Angle Parking on Iowa's Low Volume Primary Extensions in Small Towns

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16. Abstract

On-street parking has been considered problematic by engineers for many years. In fact, numerous studies have concluded that diagonal or angle parking in particular is potentially more of a safety concern than parallel or no parking at all. It is a common position of many states, including Iowa, to discourage or completely prohibit angle parking on primary road extensions in urban areas. However, with the acceptance of "context sensitive design" and traffic calming techniques, policies for on-street parking are receiving re-consideration in many agencies including the FHWA.

This study was undertaken to analyze operational and safety histories in the state of Iowa where various types of on-street parking have existed for many years, concentrating in particular on smaller communities. Specifically of interest was a comparison of diagonal parking locations to other types with regard to related crash histories. If possible, it was intended to develop guidelines to assist Iowa Department of Transportation designers in the consideration of parking requirements for road improvements through small communities. In this regard, several criteria were analyzed to determine possible contribution to crash history including road width, clearance to parked vehicles, traffic volumes, community population, and length of parking area. None of these factors, with the possible exception of population, displayed a clearly definable relationship to crash history. However, when average crash rates for various parking types were compared for non-intersection crashes, differences in rates between areas with diagonal parking and those with parallel parking were almost negligible. In fact, those observed rates were less than sample locations with no parking at all.

These results seem to indicate that indeed there may exist no compelling justification for blanket prohibition of angle parking along Iowa's primary extensions in all urban areas. Rather, a case-by-case investigation with each project design of the most applicable parking type would seem appropriate in smaller communities.

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ANGLE PARKING ON IOWA'S LOW VOLUME PRIMARY EXTENSIONS IN SMALL TOWNS

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INTRODUCTION

On-street parking has been a controversial issue for many years in urban areas. Engineers often prefer wide streets, clear of side obstructions to promote smooth, relatively safe traffic flow. Drivers and particularly business owners desire convenient access to shops and stores, with minimal walking distance for potential customers. This opinion is especially prevalent in the central business districts of smaller communities.

The Iowa Department of Transportation (Iowa DOT), in consideration of maximizing traffic flow and promoting safe operations, has established and maintained a long-standing policy addressing on-street parking along primary roadways in urban areas. While this policy, as described in Chapter 6 of the *Iowa DOT Design Manual*, allows parallel parking where sufficient space is available, angle or diagonal parking is prohibited. Where diagonal parking has been found to exist, project agreements with local communities have historically included elimination of this option as part of restoration and resurfacing projects. This practice has been controversial in many small communities where theoretical safety and operational concerns of engineers are not understood or accepted. Local drivers have become accustomed to angle parking, and actual safety experience has not been perceived as problematic. In addition, from business owners' view, angle parking can provide up to twice the capacity as parallel, resulting in better service to customers. Since primary road extensions in many smaller communities pass through the central business area, potential impacts to "Main Street" can be significant.

In recent years, many states have adopted policies of "context sensitive design." While this new approach to design can be involved and complex, a prevailing feature is flexibility. When designing street improvements in business areas, for example, engineers consider the needs of all road users, not just flow of motor vehicles. Pedestrians and bicyclists merit and receive equal regard with drivers. This design method has implications with parking restrictions as well. In lieu of removing or significantly altering existing parking patterns, accommodations can be sought and incorporated into projects resulting in more comfortable, pedestrian friendly business areas without adversely affecting safety for local citizens.

The Iowa DOT recognizes that application of inflexible parking restrictions may not be appropriate in all situations. Reduced traffic volumes and speeds, low parking turnover, adequate street widths, and minimal numbers of commercial vehicles in many small communities in Iowa may not warrant elimination of angle parking. Application of flexibility, however, can be benefited by guidelines. This study considers several factors related to on-street parking that could affect safety and congestion and develops criteria for reference when parking design is at issue.

BACKGROUND

A review of existing research identifies several studies that substantiate common traffic engineering policies prohibiting or discouraging diagonal parking. A 1990 study by

McCoy et al., "Safety Comparisons of Types of Parking on Urban Streets in Nebraska," found that, while all curbside parking contributes to higher crash rates, the safest type is parallel. This conclusion is supported by a 2002 *ITE Journal* article by Paul C. Box, "Angle Parking Issues Revisited, 2001." Considering a compendium of studies from the Federal Highway Administration (FHWA) and other states, Mr. Box opined that parallel parking is much safer than angle for local, collector, and major routes and creates far less traffic interference.

