animals)	36	**351.8**	32	**98.7**	30	**71.0**	33	**64.8**
							Condition and Injuries	
Icy	9		12		12		9	
Dark	19		73		48		73	
Wet	8		18		8		10	
Fatal	1							
Injury	10		8		10		13	

Crash Rate = # Crashes per 100 million vehicle miles of travel, Given by the equation:

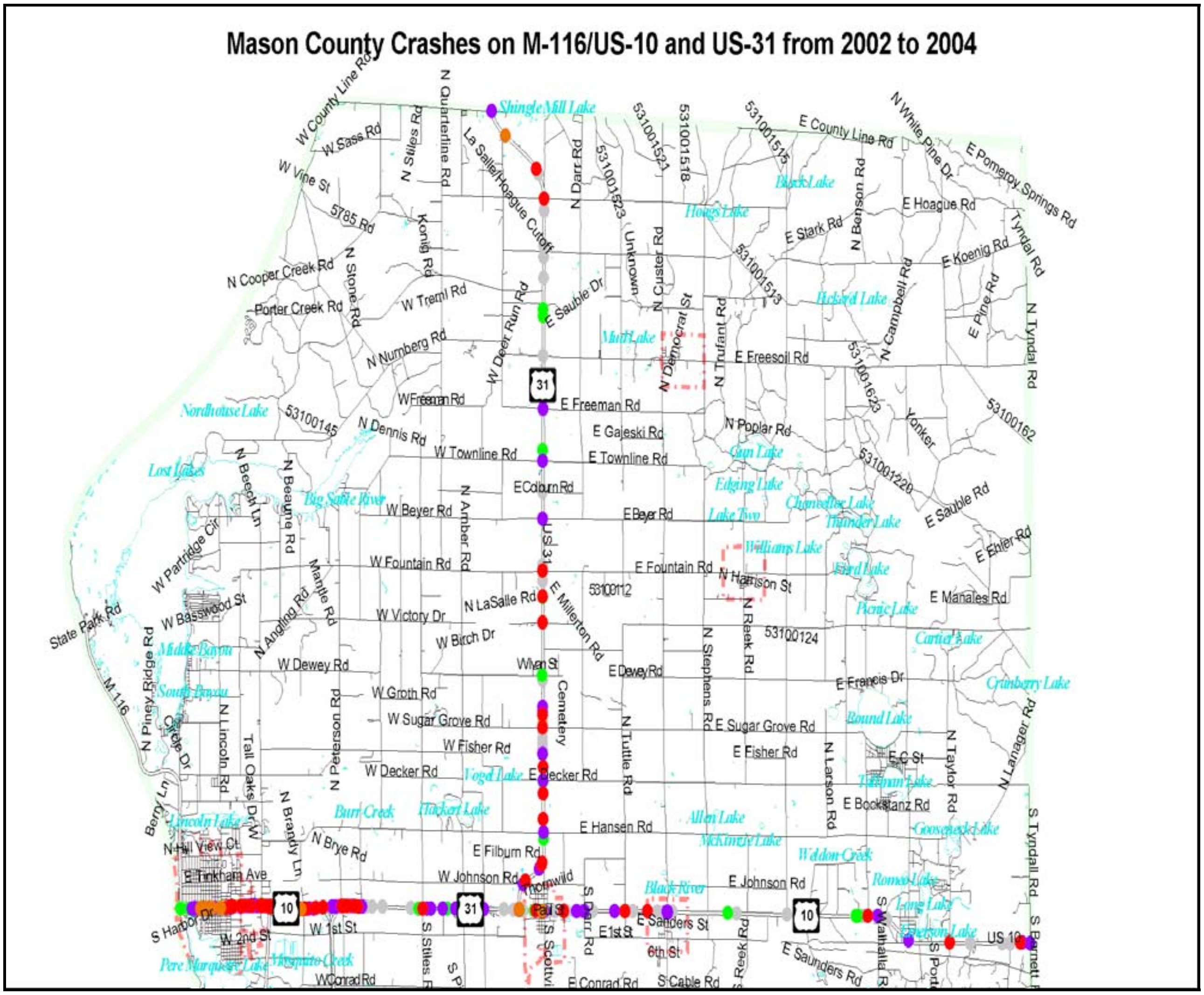
$$\text{Rate} = \frac{\frac{\#\ \text{Crashes}}{3\ \text{Years}} \times 100{,}000{,}000}{\text{ADT} \times 365\ \text{Days} \times \text{Length (mi)}}$$

Map 3-1



Source: MDOT

Map 3-2



Source: MDOT

KEY ACCESS MANAGEMENT CONCEPTS

The following sections provide an introduction to some of the concepts that will be recommended for implementation on the US-10/US-31 corridor within Chapter Four. The concepts in this section outline methods to create a uniform treatment in access management to minimize potential traffic conflicts.

Limit the Number of Driveways

A key to keeping the number of crashes low is restricting the number, location and spacing of driveways along the US-10/US-31 corridor. Numerous driveways can cause driver confusion as drivers struggle to figure out exactly which driveway they need to turn into. Driveways create conflict points for vehicles on the roadway and vehicles entering or leaving the roadway. Research shows that the more driveways per mile the higher the crash rate. See Table 3-3.

