TANTALA ASSOCIATES, LLC
CONSULTING ENGINEERS

A STUDY OF THE RELATIONSHIP BETWEEN DIGITAL BILLBOARDS AND TRAFFIC SAFETY IN ROCHESTER, MN

SUBMITTED TO

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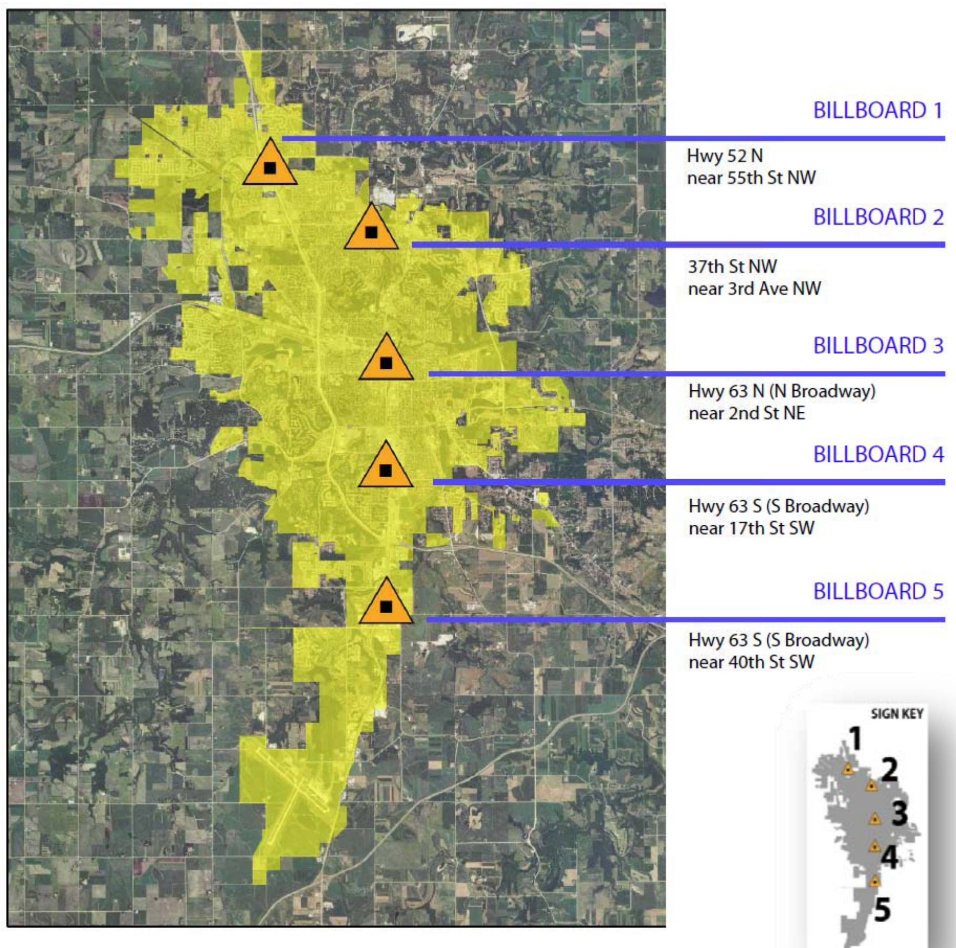


Figure 1.
Digital Billboard locations in Rochester

The overall conclusion of the study is that digital billboards in Rochester have no statistically significant relationship with the occurrence of accidents.

OVERVIEW

The purpose of this study is to examine the statistical relationship between digital billboards and traffic safety in Rochester, Minnesota. This study analyzed traffic and accident data along local roads near five existing, digital billboards (see Figure 1) with traffic volumes collectively representing 56 million vehicles per year. The study uses official data as collected, complied and recorded independently by the Rochester Police Department.

The study included five years of accident data representing approximately 18,000 accidents. Temporal and spatial statistics were summarized near billboards within multiple vicinity ranges from 0.2 to 1.0 miles upstream and downstream of the billboards. Additionally, subsets of accident day for daytime and nighttime accidents were analyzed for before and after comparisons.

The overall conclusion of the study is that digital billboards in Rochester have no statistically significant relationship with the occurrence of accidents. This conclusion is based on the Rochester Police Department's own data and an objective statistical analysis; the data shows no increase in accident rates.

STUDY REGION

The City of Rochester, in Olmstead County, Minnesota was chosen for study, because the City has multiple digital billboards in service for several years. The City is populated with 100,000 people and 41,000 households. The city is served by three U.S. highways (U.S. 14, U.S. 52, and U.S. 63), and the southern edge of Rochester is near Interstate Highway 90 and State Highway 30. In Rochester, approximately 40,000 workers commute, with a mean travel time of 15 minutes compared with 22 minutes statewide and 26 minutes nationwide. Rochester has one commercial airport.

BILLBOARD CHARACTERISTICS

Digital billboards are a relatively new technology in outdoor advertising. Digital billboards display static messages which, when viewed, resemble conventional painted or printed billboards. With digital technology, a static copy "dwells" and includes no animation, flashing lights, scrolling, or full-motion video. The static display on each of these digital billboards has a "dwell time" of eight seconds.

The digital billboards were designed and manufactured by Daktronics, and use red, green, and blue light-emitting-diode (LED) technology to present text and graphics. The digital billboards compensate for varying light levels, including day and night viewing, by automatically monitoring and adjusting overall display brightness and gamma levels. A photocell is mounted on each of the digital billboards to measure ambient light. All five digitals are owned and operated by Magic Media, Inc.

Each of the five digital billboards are freestanding, single-pole, double-faced structure with one digital face that measures 10-feet 6-inches high and 36-feet wide (a face area of 378 square feet).

The digital billboards are number 1 to 5 from north to south. The locations of the five billboards in Rochester are shown in Figures 2 and 3 which summarize direction, sizes and other sign characteristics. These are the only digital billboards within Rochester. The boards and their surroundings were observed during day and night conditions.

Figure 4 summarizes conversion dates. The billboards have various conversion dates between 2006 and 2008 which allows for before/after comparisons in excess of 4.2 years individually; or for 5 billboards, average of 3.2 years data and cumulative 16 years data.

Additional billboard-location photos, aerials, and map references for each billboard number are also included within this report.

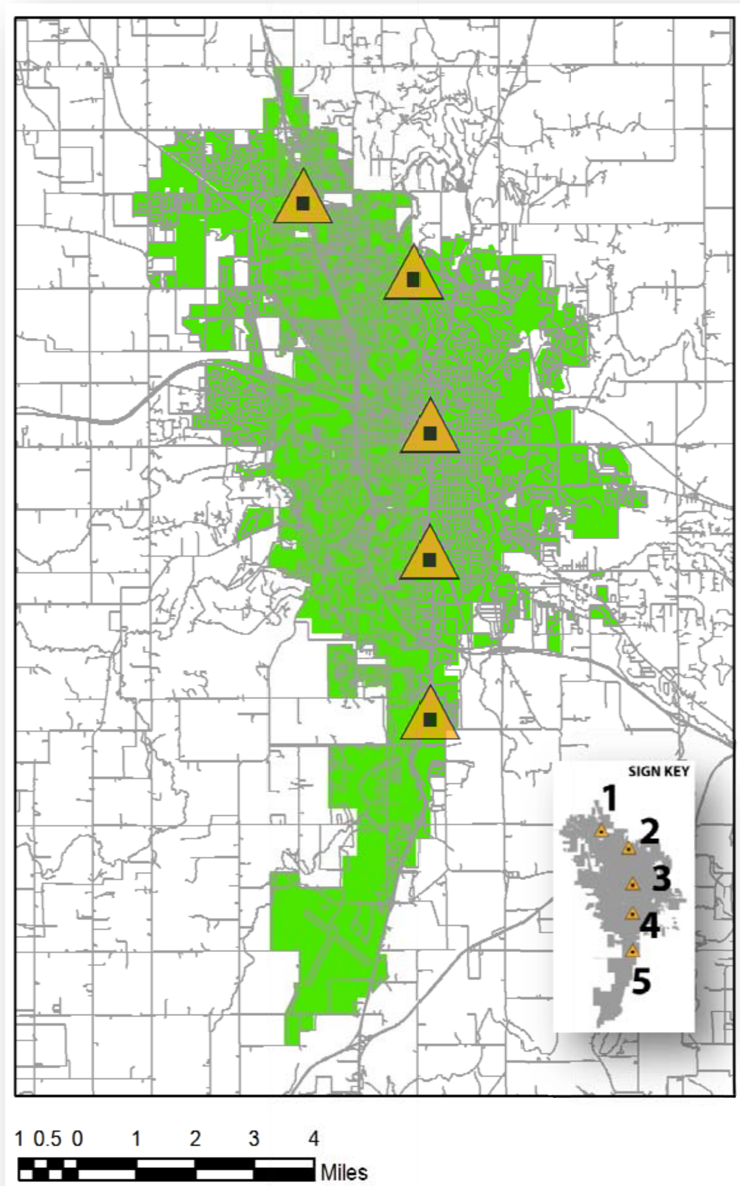


Figure 2.
Digital Billboard locations in Rochester

The static display on each of these digital billboards has a "dwell time" of eight seconds.

Billboard No.	Location	Digital Facing	Face Size	Configuration	Reader side
1	Hwy 52 N near 55th St NW	North	10' 6" x 36'	Free standing, Flag	Right
2	37th St NW near 3rd Ave NW	West	10' 6" x 36'	Free standing, Flag	Right
3	Hwy 63 N (N Broadway) near 2nd St NE	North	10' 6" x 36'	Free standing, Vee, Flag	Left
4	Hwy 63 S (S Broadway) near 17th St SW	South	10' 6" x 36'	Free standing, Flag	Right
5	Hwy 63 S (S Broadway) near 40th St SW	South	10' 6" x 36'	Free standing, Vee, Flag	Right