However, other studies have presented less conclusive results. In "Safety Evaluation of Converting On-Street Parking from Parallel to Angle" McCoy et al. (1991) found that although the number of associated crashes increased when this conversion was undertaken in Lincoln, Nebraska, the parking related crash rate did not significantly change. The on-street conversion was cost effective when the cost of increased crashes was compared with providing comparable off street facilities. A 2002 *ITE Journal* article by John D. Edwards, "Changing On-Street Parallel Parking to Angle Parking," stated that this conversion should be considered in many urban areas and presented criteria under which such a change could be implemented, such as minimum traffic volumes, speeds, street width, and land use. This report also emphasized the need for a specific investigation of each location and recommended before and after studies for impacts.

The policies of most states have historically prohibited or certainly discouraged establishment of angle on-street parking. The Code of Iowa Section 321.361 primarily relates requirements for parallel parking, although provisions for establishment of angle parking by local authorities is allowed for roadways under their jurisdiction.

Nebraska statutes prohibit angle parking on their state highway system within corporate limits unless the Nebraska Department of Roads concludes that sufficient width exists. Angle parking is not prohibited by policy, and guidance is provided to maintenance staff for laying out parking stalls. However, if analysis indicates a parking-related crash history, the Nebraska Department of Roads has advised removal of curbside parking to address the problem.

Minnesota has maintained a policy that strongly discourages angle parking on trunk highway extensions in urban areas. However, a 1997 study committee, in considering crash histories in several locations where angle parking existed, recommended a policy revision to allow angle parking under certain conditions, primarily if a need can be demonstrated and an adverse affect on safety will not occur.

The FHWA has also modified an established position on angle parking in recent years. In 1970, FHWA Instructional Memorandum 21-10-60 prohibited angle parking adjacent to through lanes on federal aid projects. However, in 1972 that position began to be modified and by 1992 reference to diagonal parking was removed from the *Federal-Aid Policy Guide*. Since no policies, procedures, or positions against diagonal parking now exist, the FHWA recommends that sound engineering judgment be applied to assess each situation considering unique local conditions.

METHODOLOGY

To study and analyze the potential impacts of diagonal parking on safety and operation, the Center for Transportation Research and Education (CTRE) requested Iowa DOT district staff to recommend cities with existing on-street parking as study candidates. From the submitted list, 29 cities from various locations in the state, ranging in population from approximately 200 to 9,500, were selected. In addition to location and population variables, these cities presented several types of existing on-street parking, including diagonal, parallel, and combinations of these types as well as some locations with no parking allowed. The list of study cities is shown in Table 1.

Table 1. List of Study Cities

District	City	County	Population
1	Roland	Story	1,324
1	Lynnville	Jasper	366
3	Albert City	Buena Vista	709
3	Battle Creek	Ida	743
3	Estherville	Emmet	6,656
3	Harris	Osceola	200
3	Milford	Dickinson	2,474
3	Plover	Pocahontas	95
3	Spirit Lake	Dickinson	4,261
3	Arnolds Park	Dickinson	1,162
3	Ashton	Osceola	461
3	Sibley	Osceola	2,796
3	Emmetsburg	Palo Alto	3,958
3	Graettinger	Palo Alto	500
3	Mallard	Palo Alto	298
3	West Bend	Palo Alto	2,188
3	Rolfe	Pocahontas	675
3	Pisgah	Harrison	316
4	Hamburg	Fremont	1,240
4	Shenendoah	Page	5,546
4	Corning	Adams	1,783
4	Atlantic	Cass	7,257
4	Essex	Page	884
5	Keosauqua	Van Buren	1,066
5	Sigourney	Keokuk	2,209
5	Fairfield	Jefferson	9,509
5	Bloomfield	Davis	2,601
5	Osceola	Clarke	4,659
5	Corydon	Wayne	1,591

Several attributes could contribute to crash history and operational characteristics, including the following:

- speed limit
- roadway width
- number of lanes
- average daily traffic (ADT)
- existing traffic control
- proximity of parking to intersections
- number of parking maneuvers per hour
- population of city
- type of area
- angle of parking stalls

Much of these data are available from Iowa DOT inventory or can easily be extracted from aerial photography, but several cities were visited by CTRE research staff to obtain specific information and measurements such as parking angle and clearance from parked vehicles to the through traffic lanes (where aerials were not available). A sketch of a typical parking configuration is shown in Illustration 1.