Table 3-3

Relationship of Driveway Density to Crash Rates

Driveways per Mile	Representative Crash Rate per Mile for a Multi-lane, Undivided Roadway	Increase in Crashes Associated with Higher Driveway Density
Under 20	3.4	-
20 to 40	5.9	+ 74%
40 to 60	7.4	+ 118%
Over 60	9.2	+ 171%

Source: MDOT Access Management Guidebook, 2001

From downtown Ludington to Brye Road, there are over 60 driveways per mile (on both sides of the road) for nearly every mile segment. Average lot widths on both sides of a road would be about 225 feet for 40 driveways per mile and about 170 feet for 60 driveways per mile. This is a substantially wider lot width than is common in Ludington, Pere Marquette Charter Township or Amber Township. Thus, as Table 3-3 demonstrates, crashes will be (and are) higher here than they would be with fewer driveways.

Whenever possible, communities and road authorities should limit the number of driveways per lot. This can be done through restrictions within the zoning ordinance and by using other techniques like shared access and connected parking lots. Recommendations will be made in Chapter Four.

When more than one business shares a driveway, and/or where parking lots are directly connected, motorists are able to move between businesses without going back out onto the highway. This can significantly reduce turning movements on the highway improving both safety and efficiency, it also reduces congestion and is more convenient for consumers. Photo 3-1 illustrates a connected parking lot near the intersection of Nelson Road and US-10 on the north side of the road. This would be better if the driveway at Kent Optical (four cars back from the traffic signal) was closed. Photo 3-2 shows a connected parking lot at the new Walgreens on the southwest corner of US-10 and Pere Marquette Highway.

Photo 3-1
Older Style Connected Parking Lot

Photo by Mark Wyckoff

Photo 3-2
Newer Style Connected Parking Lot

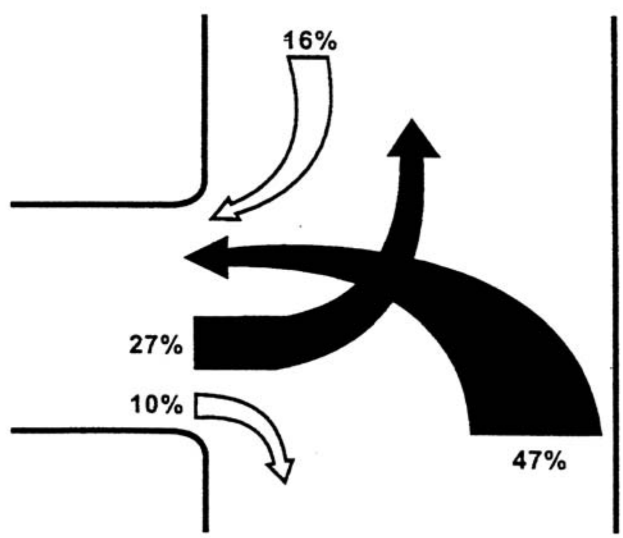
Photo by Mark Wyckoff

Speed Progression
Poorly spaced signals hamper traffic progression. At least one-half mile between signals is typically desirable. Signals can provide the necessary break in traffic flow to permit vehicles to make left-turns into or out of properties lining the arterial. If signals are located too close together, unnecessary traffic congestion can occur from through traffic which competes for road space with vehicles exiting driveways between signals. Irregularly spaced signals destroy the signal progression and therefore hamper traffic flow by increasing travel time and reducing capacity. Numerous driveways can also limit speeds because ingress and egress vehicles cause traffic to slow down. The three consecutive traffic signals in downtown Ludington are necessary to manage the high traffic volume and pedestrian traffic. The four traffic signals between Jackson Road and Pere Marquette Highway are within ¾ mile of one another. With a 40 mph speed limit, four traffic signals and high driveway density, especially on the south side of US-10, all of these factors come together to increase crash risks. It should therefore be no surprise that 28% of all the non-animal crashes on the entire US-10 and US-31 (non-freeway) highway within Mason County occurs in this short stretch of road.

Left-Turn Movements
Many studies show nearly 75% of all access related crashes are left-turns. See Figure 3-4. The left-turn movement into a driveway, without the benefit of a signal, accounts for about 47% of the crashes associated with driveways. Twenty-seven percent of the crashes are turning left out of the driveway. Only 26% of driveway crashes are right-turns (with 16% in and 10% out). Many access management techniques focus on reducing the number of driveways and eliminating left-turn movements into driveways. Medians and restricted turns can reduce the number of left-turn crashes to and from driveways. Photo 3-1 illustrates the use of specially designed channelizing islands to restrict left-turns out of a drug store parking lot.

Figure 3-4
Driveway Crashes by Movement

driveway



Percentage of Driveway Crashes by Movement

Source: National Highway Institute Research Center

Photo 3-3
Right-Turn Only

Photo by Mark Wyckoff

Existing Land Use, Zoning and Future Land Use

The land uses developed along a corridor can greatly affect the capacity, safety and operation of the roadway. Commercial development along a corridor can often be characterized by a long row of separate narrow lots with individual driveways to each business, sometimes called "strip commercial development." The large number of driveways which typically characterize this form of commercial development can result in increased congestion and traffic crashes because of the higher number of turning movements associated with commercial land uses compared to residential or other uses. There are also entrances and exits to some businesses along the US-10/US-31 corridor that are not well defined – especially along the more rural parts of the highway. These are commonly characterized by large areas of pavement without curbing or pavement markings to direct traffic coming in and going out (see Photo 3-4). This results in too many places for vehicles to turn into or out of a business and adds to driver confusion.