Figure 3.
Digital Billboard direction, sizes and other sign characteristics

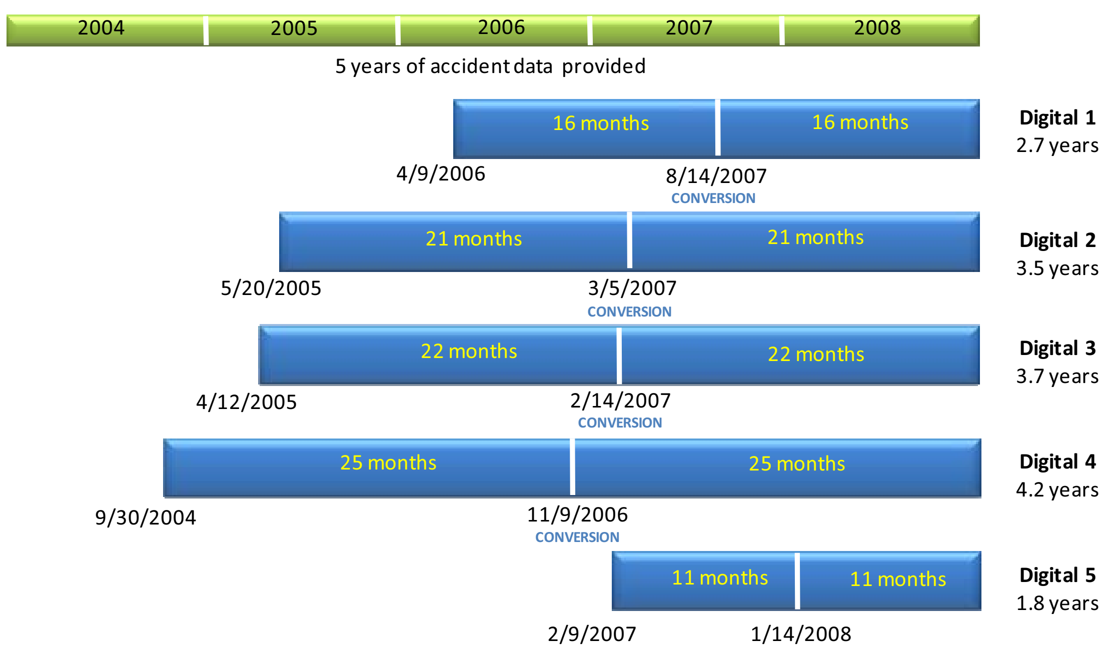


Figure 4.
Digital Billboard Conversion Dates

Billboard No. 1 faces north, advertises to traffic on the southbound lanes of Highway 52 North near 55th Street NW. Billboard No. 1 is a right-hand reader with a parallel-faced, flag configuration. Figure 8 shows the location in an oblique aerial. Figure 5 is a photo of the digital face. The digital face was converted from a conventional face on the existing structure.

Figure 5. Digital 1

Billboard No. 2 faces west, advertises to traffic on the eastbound lanes of 37th Street NW near 3rd Avenue NW. Billboard No. 2 is a right-hand reader with a parallel-faced, flag configuration. Figure 9 shows the location in an oblique aerial. Figure 6 is a photo of the digital face. The digital face was converted from a conventional face on the existing structure.

Figure 6. Digital 2

Billboard No. 3 faces north, advertises to traffic on the southbound lanes of North Broadway (Highway 63 North) near 2nd Avenue NE. Billboard No. 3 is a cross reader with a vee flag configuration. Figure 10 shows the location in an oblique aerial. Figure 7 is a photo of the digital face. The digital face was part of a new sign; there was no existing billboard at this location.

Figure 7. Digital 3

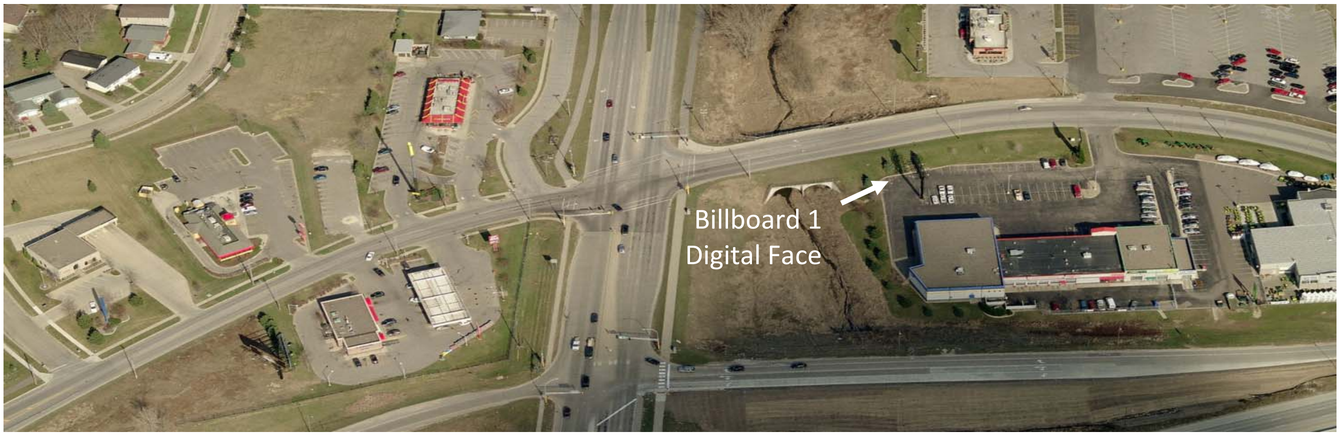


Figure 8. Oblique Aerial of Digital 1

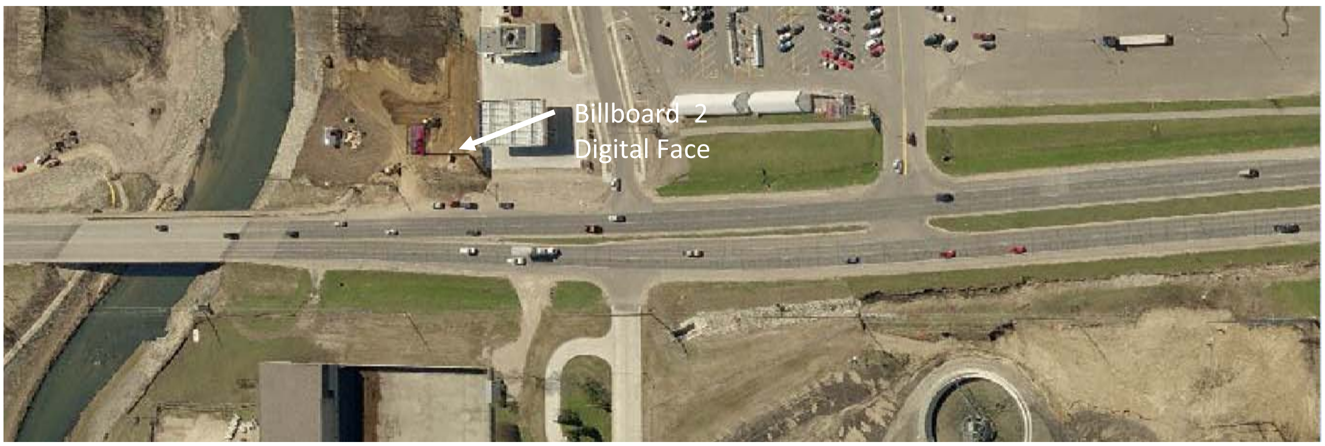


Figure 9. Oblique Aerial of Digital 2

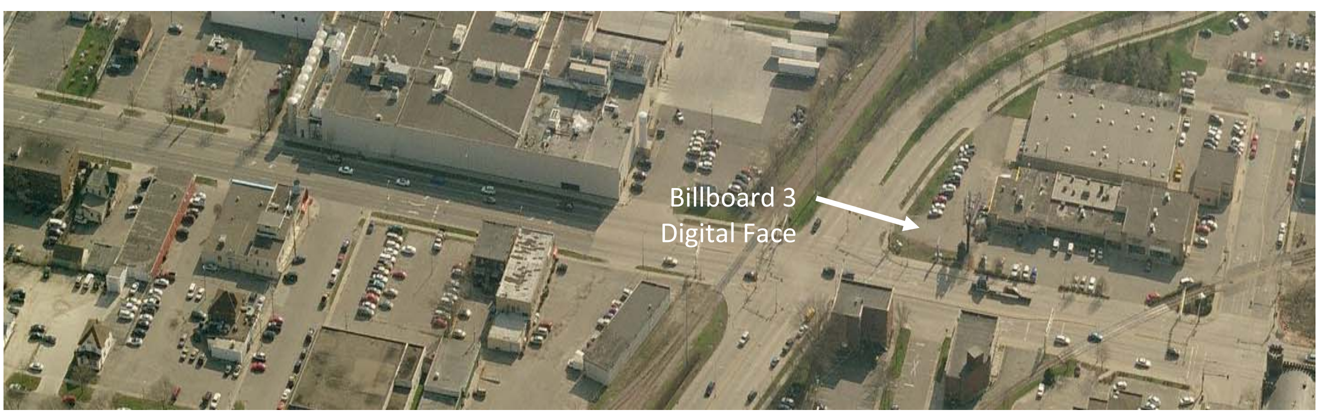


Figure 10. Oblique Aerial of Digital 3

Billboard No. 4 faces south, advertises to traffic on the northbound lanes of South Broadway (Highway 63 South) near 17th Street SW. Billboard No. 4 is a right-hand reader with a parallel-faced, flag configuration. Figure 13 shows the location in an oblique aerial. Figure 11 is a photo of the digital face. The digital face was converted from a conventional face on the existing structure.

Figure 11. Digital 4

Billboard No. 5 faces south, advertises to traffic on the northbound lanes of South Broadway (Highway 63 South) near 40th Street SW. Billboard No. 5 is a right-hand reader with a vee flag configuration. Figure 14 shows the location in an oblique aerial. Figure 12 is a photo of the digital face. The digital face was converted from a trivision face on the existing structure. Some roadway and construction work had occurred during the service life of the billboard. The digital was removed from this location and relocated in late December 2008.