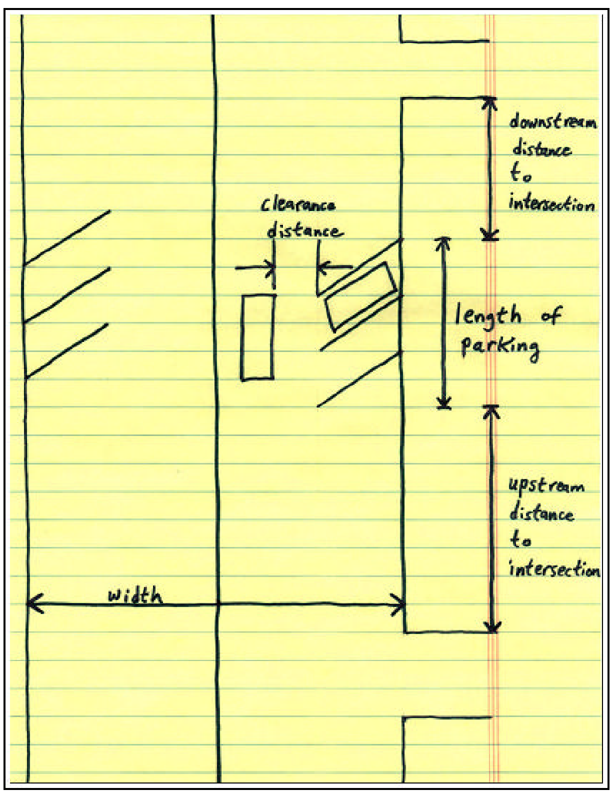


Illustration 1. Typical Parking Configuration

A principal task for this study was to stratify similar conditions to the maximum extent possible and then compare crash histories for various parking configurations. For this purpose, major variables from the above list were selected for analysis, including ADT, population and roadway width, as well as length of parking area in a community, and clearance behind parked vehicles.

For analysis of crash histories, only certain types of crashes were assumed as potentially related to on-street parking (hereafter referred to as "parking related"):

- head-on
- sideswipe/opposite direction
- sideswipe/same direction
- sideswipe/right turn
- sideswipe/left turn
- pedestrian
- bicycle
- rear end
- rear end/right turn
- parking
- other

For analysis, total crashes (including intersection related crashes) and non-intersection related crashes (parking related crashes) were studied. A five-year crash history from the Iowa DOT database, 1996 through 2000, was reviewed. Summaries of both results are included in the report.

All pertinent data were listed by segment (typically one city block) in an Excel spreadsheet. Several characteristics were extracted from the Iowa DOT GIMS database, including speed limit, annual average daily traffic (AADT), number of lanes, and population. Other elements were extracted from the Iowa DOT's ALAS database including frequency/location of crashes, number of injuries and fatalities, injury loss, property damage, and total loss. Some elements were measured from aerials or field visits, such as type of parking, length of parking, angle of parking, street width, and clearance. Regression analysis was performed on most of the variables and combinations of variables to see if a statistically reliable relationship existed between any of them and the observed crash rates. However, no statistically reliable models could be developed using the collected data. Therefore, some of the characteristics that were expected to be causal were used to develop univariate crash rates.

Two crash rates (rate per hundred million vehicle miles traveled, 100 MVMT, and rate per million entering vehicles, MEV) were calculated for each segment for each of five characteristics (road width, length of parking, clearance to traveled lane, AADT, and city population).

For the five-year study period,

100 MVMT = AADT * segment length * 365 * 5 / 100,000,000

and

MEV = AADT * 365 * 5 / 1,000,000

Note: Iowa DOT convention for MEV includes an adjustment for segments greater than 0.6 miles in length. None of the studied segments was longer than 0.6 miles.

Complete data records are included in the appendix.

DISCUSSION OF FINDINGS

A number of variables existing in the study cities permitted several interesting although not statistically sound comparisons. Table 2 lists average crash rates for each parking type and combination, including no parking. This summarization indicates a relatively high crash rate for diagonal parking areas compared to parallel when intersection crashes are scrutinized. However, relevant crash causes in intersections include many not related to parking and for that reason only non-intersection crash data will be discussed in this report. Referring to the summarized average crash rates for non-intersection data, Table 2 indicates comparable histories for diagonal and parallel parking areas. (Note that while “parking related” does not include crash types that are clearly not parking related, the rate may include some crashes that did not involve a parking maneuver.) Those crash rates even compare favorably to study areas without existing on-street parking.