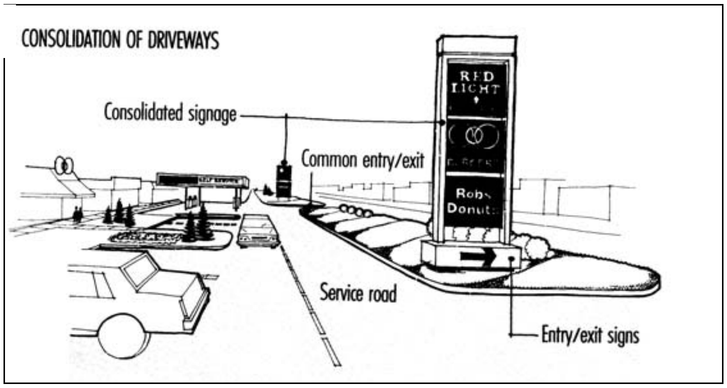
Photo 3-4
Poorly Defined Driveway Opening

Southwest corner of Custer Road and US-10 looking west. *Photo by Robert Garrett*

To avoid the access management problems of strip commercial development, it is important to: plan and zone for mixed uses along arterials; cluster multiple commercial uses around a single access road, and limit the number of driveways. Mixed-use development can be designed to link residential uses with commercial, so that people do not need to always use their car to go shopping. Mixed-use development can also provide office buildings with restaurants and shopping so workers could link potential lunchtime or after work trips. Linking day care establishments with office developments has been popular in mixed-use developments which allows children to be near parents and reduces two daily trips from the roadway. Specific land use and zoning recommendations for the US-10/US-31 corridor will be introduced within Chapter Four.

Scenic and Aesthetic Considerations
Typically improving signage, views and landscaping is thought of as an aesthetic improvement. But these improvements can also help improve safety on the corridor as well. US-10 has a large number of big signs especially in the area from Jackson Road to Pere Marquette Highway. These signs add to the complex visual scene and traffic congestion that already poses challenges for drivers in this area. Creating uniform signage for traffic and pavement markings can help driver orientation to the road, and simple, uncluttered signs for private businesses can also help improve driver safety. This involves establishing maximum height, area and location standards for signs. Also important is limiting the number of signs, which can be distracting to the driver. The consolidation of sign marques can provide a neater appearance as well as a safer corridor. See Figure 3-5.

Figure 3-5
Consolidated Sign



Source: Ontario Ministry of Municipal Affairs, Design Guidelines for Highways and Commercial Areas, 1985, p.23.

Landscaping and street trees are very important to “soften” the built environment and reduce the amount of pavement. However, these plantings need to take into account the road right-of-way as well as sight distances in and out of driveways. Vegetation also needs to be salt tolerant. US-10 is the principal gateway to Ludington and many points of regional interest, but there is no evidence of concern about the benefits of planned landscaping along any part of the corridor. With an aggressive program of driveway closure and consolidation there would be more room for landscaping.

ROADWAY AND DRIVEWAY DESIGN TECHNIQUES

Following are specific techniques referenced in the recommendations in Chapter Four. For more detail on any of these techniques, see the **Michigan Access Management Guidebook**.

Capacity Improvements

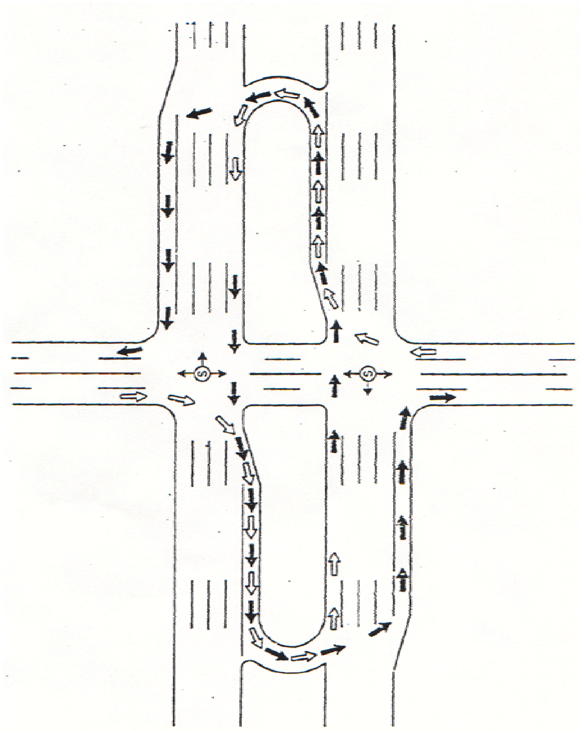
Additional Lanes

Adding lanes is a traditional solution implemented by many local governments and road agencies facing traffic congestion. However, particularly in urban areas where there is a lot of development adjacent to a highway, implementing access management strategies is often more cost effective than adding lanes due to the extremely high cost of purchasing additional right-of-way, moving utilities, and relocating parking, signs and any structures. Widening often also results in businesses and homes being very close to the new lanes, causing sight distance problems for motorists and noise problems for residents and shoppers.

Yet, where traffic volumes warrant widening a road and adding lanes, the investment will be maximized by also consolidating driveways, installing parallel access roads, and implementing other appropriate access management techniques as a part of the widening project. The investment in added capacity should be protected by regulating the number and spacing of driveways that access the roadway.

There are no places along US-10 and US-31 that need capacity improvements any time soon. From Jackson Road to Scottville, US-10 is already five lanes, and is three lanes through Scottville and Custer. Additional intermittent passing relief lanes may eventually be needed between Scottville and the Lake and Manistee County lines. But other than intersection improvements, few other capacity improvements should be needed for at least a decade.