Figure 12. Digital 5

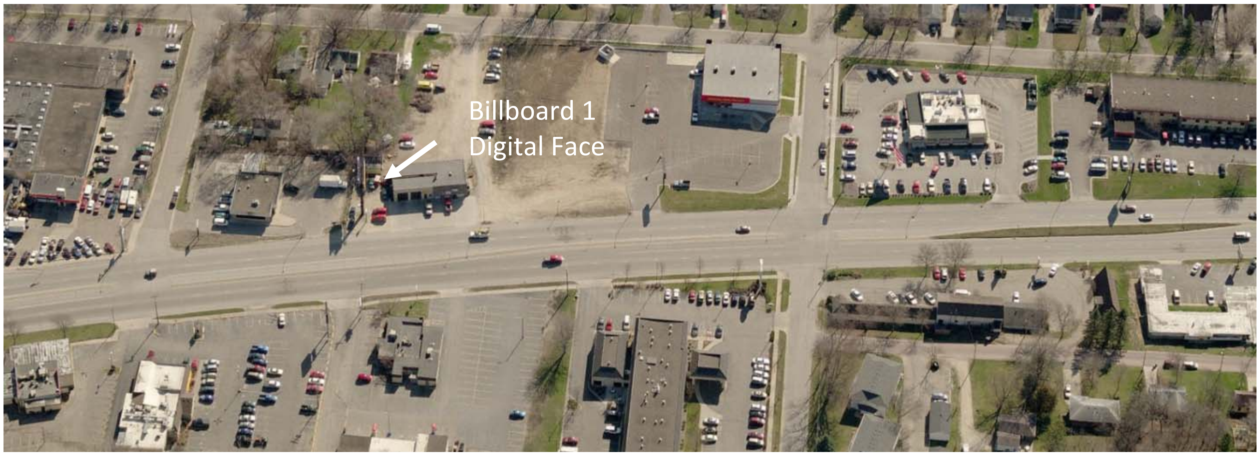


Figure 13. Oblique Aerial of Digital 4

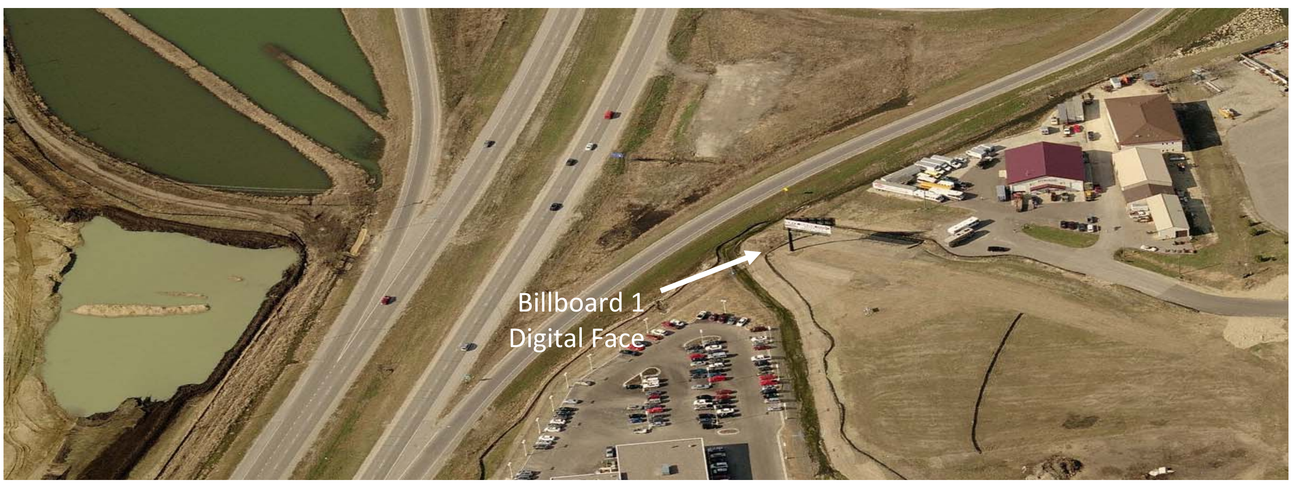


Figure 14. Oblique Aerial of Digital 5

AADT ranges individually near the five billboards from 21,000 to 44,000 vehicles per day, or equivalently 7.7 to 16 million vehicles per year.

TRAFFIC VOLUME DATA

Traffic volume data for the City of Rochester was obtained from the Minnesota Department of Transportation (DOT) included the annual average daily traffic (AADT), which is the average of 24-hour counts collected every day in the year. AADT Traffic volumes were recorded in Rochester between 1994 and 2008.

The AADT values of are summarized in Figures 15 and 16. AADT ranges individually near the five billboards from 21,000 to 44,000 vehicles per day, or equivalently 7.7 to 16 million vehicles per year. For all five billboards, this collectively represents 155,000 vehicles per day or 56 million vehicles per year.

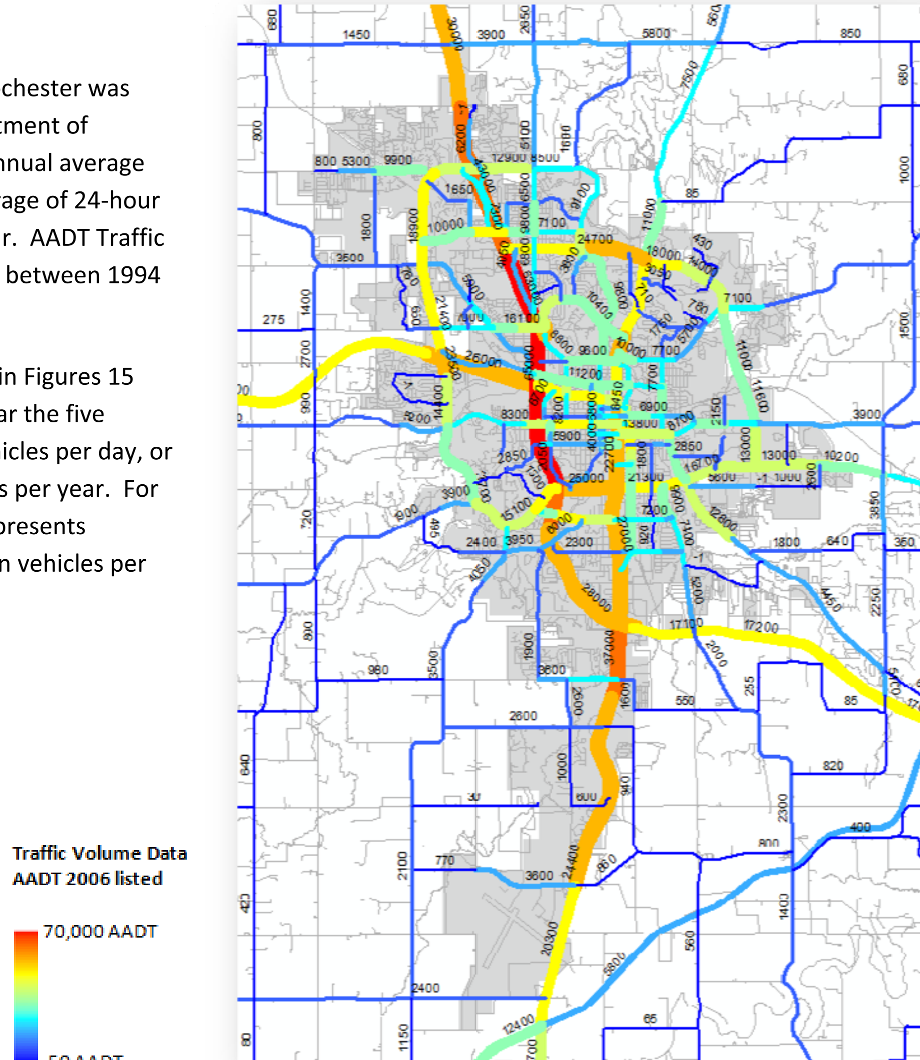
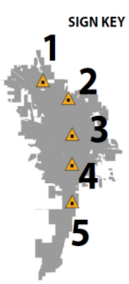


Figure 15. AADT Traffic Volume Data in Rochester



Year	Sign 1	Sign 2	Sign 3	Sign 4	Sign 5
1994	29,000	20,700	18,500	21,900	17,400
1996	28,600	-	18,200	20,600	17,800
1998	33,600	23,600	18,200	20,700	19,600
2000	33,200	23,000	17,900	23,300	21,100
2002	38,500	25,500	18,600	23,400	22,600
2004	40,000	31,100	24,000	30,000	24,400
2006	43,000	24,700	21,600	27,000	24,400
2008	43,500	32,000	24,000	30,500	25,200

Figure 16. AADT Traffic Volume Data near digital billboards

ACCIDENT DATA

In Rochester, Minnesota, the majority of accident reports are investigated and recorded by the Rochester Police Department, date is maintained by the City and by Minnesota Department of Public Safety, Driver and Vehicle Services. Within ten days of a crash, law enforcement officials are required to submit reports on crashes they investigate that meet the reporting threshold provided by statue, which is one thousand dollars or more in property damage, or that anyone was injured, or killed in the crash. Data generally conforms to the American National Standards Institute's (ANSI) Standard D16.1 – 1996, Manual on Classification of Motor Vehicle.

The accident data set provided by the Rochester Police Department includes 18,000 accidents in over five years of data between 2004 and 2009. Most of the data is specified by addresses and intersections. Figure 17 shows the geocoded accident locations in Rochester.

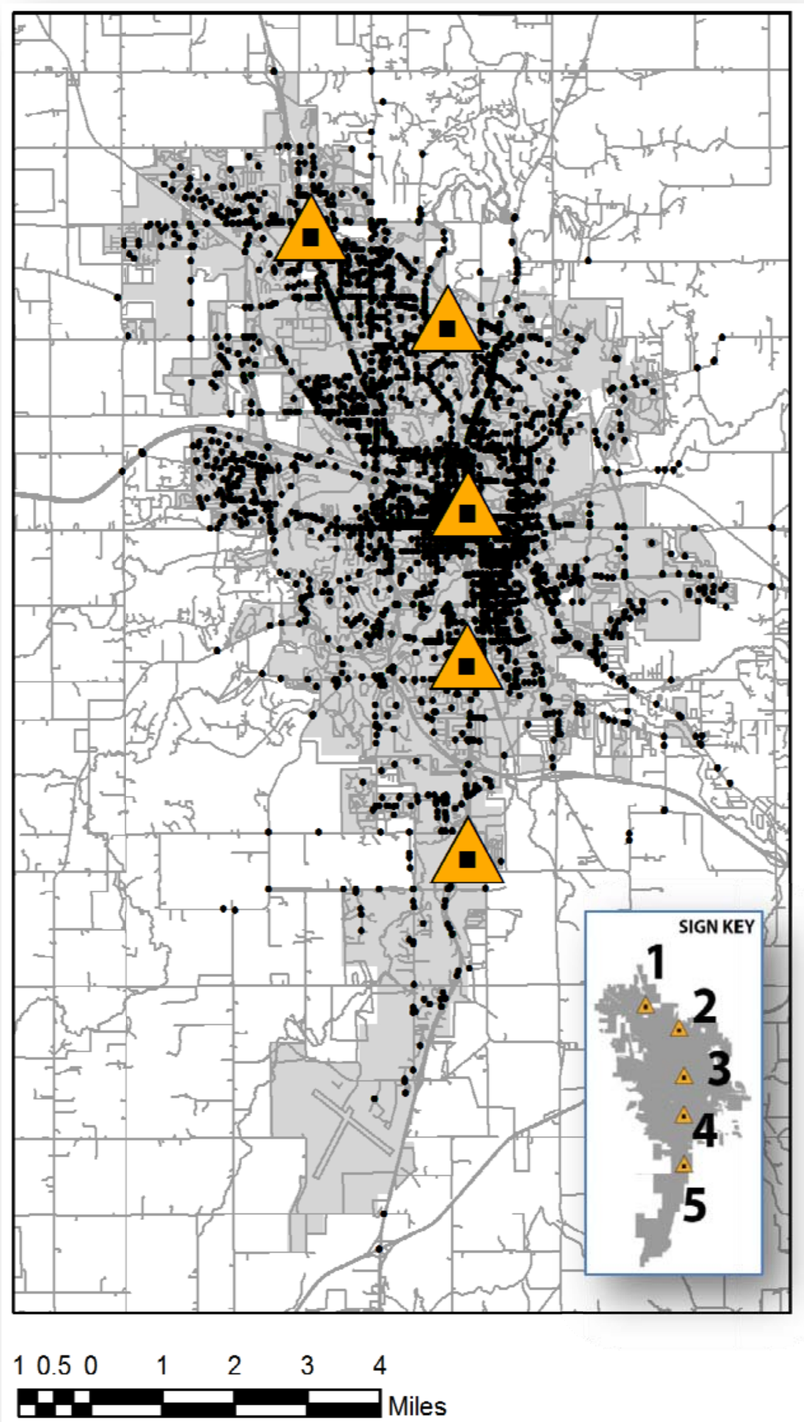
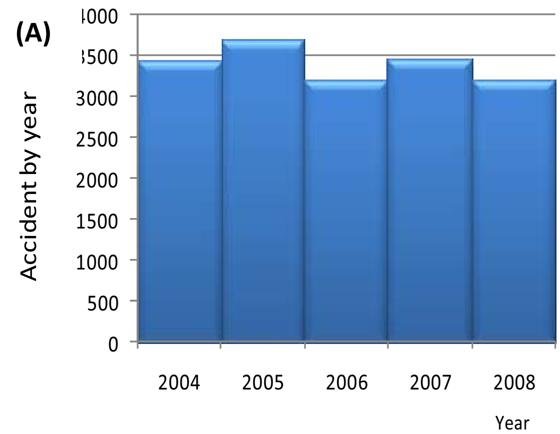