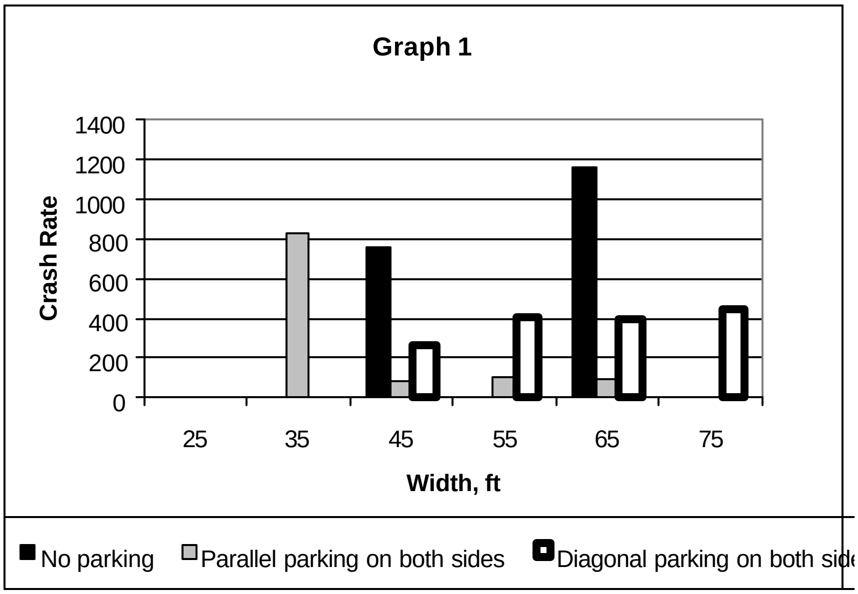
Table 2. Parking Type and Crash Rate

Parking Type	Number of Segments	Average Crash Rate, All Crashes		Average Crash Rate, Non-Intersection/“Parking Related”	
		per 100 MVMT	per MEV	per 100 MVMT	per MEV
Diagonal both sides	72	1,620	1.1	400	0.3
Parallel both sides	26	910	0.7	420	0.3
Diagonal one side only	4*	2,710	1.9	860*	0.7
Parallel one side only	3*	1,540	1.1	0*	0.0
Diagonal one side, parallel other	19	1,750	1.2	320	0.2
Diagonal center with parallel on both sides	3*	1,450	1.4	250*	0.2
None	14*	1,870	1.4	630**	0.5

* Caution: small sample size.

** The higher crash rate for no-parking areas may indicate that for low volume roads, parking type is a weak predictor of crash rate. It could also mean that streets with parking are safer, possibly because drivers use more care when another driver might be pulling in or out, or where pedestrians are likely to cross the road. It could also indicate that in these areas drivers drive more slowly while hunting for a parking place, or searching for a store, etc. This study did not attempt to quantify these phenomena.

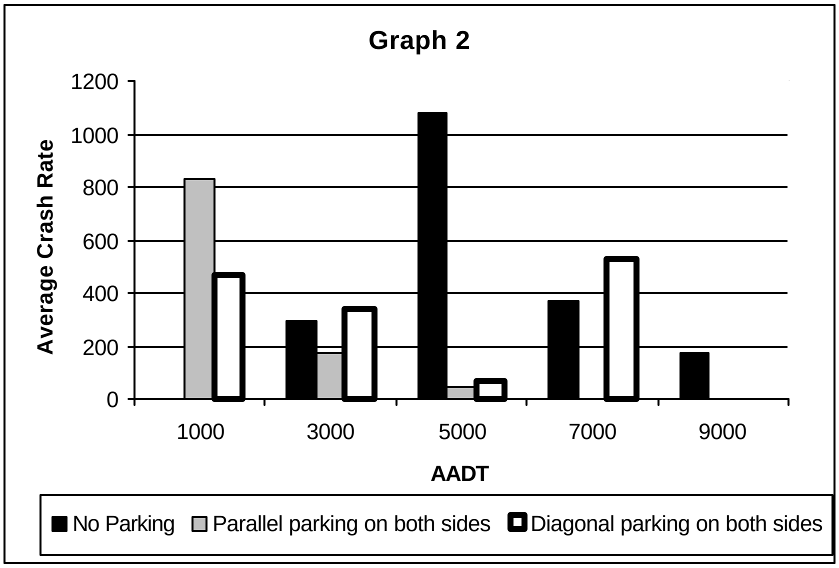
Other features were also compared to observed crash rates to determine a possible correlation. Graph 1 compares roadway width to crash rates. While parallel parking crash rates show a decreasing relationship to width, diagonal parking crash rates showed no such relationship.