Figure 3-6
Indirect U-turn



Source: Levinson, Herbert, et al. "*Indirect Left-turns-The Michigan Experience*" for the 4th Access Management Conference, 2000.

Boulevard Designs

Raised medians separate opposing traffic and reduce conflict points by eliminating left-turns into and out of driveways along an arterial. In fact, when properly designed, a roadway with limited median crossovers is the safest design with the maximum traffic carrying capacity. Medians are also effective at intersections to guide traffic while also separating it from opposing traffic. Separation allows for quicker turns and less traffic backups.

Standard Median

The standard MDOT 50-60 foot median requires about 270 feet of total right-of-way. The standard median design also does not allow left-turns at intersecting roads. Figure 3-6 illustrates a standard Michigan median with an indirect left-turn. This is a safe design that has been widely copied around the world.

Narrow Width Medians

Narrow width medians, center islands that vary from 20 to 40 feet have been utilized in urban or suburban areas in Michigan where the right-of-way did not allow a standard median width. See Photo 3-5 for an example. The narrow width median may require special turn-around lanes for trucks and buses because the narrow width geometry cannot adequately accommodate the large vehicles. If boulevards were constructed on US-10, narrow width medians would be necessary because there is inadequate space for a standard MDOT boulevard design. While this would be a safer road design from Ludington to Scottville, the current investment in the five-lane road is more than adequate to meet existing and projected traffic volumes for more than twenty years; and with appropriate access management regulations applied by each of the zoning authorities, that investment will be protected for decades.

Photo 3-5
Narrow Width Median

Median on West Ludington Avenue in the City of Ludington. *Photo by Robert Garrett*

Roundabouts

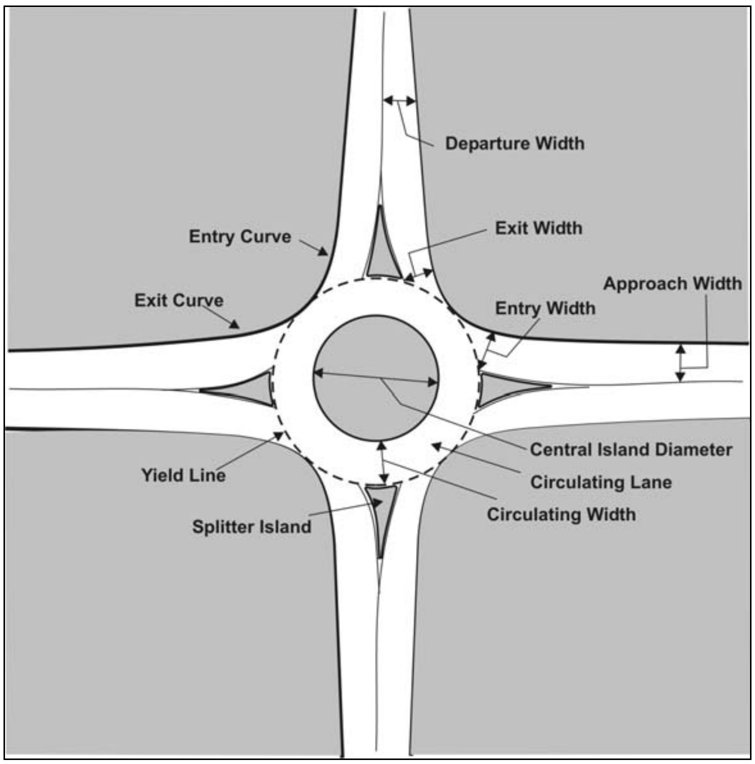
Roundabout design is beginning to be popular in America because of the safety benefits, better traffic progression, and sometimes because roundabouts can create an "entry" point to a community by creating a more interesting intersection design. Roundabouts are also typically easy to maintain in the winter because the snow plows can turn-around so easily. There are several dozen roundabouts built or under construction in Michigan, but none near Mason County.

A roundabout is often used for intersections as an alternative to signalization. Roundabouts are designed with yield signs at entry points, which allow drivers to flow around the circle without stopping at a traffic light. Geometry of a roundabout is limited to speeds of 10-20 MPH within the circle. The diameter must be large enough to accommodate semi-trucks, logging trucks and other large vehicles that commonly use the intersection. Roundabouts have been documented as safer than old traffic circles and traffic signal controlled intersections because of the reduced number of conflict points from drivers making left-turns. *"The injury crashes are documented to be 35 to 78% lower than a typical signaled intersection. Overall, the average delay at a roundabout is estimated to be less than half of that at a typical signalized intersection."*[1] However, roundabouts typically require more land than a standard intersection and must have well designed approaches and exits to function properly. They are also expensive. See Figure 3-7. Two intersections on the corridor may be worthy of study for a

[1] Jacquemart, Georges. "*Let's Go Round and Round,*" **Planning**, June 1996.

roundabout design. These are the north and south junctions (US-10/US-31 where US-31 goes north, west of Scottville and where Scottville Road intersects US-31 just north of Scottville on the bypass, respectively). If a roundabout design was the desired preferred intersection alternative for either of these intersections, each location would require a feasibility study to determine if the roundabout design could be achieved in a safe and cost-effective way that retained, if not improved, traffic flow (without decreasing level of service or causing additional user delay). If the analysis demonstrated feasibility and cost-effective results compared to alternative intersection designs with the same benefits, then the specifics of the roundabout design would be decided upon during the design phase.