Figure 17. Traffic Accident in Rochester, 2004-2009

Figure 18 summarizes the traffic accident data of the past five years in Rochester and shows the distribution of accidents by year, month, day of week and time of day. This represents a consistent pattern of data and illustrates that more accidents occur on weekdays and at rush hour (before and after work).



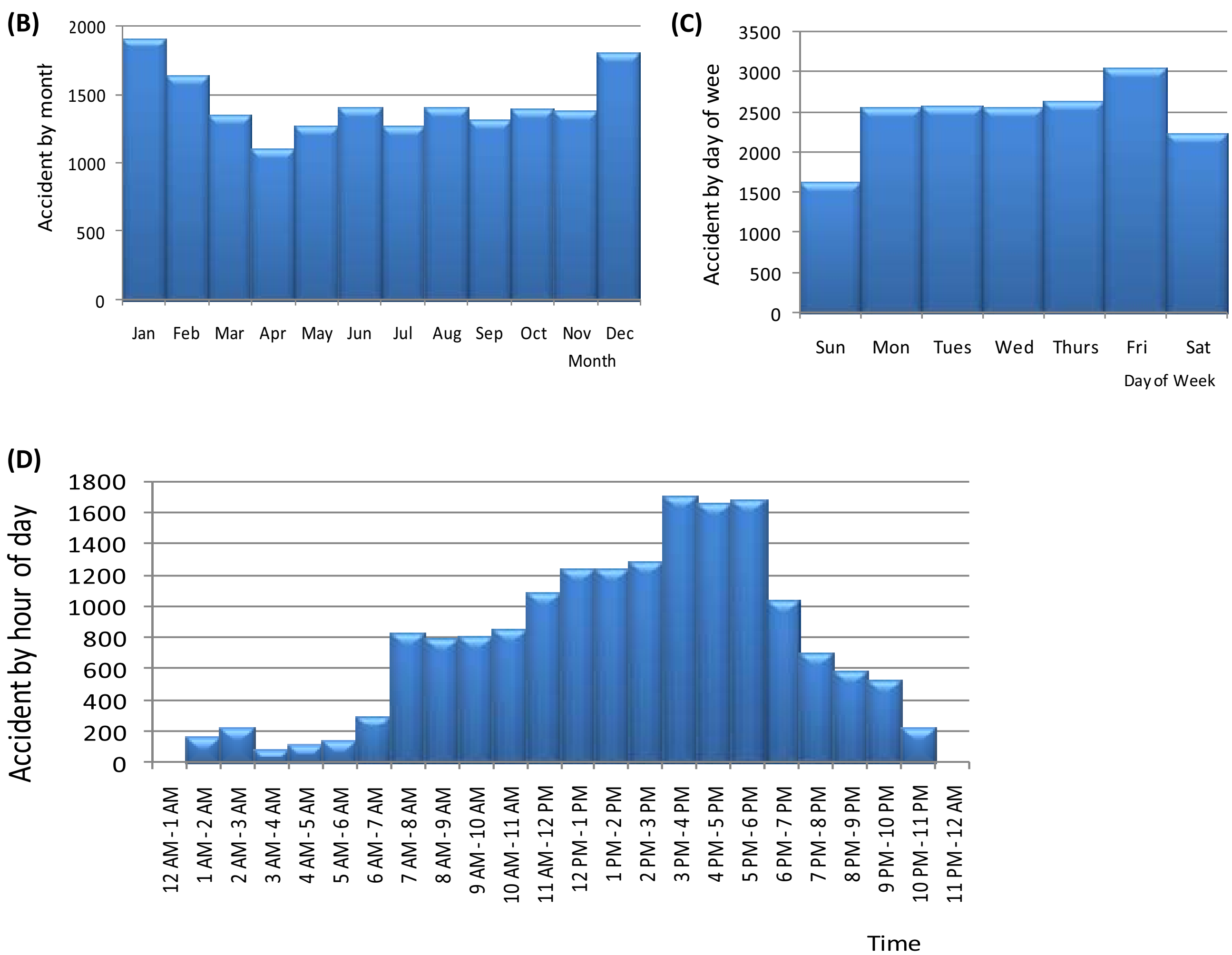


Figure 18. Histogram of traffic accident data of the past five years in Rochester by (A) year, (B) month, (C) day of week and (D) time of day

The analysis of this robust data, involves an engineering-statistics based approach and uses a widely accepted method to show what happened when these five digital were installed in Rochester.

ANALYSIS

The analysis of this robust data, involves an engineering-statistics based approach and uses a widely accepted method to show what happened when these five digital were installed in Rochester. The analysis has two parts.

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In the first part, the temporal analysis, the incidence of traffic accidents near the digital billboards is examined for an equal length of time before and after the boards were installed and activated, for the purpose of establishing if traffic accidents occurred more or less frequently with the presence of the digital billboards. From information collected from police accident reports, the temporal analysis uses metrics such as traffic volumes, the accident rates values (APV) and the maximum number of accidents during any given month.

For comparison, accident statistics were summarized near billboards within multiple vicinity ranges of 0.2, 0.4, 0.6, 0.8 and 1.0 miles both upstream and downstream of the billboard. These vicinity ranges were also sampled: (1) for accidents along the principal roads to which the digital directly advertises (2) for roads, ramps and local roads adjacent to the primary road where the digital may also advertise to, (3) for accidents recorded as occurring within the intersection of the primary road and any cross roads and (4) for crossroad accidents within a reasonable distance from the primary road to include drivers turning onto or leaving the primary road. Accident data for roads to which the digital does not advertise or wasn't connected were excluded even if there were within the desired vicinity range.

The second part, the spatial analysis, establishes statistical correlation coefficients between the digital billboards and accidents. Correlation coefficients are statistical measures of the "association" between two sets of data, for example, billboards and traffic accidents. The results are analyzed for various scenarios between accident density to billboard density (the number of billboards) and to billboard proximity (the distance from the accident to the nearest billboard).

Additionally, subsets of accident data for daytime and nighttime accidents were analyzed for before and after comparisons.

For a more lengthy discussion of analysis methods, please refer to previous studies (see References 6 and 7).

The number of accidents and rates of accidents near the five digital billboards decreased in all vicinity ranges.

Results

Figure 19 shows a comparison of the accident metric for before and after conversion near the five digital billboards in the City Rochester. The statistics are summarized for vicinity ranges within 0.2, 0.4, 0.6, and 1.0 miles of the billboard.

The metric include the total number of accidents, the average number of accidents in any given month, and the peak number of accidents in any given month. Other metrics including rates and vehicle miles traveled were also analyzed.

The number of accidents and rates of accidents near the five digital billboards decreased in all vicinity ranges. The benchmark 0.6 mile vicinity experience a 5% decrease in accidents over the average 3.2 year span for all signs.

Consistent results were obtained for daytime and nighttime comparisons. Low correlation coefficients were calculated for the spatial analysis.

		DISTANCE RANGE FROM BILLBOARD (MILES)				
		0.2	0.4	0.6	0.8	1.0
Prior to Installation	Total Accidents as Conventional Billboard	489	1162	1883	2783	4088
	Average Number of Accidents in a Month	17	42	65	87	117
	Peak Number of Accidents in Any Given Month	35	82	123	169	238
Digital Billboard	Total Accidents as Digital Billboard	408	1087	1784	2660	3914
	Average Number of Accidents in a Month	15	41	63	85	114
	Peak Number of Accidents in Any Given Month	29	71	116	163	210
% Change	Total Accidents per month	-17%	-6%	-5%	-4%	-4%

Figure 19. Summary accident statistics near all five digital billboards in Rochester, MN

Specific Results for Billboard 1

Figures 20 summarizes the statistics and composite accident metrics for billboard number 1 for all vicinity distances. Figure 21 shows the billboard location, geocoded accident records and approximate vicinity ranges. Figure 22 shows the 0.6 mile vicinity histogram as an example for before and after the conversion of the billboard centered on the conversion date of the board to digital format.

These figures represent a 32 month window (16 before and 16 after) of accidents within various vicinities. A comparison of the histograms of accidents (on either a monthly basis) at the location before and after the digital conversion indicates no substantial change in accident patterns. Comparing 2.7 years of data for this location, indicates that the total number of accidents on any given month increased insignificantly from 244 to 252 (3%) within 0.6 miles, after the introduction of the digital billboard at the location; the average number of accidents in any given month remained about the same at 20 per month.