Graph 1. Parking Type, Roadway Width, and Crash Rate

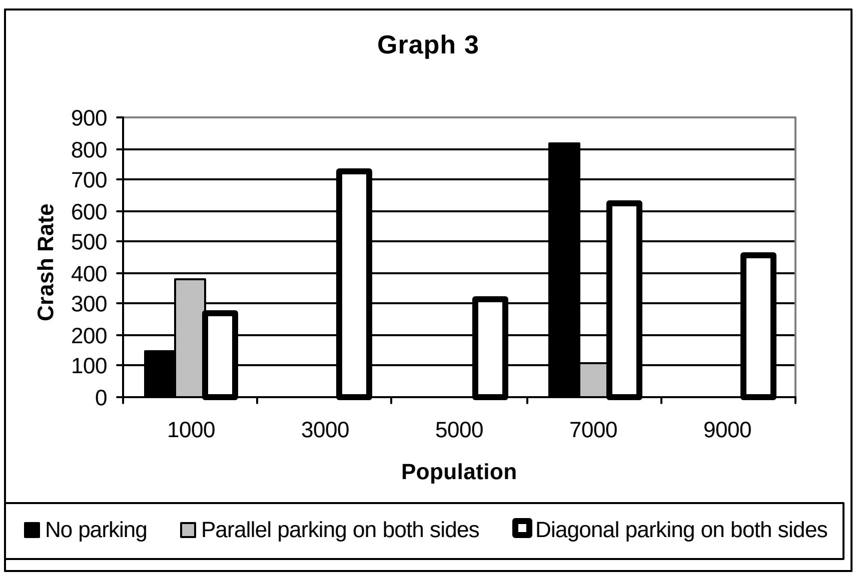
Comparing length of parking area to crash rate presented even less correlation. Crash rate versus clearance to parked vehicles also indicated no discernable relationships.

Some parking types may show a relationship to traffic volumes, however. Graph 2 depicts a decreasing relationship for parallel parking and somewhat random for no parking, both decreasing with higher traffic volumes, a not uncommon observance in crash analysis. However, diagonal parking overall shows no definable relationship.



Graph 2. Parking Type, Traffic Volume, and Crash Rate

In Graph 3, both no parking and diagonal parking locations show little relationship of crash rate to population for the study cities.



Graph 3. Parking Type, Population, and Crash Rate

CONCLUSIONS AND RECOMMENDATIONS

On-street parking has been considered problematic by engineers for many years. In fact, numerous studies have concluded that diagonal or angle parking in particular is potentially more of a safety concern than parallel or no parking at all. It is a common position of many states, including Iowa, to discourage or completely prohibit angle parking on primary road extensions in urban areas. However, with the acceptance of "context sensitive design" and traffic calming techniques, policies for on-street parking are receiving re-consideration in many agencies including the FHWA.

This study was undertaken to analyze operational and safety histories in the state of Iowa where various types of on-street parking have existed for many years, concentrating in particular on smaller communities. Specifically of interest was a comparison of diagonal parking locations to other types with regard to related crash histories. If possible, it was intended to develop guidelines to assist Iowa DOT designers in the consideration of parking requirements for road improvements through small communities. In this regard, several criteria were analyzed to determine possible contribution to crash history including road width, clearance to parked vehicles, traffic volumes, community population, and length of parking area. As presented in the previous section, none of these factors, with the possible exception of population, displayed a clearly definable relationship to crash history. However, when average crash rates for various parking types were compared for non-intersection crashes, differences in rates between areas with diagonal parking and those with parallel parking were almost negligible. In fact, those observed rates were less than sample locations with no parking at all.

While the scope of this project did not allow complete analysis of a statistically sound sample of locations, the data gathered were quite substantial and covered most areas of the state of Iowa. These results seem to indicate that indeed there may exist no compelling justification for blanket prohibition of angle parking along Iowa's primary extensions in all urban areas. Rather, a case-by-case investigation with each project design of the most applicable parking type would seem appropriate in smaller communities.