Figure 3-7
Roundabout Example

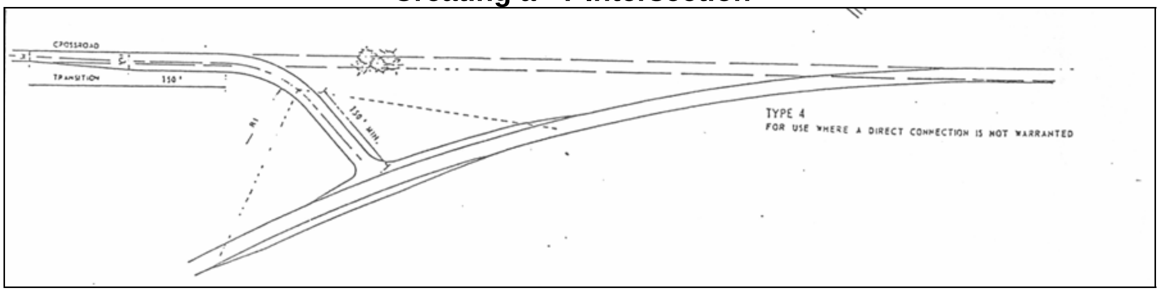


Source: Planning and Zoning Center, Inc. May 2000

Other Intersection Safety Improvements
Improve Turning Radius
Oblique intersections create visibility and safety issues for drivers. “T intersections” are a safer design alternative. Creating a “T intersection” involves realigning the intersecting road so it is perpendicular to the main roadway. This allows for better and safer turning angles. See Figure 3-8.

Figure 3-8

Creating a “T Intersection”



Source: MDOT Traffic and Safety Note VII-640A “Turned-In Roadways” 2-4-91

Right-turn Lanes

Right-turning vehicles can be removed from the arterial traffic with dedicated right-turn lanes. This allows through traffic to proceed without much slowing, preserving capacity and reducing the potential for crashes. MDOT guidelines suggest the use of right-turn lanes at any intersection where a capacity analysis determines a right-turn lane is necessary to meet a desired level of service.

Access Management Techniques

This section provides a brief introduction to access management techniques which are recommended within Chapter Four.

Close or Alter Driveways

A common problem along US-10/US-31 is properties with more driveways than necessary for safe ingress and egress. Sometimes there are three or four driveways when one or two well-designed driveways are all that is needed. When there is not more than one driveway per parcel, and when driveways are properly spaced between properties, there are fewer conflict points, the roadway is safer, there are fewer crashes, and traffic flows better. As a result, one of the most effective access management techniques is driveway closure and/or redesign. An existing driveway to a parcel can not be closed unless there will still be reasonable access provided in another way, such as from a shared driveway or, from an alternative access point as for example, from the rear or side of the property. Closing driveways requires careful education of property owners and should be a key part of any plan to rebuild or expand capacity on a roadway.

Driveway alterations can be a fairly inexpensive fix that provides a large benefit through reduction of crashes. Most commonly, driveway closures and alterations occur as part of a road reconstruction project, or when a property is proposed for redevelopment or a new use. In these instances, site plan review is used as the process to ensure appropriate driveway design. In some cases, business owners have already closed off a driveway as they need the space for parking and have an alternative means of access anyway. These driveways should be promptly closed permanently by curbing the driveway opening. See Photo 3-6.

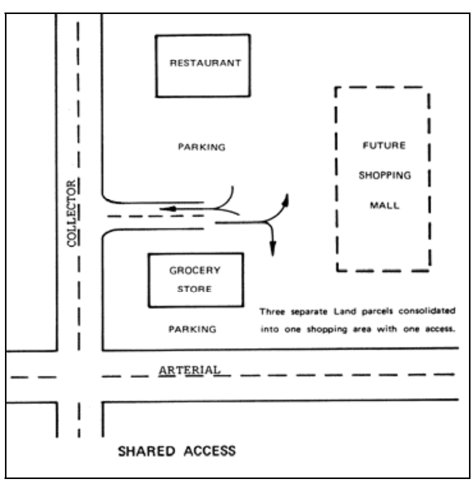
Closed driveways provide additional space for parking or landscaping. Shared driveways pose maintenance issues, but MDOT has sample shared maintenance agreements that make the task easier.

Photo 3-6
Voluntary Driveway Closure Adds Parking Spaces

Photo by Mark Wyckoff

Combine or Consolidate Driveways
Close driveway spacing is a problem for two reasons: 1) for drivers turning out of adjacent driveways, competing for the same roadway; 2) for drivers that have to react to the turning movements from ingress and egress traffic at several points simultaneously. Patrons frequently go in the “wrong” driveway because of the poor design. Consolidating driveways can remove a conflict point from the road and if the driveways are too closely spaced, consolidating driveways can result in the redesign of a safer driveway for both businesses. Figure 3-9 illustrates how driveways may link together and serve several properties at once. Driveway width and spacing standards are established by MDOT and the County Road Commission, and it is important that local access regulations be the same as MDOT standards on state highways, County Road Commission standards on county roads.

Figure 3-9
Shared Driveways and Connected Parking Lots



Source: *Arterial Street Access Control Study*, Tri-County Regional Planning Commission, 1981, p.24.

Two or more adjacent properties can often share driveways and limit access points to an arterial. Sharing driveways is particularly valuable when lot frontages are narrow and alternative access is not available. In newer commercial developments, shared driveways are very common. Shopping plazas often provide one or two driveways for all the stores within them. Abutting shopping plazas can also often be linked together by connecting parking lots so that drivers can avoid exiting onto main arterials when going to adjacent properties.