		DISTANCE RANGE FROM BILLBOARD (MILES)				
		0.2	**0.4**	**0.6**	**0.8**	**1.0**
Prior to Installation	**Total Accidents as Conventional Billboard**	69	118	244	304	478
	Average Number of Accidents in a Month	6	10	20	25	40
	Standard Deviation	3	4	8	9	14
	Peak Number of Accidents in Any Given Month	12	17	34	39	64
	Minimum Number of Accidents in	1	1	11	15	22
Digital Billboard	**Total Accidents as Digital Billboard**	47	108	252	296	441
	Average Number of Accidents in a Month	4	9	21	25	37
	Standard Deviation	4	7	12	12	16
	Peak Number of Accidents in Any Given Month	12	25	48	53	71
	Minimum Number of Accidents in	0	1	6	8	12
% Change	**Total Accidents**	-32%	-8%	3%	-3%	-8%

Figure 20. Summary accident statistics near digital billboard 1 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

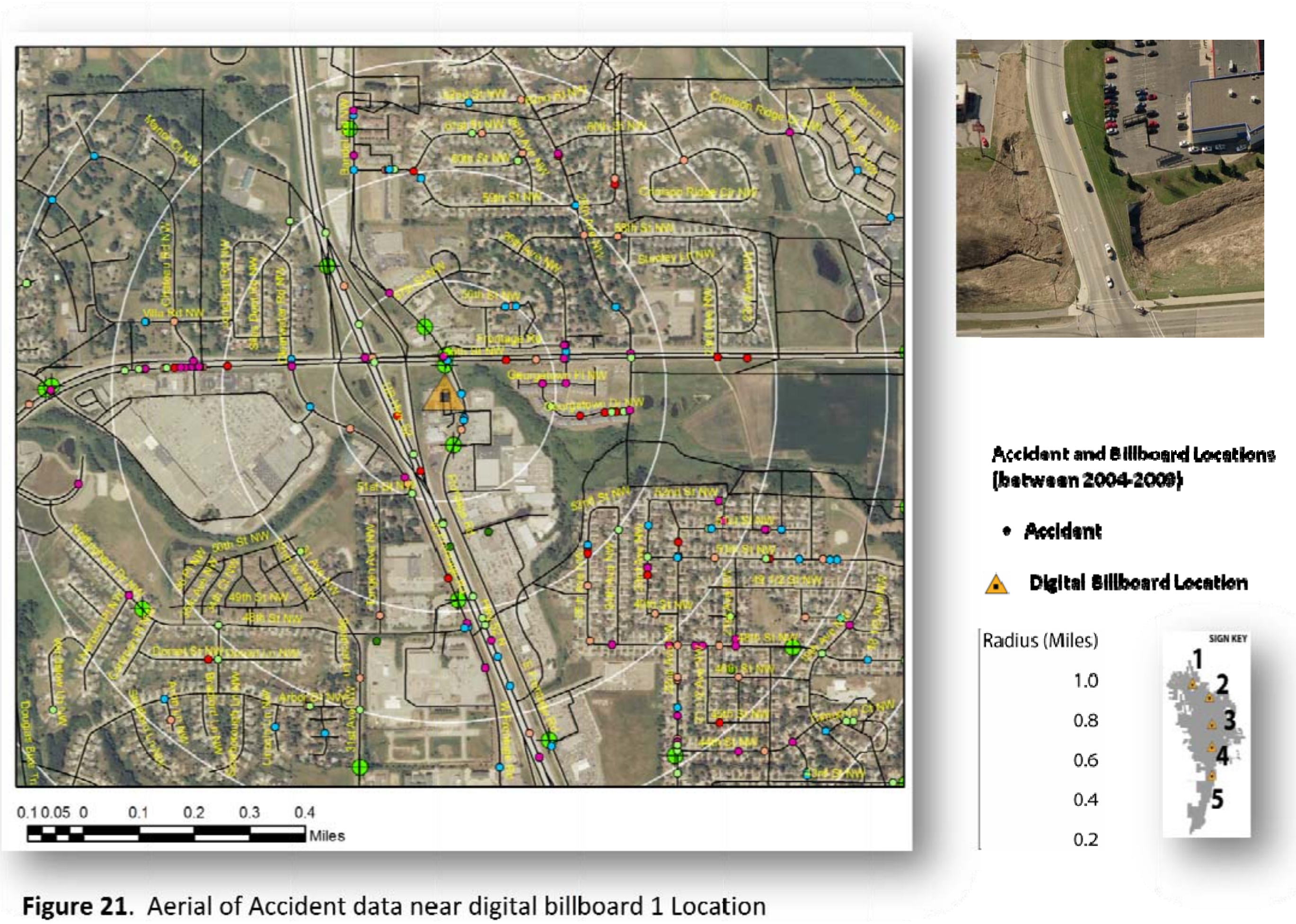

Figure 21. Aerial of Accident data near digital billboard 1 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

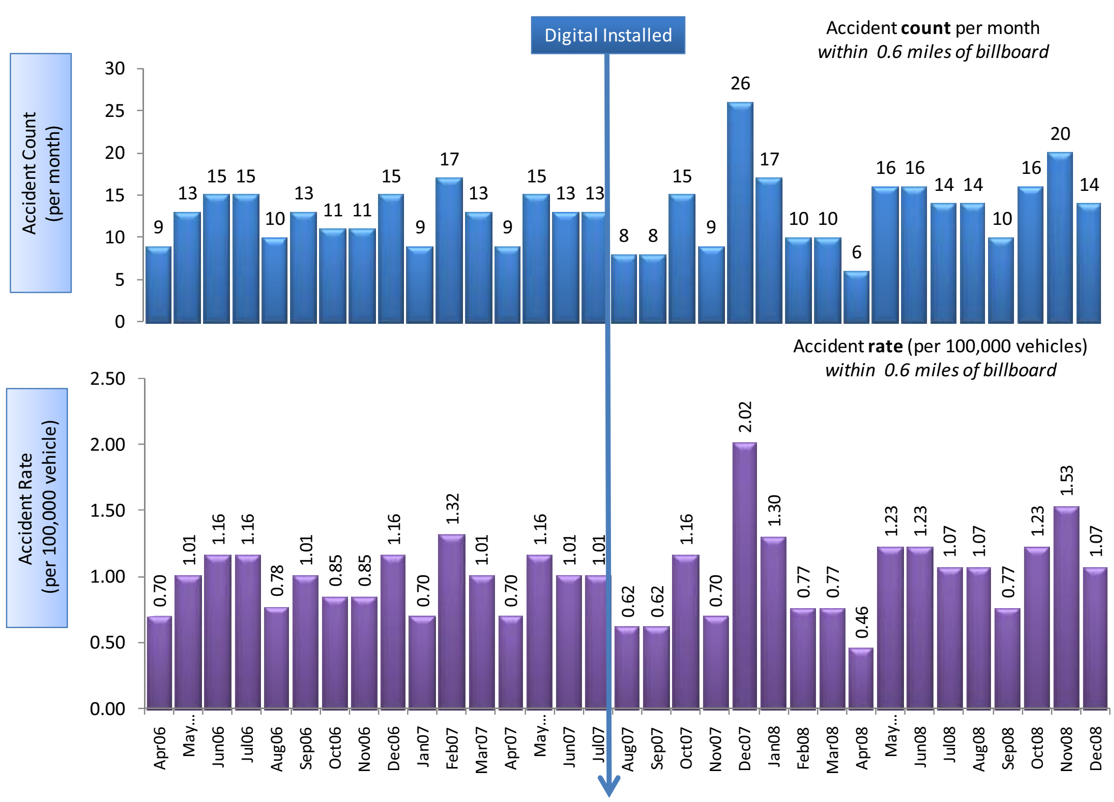

Figure 22. Accident Counts per month and Accident Rates per 100,000 vehicles near digital billboard 1 within 0.6 mile vicinity

Specific Results for Billboard 2

Figures 23 summarizes the statistics and composite accident metrics for billboard number 1 for all vicinity distances. Figure 24 shows the billboard location, geocoded accident records and approximate vicinity ranges. Figure 25 shows the 0.6 mile vicinity histogram as an example for before and after the conversion of the billboard centered on the conversion date of the board to digital format.

These figures represent a 42 month window (21 before and 21 after) of accidents within various vicinities. A comparison of the histograms of accidents (on either a monthly basis) at the location before and after the digital conversion indicates no substantial change in accident patterns. Comparing 3.5 years of data for this location, indicates that the total number of accidents on any given month decreased from 206 to 165 (20%) within 0.6 miles, after the introduction of the digital billboard at the location; the average number of accidents in any given month decreased from 17 to 14 per month.

		DISTANCE RANGE FROM BILLBOARD (MILES)				
		0.2	0.4	0.6	0.8	1.0
Prior to Installation	Total Accidents as Conventional Billboard	54	152	206	395	553
	Average Number of Accidents in a Month	5	13	17	33	46
	Standard Deviation	2	4	5	9	14
	Peak Number of Accidents in Any Given Month	7	18	24	46	60
	Minimum Number of Accidents in	2	5	6	11	15
Digital Billboard	Total Accidents as Digital Billboard	48	118	165	302	457
	Average Number of Accidents in a Month	4	10	14	25	38
	Standard Deviation	3	3	3	7	13
	Peak Number of Accidents in Any Given Month	9	16	20	39	61
	Minimum Number of Accidents in	1	5	9	13	17
% Change	Total Accidents	-11%	-22%	-20%	-24%	-17%

Figure 23. Summary accident statistics near digital billboard 1 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

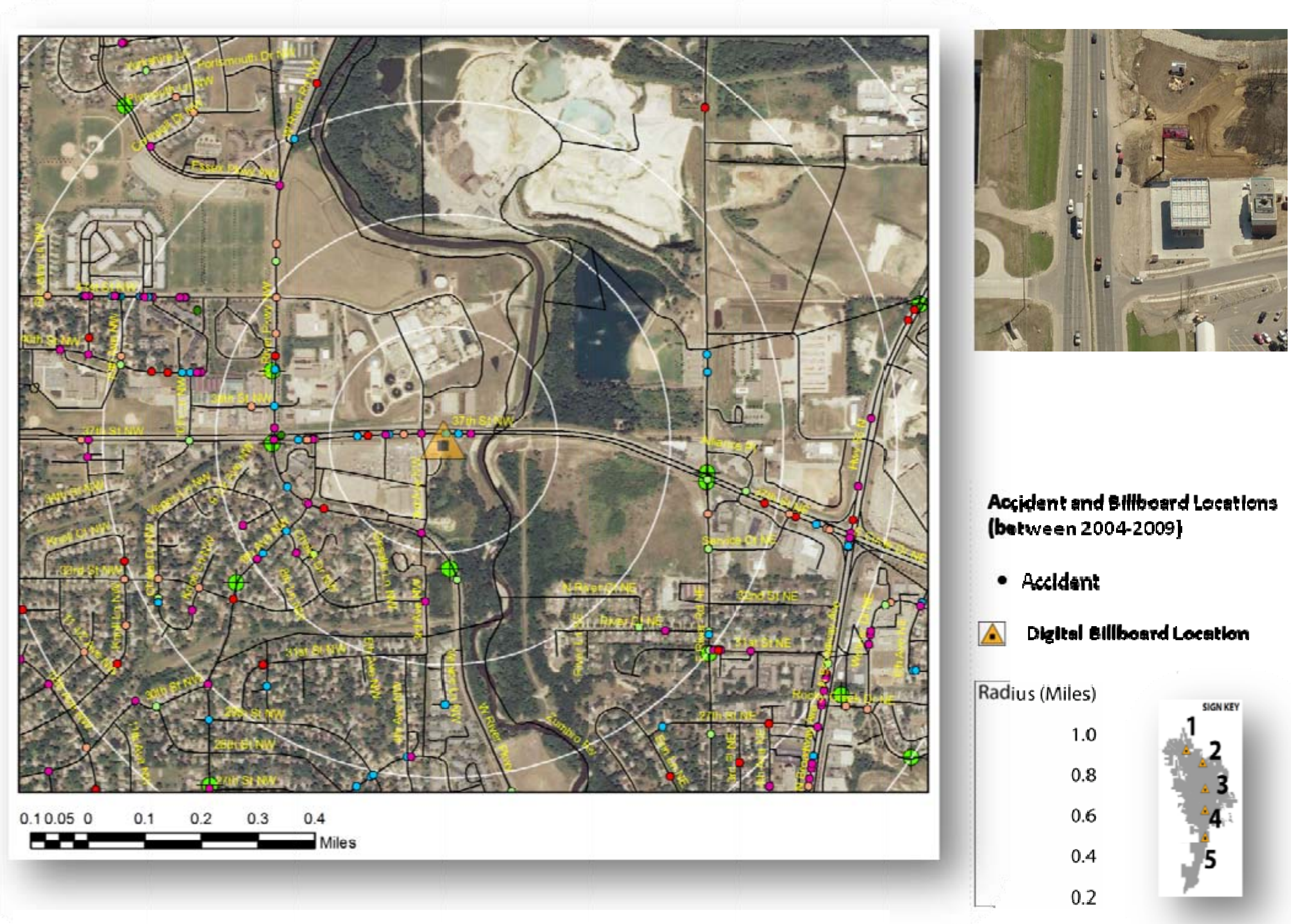

Figure 24. Aerial of Accident data near digital billboard 2 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

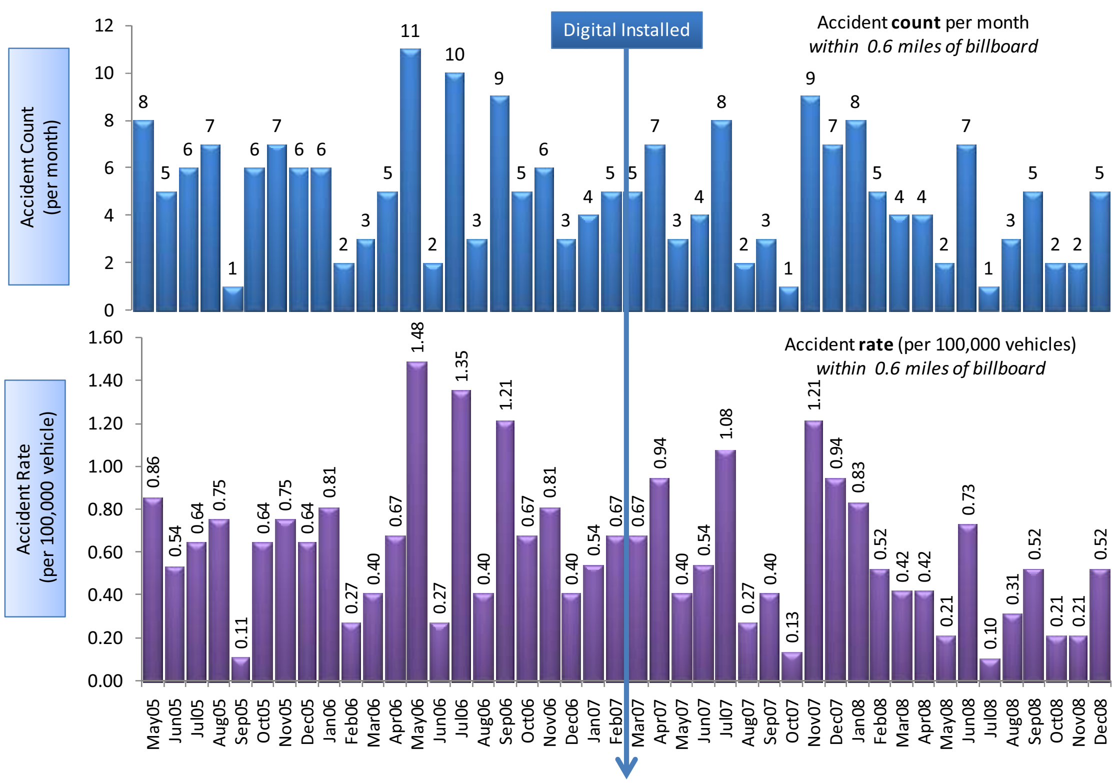

Figure 25. Accident Counts per month and Accident Rates per 100,000 vehicles near digital billboard 2 within 0.6 mile vicinity

Specific Results for Billboard 3

Figures 26 summarizes the statistics and composite accident metrics for billboard number 1 for all vicinity distances. Figure 27 shows the billboard location, geocoded accident records and approximate vicinity ranges. Figure 28 shows the 0.6 mile vicinity histogram as an example for before and after the conversion of the billboard centered on the conversion date of the board to digital format.

These figures represent a 44 month window (22 before and 22 after) of accidents within various vicinities. A comparison of the histograms of accidents (on either a monthly basis) at the location before and after the digital conversion indicates no substantial change in accident patterns. Comparing 3.7 years of data for this location, indicates that the total number of accidents on any given month decreased from 1135 to 1094 (4%) within 0.6 miles, after the introduction of the digital billboard at the location; the average number of accidents in any given month decreased from 95 to 91 per month. This represents a high volume area that remained consistent after the conversion.

		DISTANCE RANGE FROM BILLBOARD (MILES)				
		0.2	0.4	0.6	0.8	1.0
Prior to Installation	Total Accidents as Conventional Billboard	301	718	1135	1546	2072
	Average Number of Accidents in a Month	25	60	95	129	173
	Standard Deviation	8	17	24	31	42
	Peak Number of Accidents in Any Given Month	35	82	123	169	238
	Minimum Number of Accidents in	5	25	45	64	90
Digital Billboard	Total Accidents as Digital Billboard	260	701	1094	1500	2009
	Average Number of Accidents in a Month	22	58	91	125	167
	Standard Deviation	4	9	14	20	22
	Peak Number of Accidents in Any Given Month	29	71	116	163	210
	Minimum Number of Accidents in	16	38	65	92	130
% Change	Total Accidents	-14%	-2%	-4%	-3%	-3%

Figure 26. Summary accident statistics near digital billboard 1 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

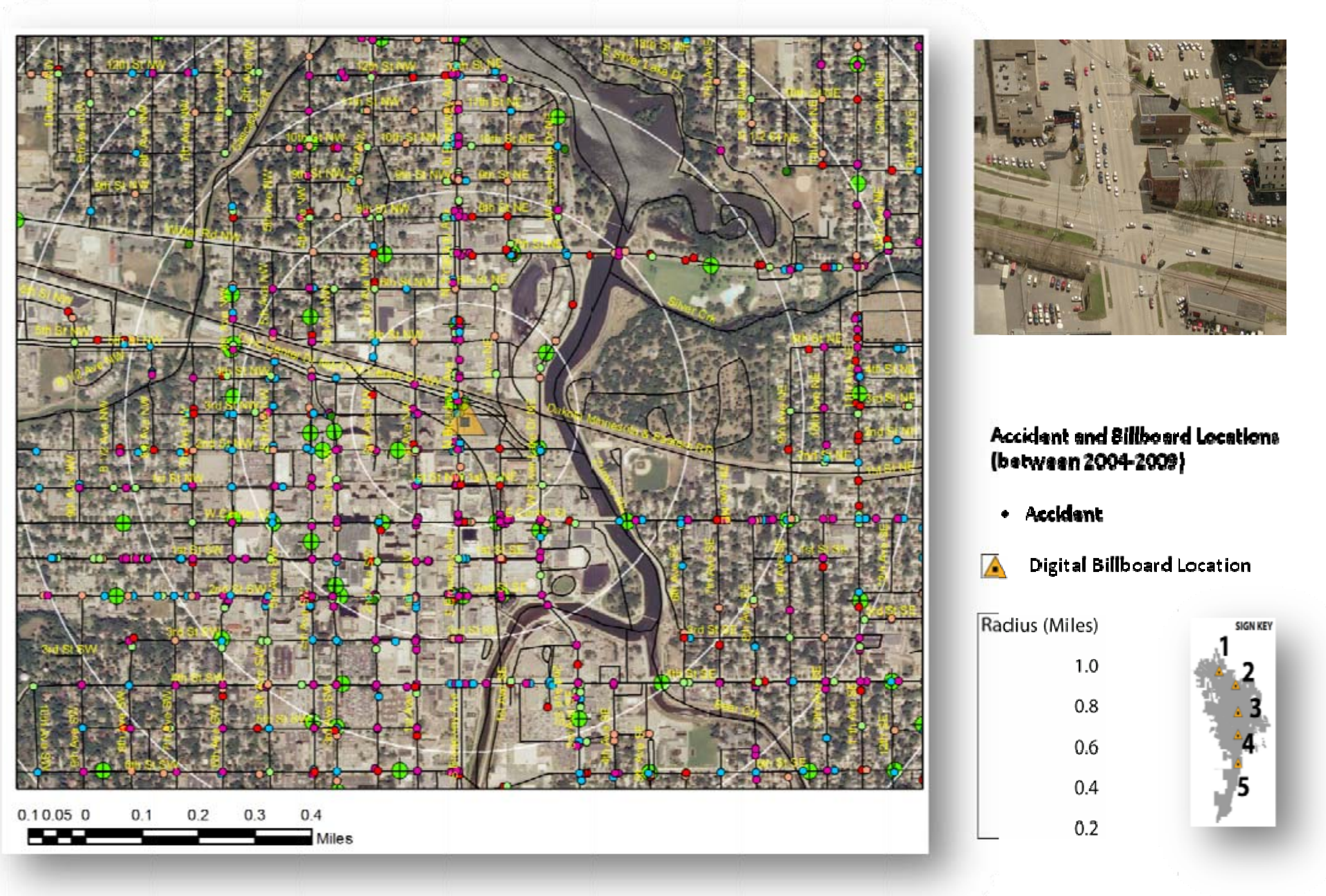

Figure 27. Aerial of Accident data near digital billboard 3 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