A common situation on US-10 and US-31 is U-shaped driveways, especially on residential properties. A better design is the Y-shaped driveway which can serve two abutting properties or a single property. See Figure 3-10.

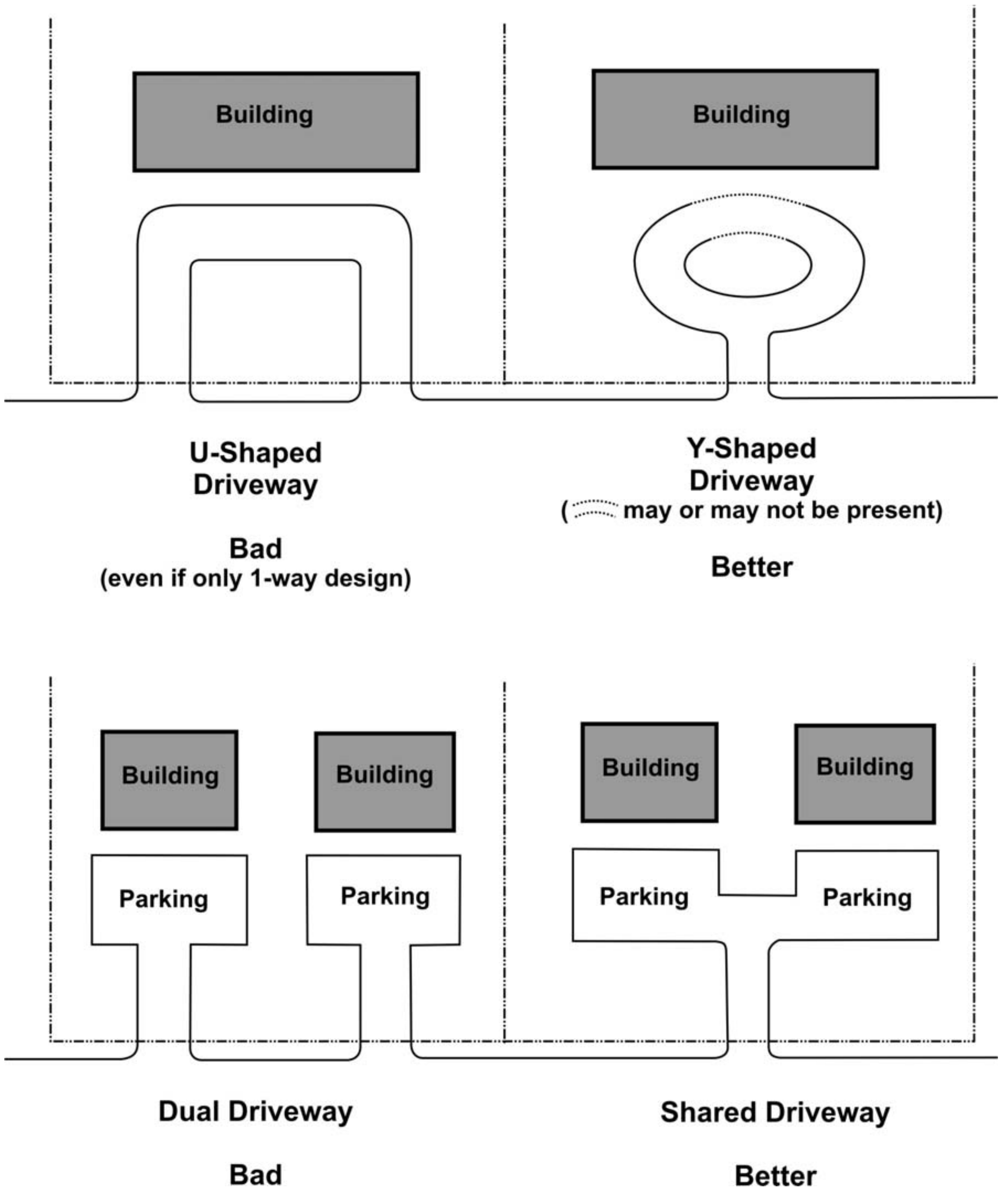
Connected Parking Lots
Earlier in this chapter, examples of connected parking lots were illustrated because of the great benefits they offer in keeping travel movements off the main highway. Sometimes when drivers realize parking lots should be connected but are not, take matters into their own hands. Photo 3-7 illustrates a "connection" between the Wendy's restaurant on US-10 to the adjacent private drive (look carefully to see tire tracks in the snow). Photo 3-8 illustrates a connection between the back and front parking lots at the movie theatre east of the Home Depot.