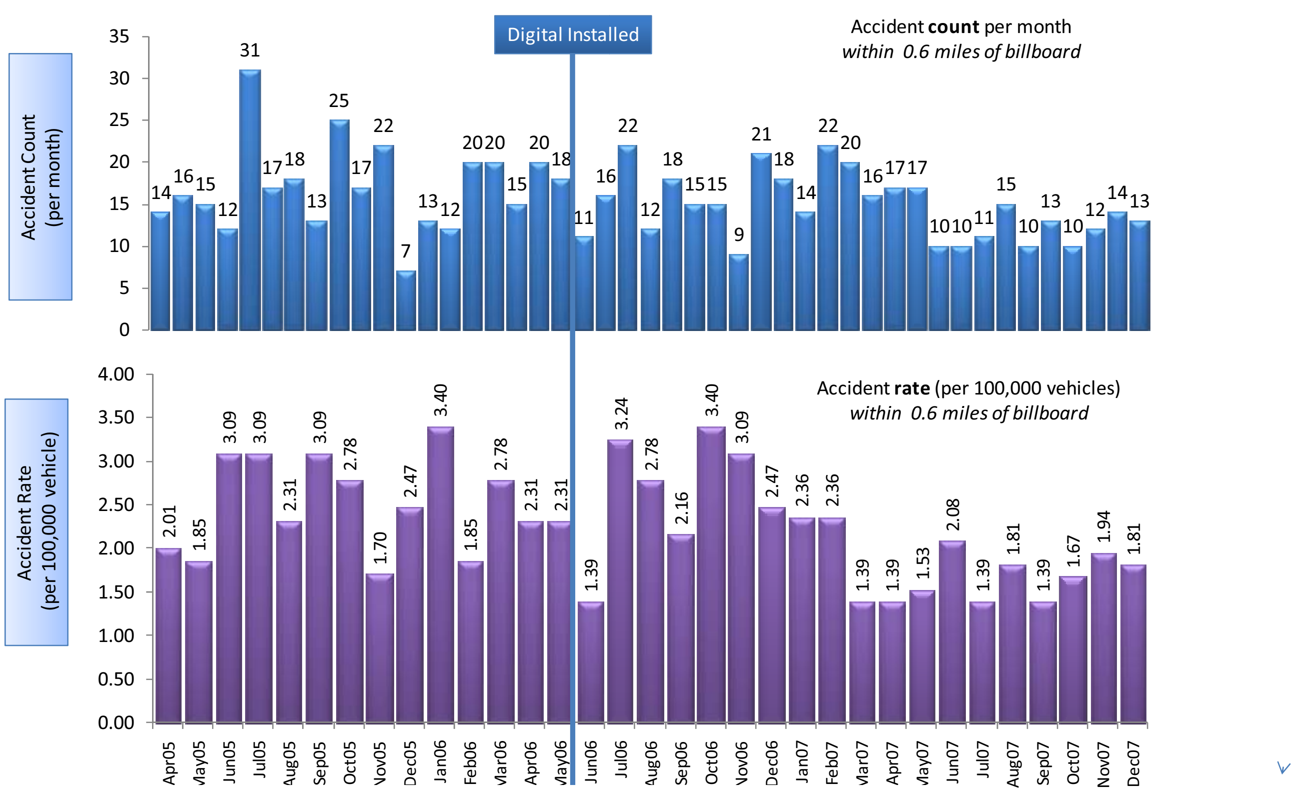

Figure 28. Accident Counts per month and Accident Rates per 100,000 vehicles near digital billboard 3 within 0.6 mile vicinity

Specific Results for Billboard 4

Figures 29 summarizes the statistics and composite accident metrics for billboard number 1 for all vicinity distances. Figure 30 shows the billboard location, geocoded accident records and approximate vicinity ranges. Figure 31 shows the 0.6 mile vicinity histogram as an example for before and after the conversion of the billboard centered on the conversion date of the board to digital format.

These figures represent a 50 month window (25 before and 25 after) of accidents within various vicinities. A comparison of the histograms of accidents (on either a monthly basis) at the location before and after the digital conversion indicates no substantial change in accident patterns. Comparing 4.2 years of data for this location, indicates that the total number of accidents on any given month decreased from 275 to 247 (10%) within 0.6 miles, after the introduction of the digital billboard at the location; the average number of accidents in any given month decreased from 23 to 21 per month. This represents a longer term period (4.2 years) that remained consistent after the conversion.

		DISTANCE RANGE FROM BILLBOARD (MILES)				
		0.2	**0.4**	**0.6**	**0.8**	**1.0**
Prior to Installation	**Total Accidents as Conventional Billboard**	65	163	275	506	946
Prior to Installation	**Average Number of Accidents in a Month**	5	14	23	42	79
Prior to Installation	**Standard Deviation**	2	5	6	11	18
Prior to Installation	**Peak Number of Accidents in Any Given Month**	10	19	33	69	124
Prior to Installation	**Minimum Number of Accidents in**	2	5	12	27	57
Digital Billboard	**Total Accidents as Digital Billboard**	53	149	247	529	967
Digital Billboard	**Average Number of Accidents in a Month**	4	12	21	44	81
Digital Billboard	**Standard Deviation**	2	5	7	10	22
Digital Billboard	**Peak Number of Accidents in Any Given Month**	9	20	32	61	130
Digital Billboard	**Minimum Number of Accidents in**	1	3	13	29	56
% Change	**Total Accidents**	-18%	-9%	-10%	5%	2%

Figure 29. Summary accident statistics near digital billboard 1 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

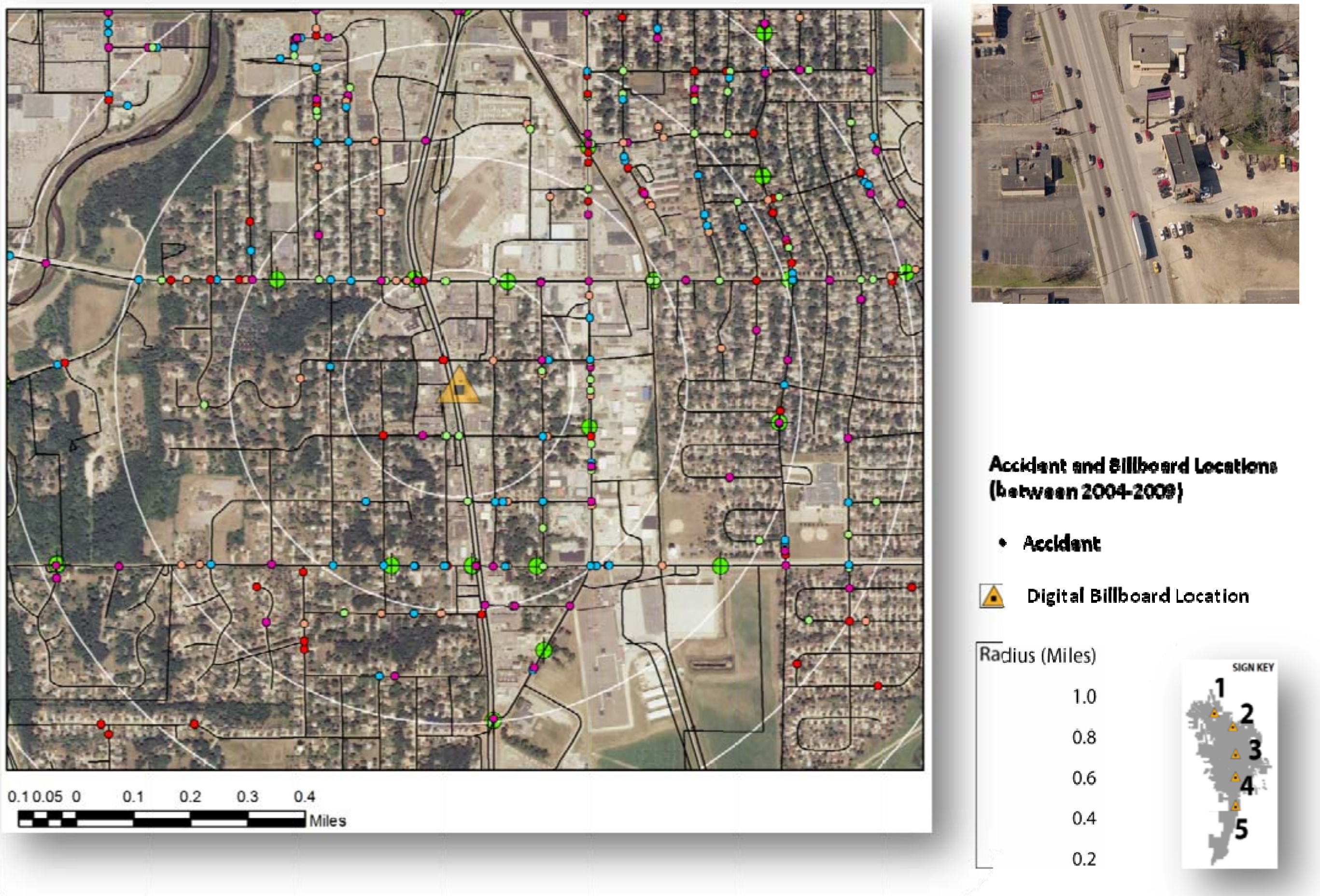

Figure 30. Aerial of Accident data near digital billboard 3 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

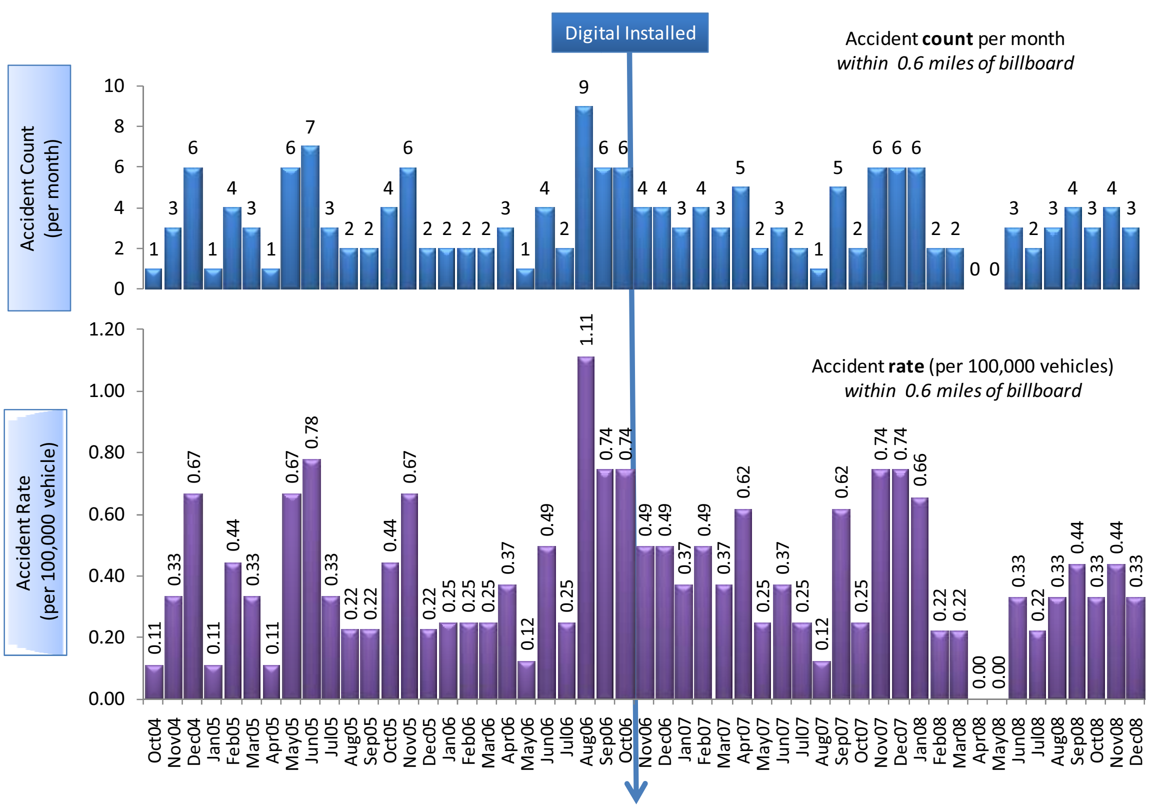

Figure 31. Accident Counts per month and Accident Rates per 100,000 vehicles near digital billboard 4 within 0.6 mile vicinity

Specific Results for Billboard 5

Figures 32 summarizes the statistics and composite accident metrics for billboard number 1 for all vicinity distances. Figure 33 shows the billboard location, geocoded accident records and approximate vicinity ranges. Figure 34 shows the 0.6 mile vicinity histogram as an example for before and after the conversion of the billboard centered on the conversion date of the board to digital format.

These figures represent a 22 month window (11 before and 11 after) of accidents within various vicinities. A comparison of the histograms of accidents (on either a monthly basis) at the location before and after the digital conversion indicates no substantial change in accident patterns. Comparing 1.8 years of data for this location, indicates that the total number of accidents on any given month increased from 23 to 26 (13%) within 0.6 miles, after the introduction of the digital billboard at the location; the average number of accidents in any given month remained the same with 2 per month. Limited data was available for this location because of the length of operation of the billboard. Additionally, roadwork was performed during the service life of the billboard.

		DISTANCE RANGE FROM BILLBOARD (MILES)				
		0.2	0.4	0.6	0.8	1.0
Prior to Installation	Total Accidents as Conventional Billboard	0	11	23	32	39
	Average Number of Accidents in a Month	0	1	2	3	3
	Standard Deviation	0	1	1	2	2
	Peak Number of Accidents in Any Given Month	0	2	4	5	7
	Minimum Number of Accidents in	0	0	0	0	1
Digital Billboard	Total Accidents as Digital Billboard	0	11	26	33	40
	Average Number of Accidents in a Month	0	1	2	3	3
	Standard Deviation	0	1	2	2	2
	Peak Number of Accidents in Any Given Month	0	3	7	7	9
	Minimum Number of Accidents in	0	0	0	0	1
% Change	Total Accidents	0%	0%	13%	3%	3%

Figure 32. Summary accident statistics near digital billboard 1 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

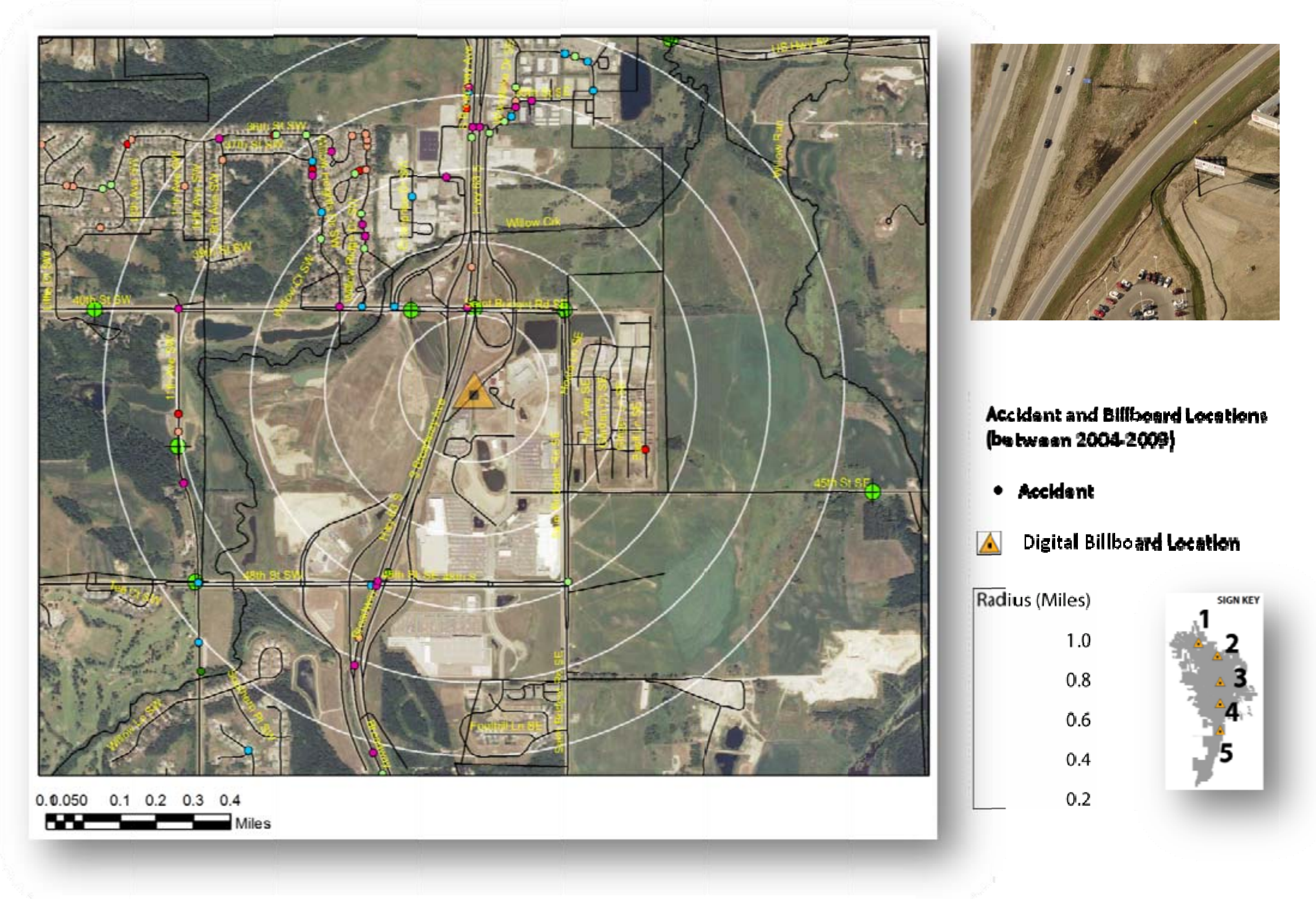

Figure 33. Aerial of Accident data near digital billboard 5 Location with 0.2, 0.4, 0.6, 0.8, and 1.0 mile vicinities

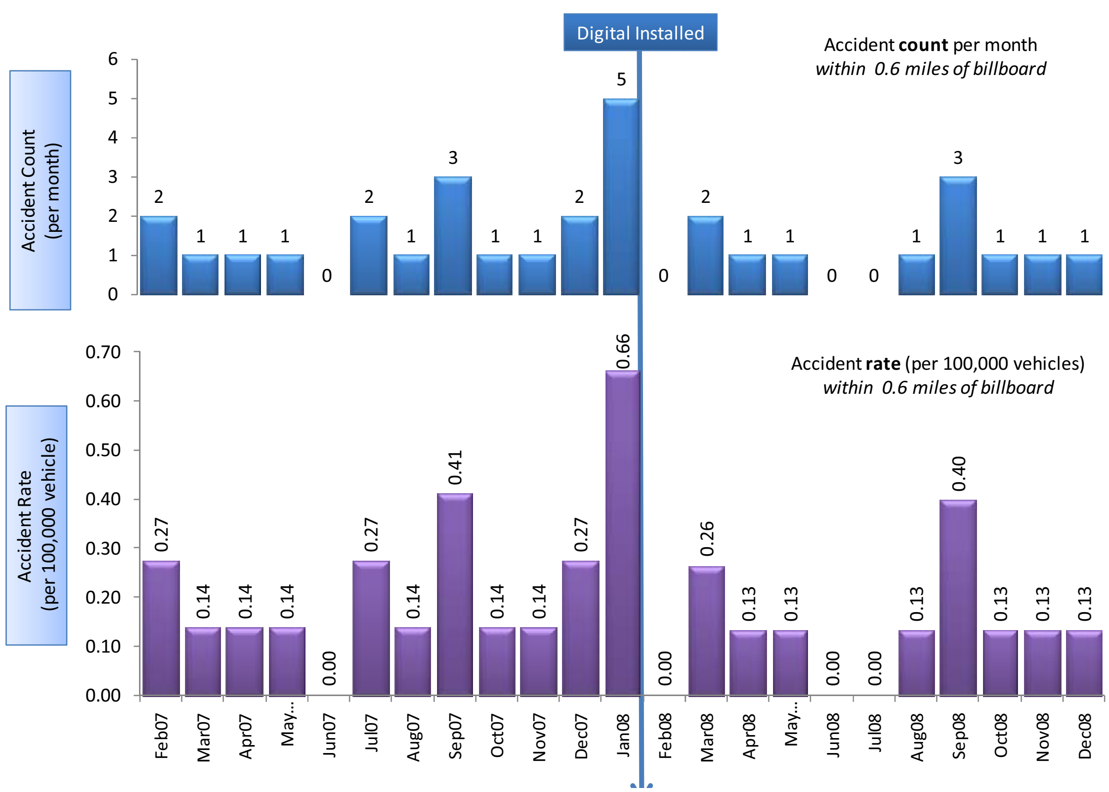

Figure 34. Accident Counts per month and Accident Rates per 100,000 vehicles near digital billboard 5 within 0.6 mile vicinity

Simply stated, the data shows no increase in the incidence of accident rates near these billboards.

FINDINGS

Rochester was a unique opportunity for study about the statistical associations between digital billboards and traffic safety using robust data sets and analyzing multiple locations for periods in excess of four years. The overall conclusion is that the digital billboards in Rochester have no statistically significant relationship with the occurrence of accidents. This conclusion is based on the Rochester Police Department's own data and an objective statistical analysis.

The specific conclusions of this study of Rochester indicate the following:

• The rate of accidents near the five digital billboards shows that there was an 5% decrease in the rate of accidents within 0.6 miles of all digital over an average 3.2 years. Similar decreases occur within smaller or larger vicinities.

• The accident statistics and metrics remain consistent, exhibiting statistically insignificant variations, at each of the digital billboards. The metrics include the total number of accidents in any given month, the average number of accidents over the 10- to 24-month periods, the peak number of accidents in any given month, and the number of accident-free months. These conclusions account for variations in traffic-volume and other metrics.

• The accident statistics and metrics remain consistent for before and after comparisons of daytime only accidents and for nighttime only accidents.

• The correlation coefficients demonstrate no statistically significant relationship between accidents and these billboards.

• Accidents occur with or without billboards (digital or conventional). The accident statistics on sections and roads near these billboards are comparable to the accident statistics on similar sections that have no billboards.

Simply stated, the data shows no increase in the incidence of accident rates near these billboards.

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