Photo 3-7
Impatient Driver Connects Parking Lot and Side Street

Photo 3-8
Impatient Driver Connects Parking Lots

Photos by Mark Wyckoff

Figure 3-10
U-Shaped Driveway versus Y-Shaped Driveways

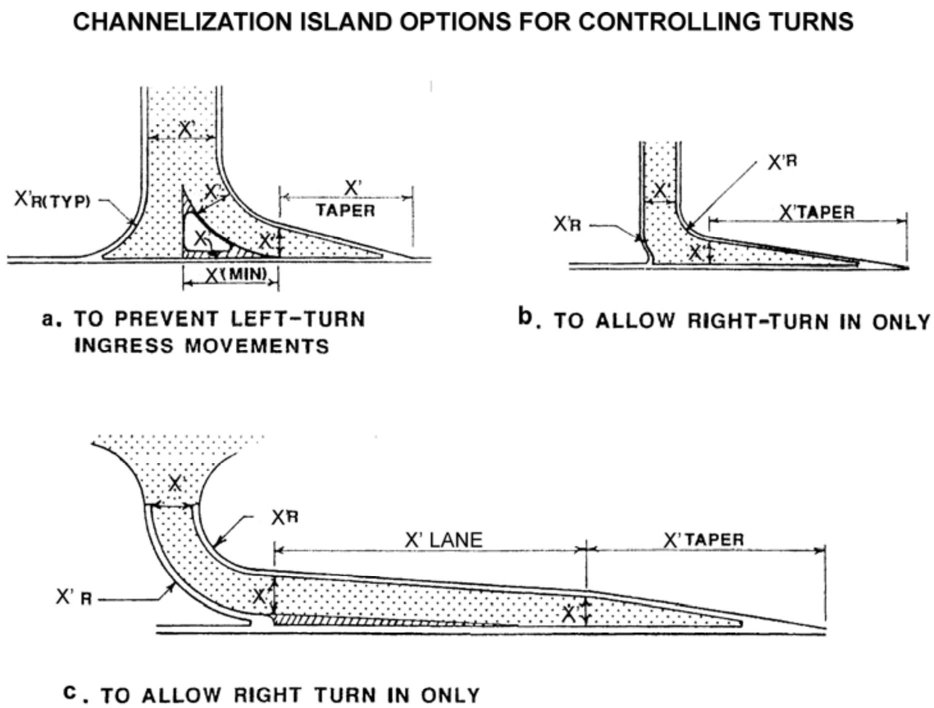


Note: Some businesses need two driveways to accommodate semi-trucks and other large vehicles, such as fueling stations and truck stops that don't have a turnaround area on site. Then it is important to get a proper separation distance between the driveways on the site and driveways on adjacent property.

Tapers and Right-Turn Lanes

High volume driveways often benefit from channelization islands (as shown in Photo 3-3), as well as from tapers and/or right-turn lanes. These paved entries allow right-turning vehicles to leave the flow of traffic and then slow before turning, preserving speed and capacity on the highway. See Figure 3-11. Channelization islands pose maintenance challenges (especially with snow and ice) unless they are high. They should be avoided unless other options are not available due to site constraints.

Figure 3-11



Note: The dimension of X' is variable depending on site conditions, speed, number of vehicles and the design needs of the vehicles to use it.

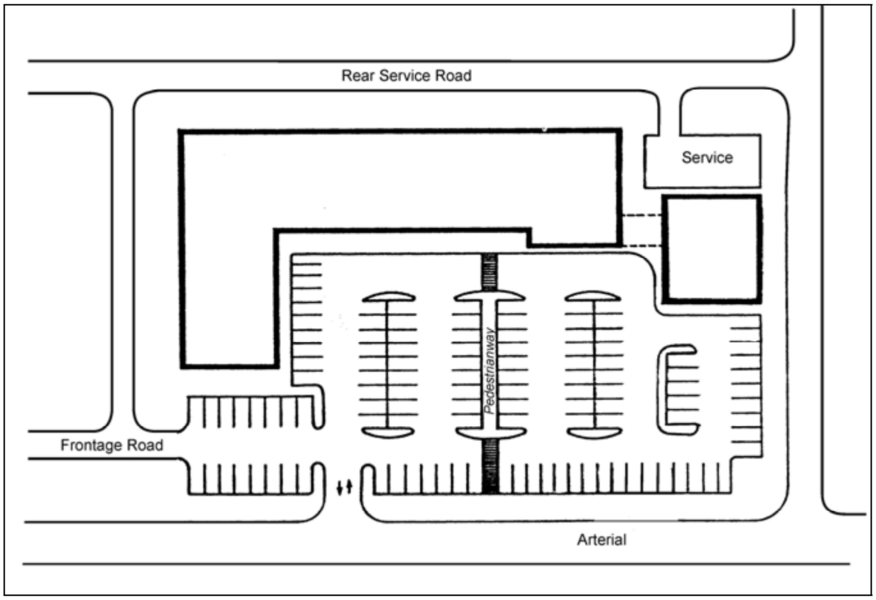
Source: adapted from Delta Township Zoning Ordinance. See also MDOT *Geometric Design Guide VII-680 and VII-650 series.*

Frontage Roads and Rear Service Roads

Frontage roads and rear service roads can be utilized to keep traffic off of the main arterial. They can greatly reduce turning movements and direct traffic to collectors or local roads where safer turns can take place, especially if there is a traffic signal. However, frontage roads have come under some scrutiny, because they often have little stacking space near the arterial and can create confusing turning movements, if used with high traffic generation land uses. Adequate space may also be unavailable for a frontage or rear service road. Frontage roads can be most effectively utilized with low traffic generators like residential and small office uses or service uses like dental and eye care. Rear service roads can usually be designed to handle larger volumes of traffic and are better for servicing commercial and industrial uses.

Frontage roads or rear access between parcels can also aid connections between properties on a smaller scale. Rear access roads should be used whenever possible to more effectively move truck traffic around a commercial site and provide alternative access connections for automobile traffic between businesses. These connections can allow traffic to circulate between adjacent commercial properties without going onto the main arterial. See Figure 3-12 which illustrates front and rear access roads.

Figure 3-12
Frontage Roads and Rear Service Roads



Note: Rear access roads are usually safer and more effective than frontage roads and should be used whenever possible. Frontage roads should not be too close to the roadway or used where the volume of traffic is too great for safe vehicle use. *Source: MDOT Michigan Access Management Guidebook, page 3-25, 2001*

Improved Local Street Connections

Secondary streets can be a very effective means of access management when they function to keep local vehicles off of the main roadway. This requires an interconnected design with streets running parallel to the main road and intersecting streets at appropriate intervals. Outside of Ludington and Scottville, there are very few places along the corridor where this design exists and functions well. Chapter Four includes recommendations for extending local streets, particularly in areas where more intensive commercial or residential development could be accommodated if there were parallel local roads.

Lock-In Access Points

In rural undeveloped areas, it is important to limit the number of points of access from future land divisions. This can be accomplished by a short ordinance requirement that “locks-in” not more than one access point per parcel as of the date of the ordinance. Future land divisions must take access off of the locked-in access and cannot have separate access. This dramatically reduces the number of future driveways along rural highway segments. See Figure 3-13. The sample ordinance language in Appendix A includes this technique.

Figure 3-13
Locking-in Access

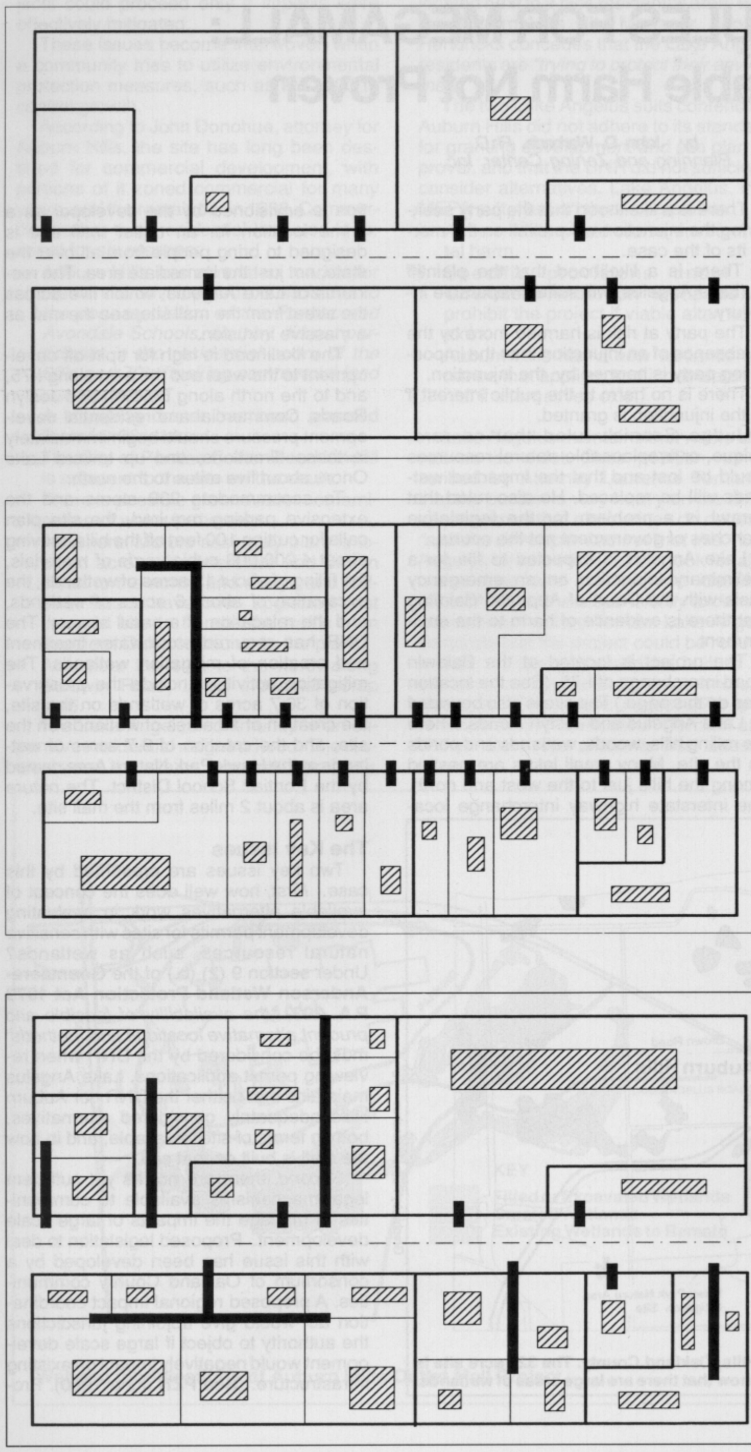


Figure A: Represents an arterial highway in a semi-rural area; one which still has rural characteristics, but is experiencing development pressures. The large parcels present numerous opportunities for careless land divisions;long, narrow lots with minimal road frontage will likely be created, and each will have its own driveway. There are some commercial land uses and a few driveways onto the roadway, but they are not substantial enough to inhibit traffic movement and safety.

10 driveways for 10 lots

Figure B: This is the same arterial after typical commercial strip development. Misguided development and unregulated land divisions have led to too many long, narrow lots and "flag" lots and consequently, too many driveways. Numerous driveways substantially increase the number of turning, accelerating and decelerating cars, which serves to undermine the traffic movement function of the roadway and pose traffic safety hazards.

23 driveways for 28 lots

Figure C: This is the same strip after development with controlled land division and access. All of the original parcels were allowed one driveway each onto the roadway. All subsequently created lots obtained their access to the road from the single access points. Traffic congestion and hazards are minimized and the road retains its traffic movement function as an arterial.

10 driveways for 29 lots

Graphics by Tim McCauley

*Source: McCauley, Tim, "Preventing Commercial Driveways in Strip Commercial Areas", **Planning and Zoning News**, September 1990.*