Based on these findings the following recommendations are offered for consideration:

- Chapter 6 of the *Iowa DOT Design Manual* could be revised to allow consideration of angle parking in appropriate locations along low volume primary extensions. This option would be particularly applicable in communities with populations under approximately 2,500 and low parking turnover.

- The Code of Iowa Section 321 could be reviewed for any needed revisions to permit angle parking on primary extensions in small towns.

- Design standards for angle parking could be developed by the Iowa DOT, including but not limited to road width, length and angle of stall, proximity of parking areas to intersections, and recommended signing and pavement marking.

- Iowa DOT design staff in the central office and districts could review each situation in small community applications, considering unique local conditions, including parking related crash history. CTRE can assist in these investigations, if desired. Close coordination and communication with local officials, business interests, and general public during initial design would be most beneficial.

The scope of this study did not permit an extensive investigation of the topic. Additional, more precise guidelines could be developed if expanded data were available. Statistical sampling methods would produce more reliable conclusions and other potential impacts on safety and operational experience, such as parking turnover, could be investigated. The impacts of population demographics, visibility consequences with larger vehicles, and angle of parking could also be studied. As context sensitive design techniques and traffic calming initiatives receive increased popularity in urban areas, impacts of available parking will also merit further consideration.

APPENDIX: RAW AND INTERMEDIATE DATA FOR STUDY SEGMENTS

Table A.1. Data

SEG. #	LEN.	VMT	AADT	FREQ	INJURY LOSS	FATAL.	INJ.	PROP. DAMAGE	TOTAL LOSS	VMT RATE	MEV RATE	STREET
NO PARKING												
17	0.0690	793328	5100	9	5000	0	2	18515	23515	1401.4	1.0	POPLAR ST
21	0.0680	221738	4860	7	15000	0	6	15000	30000	1160.6	0.8	WALNUT ST
58	0.0820	716824	4530	4	0	0	0	6300	6300	590.0	0.5	JEFFERSON ST
87	0.0680	445519	3390	5	30000	0	3	5500	35500	1188.5	0.8	S 9TH ST
88	0.0690	535181	4020	15	65000	0	12	13100	78100	2963.1	2.0	N 9TH ST
89	0.0780	1209975	8000	6	22500	0	3	10290	32790	526.9	0.4	CENTRAL AVE
90	0.0640	496400	4020							0.0	0.0	N 9TH ST
91	0.1770	3036435	8900							0.0	0.0	CENTRAL AVE
93	0.0920	1545410	8450	5	5000	0	2	3500	8500	352.4	0.3	CENTRAL AVE
94	0.1280	1985600	8000	4	0	0	0	2000	2000	214.0	0.3	CENTRAL AVE
140	0.0410	191552	2420							0.0	0.0	MAPLE ST
143	0.0720	336384	2420							0.0	0.0	MAPLE ST
144	0.0760	355072	2420							0.0	0.0	MAPLE ST
200	0.0730	566206	4020	2	0	0	0	1500	1500	373.4	0.3	N 9TH ST
AVERAGE		**888258.9**	**5039.3**							**626.5**	**0.5**	
PARALLEL ON ONE SIDE ONLY												
35	0.0730	424988	3190							0.0	0.0	FRANKLIN
50	0.0650	34283	289							0.0	0.0	ADAMS ST
51	0.0690	36392	289							0.0	0.0	ADAMS ST
AVERAGE		**165221.0**	**1256.0**							**0.0**	**0.0**	
PARALLEL AND DIAGONAL												
26	0.0440	72270	900							0.0	0.0	WALNUT ST
36	0.0690	351331	2790	5	0	0	0	4703	4703	1423.2	1.0	FRANKLIN
42	0.0710	274699	2120							0.0	0.0	MADISON
44	0.0720	253602	1930							0.0	0.0	MADISON
47	0.0670	78256	640							0.0	0.0	BENTON ST
82	0.0810	164086	1110							0.0	0.0	IOWA AVE
86	0.0580	41282	390							0.0	0.0	CENTRAL ST
95	0.0670	733650	5700	7	12500	0	5	13600	26100	1004.4	0.7	MAIN ST
101	0.0630	120954	1052							0.0	0.0	MAIN ST
105	0.0640	116800	1000							0.0	0.0	COURT ST
116	0.0390	247689	3190							0.0	0.0	MAIN ST~BROAD ST
117	0.0700	480340	3560							0.0	0.0	MAIN ST~BROAD ST
126	0.0640	49056	420							0.0	0.0	EAST ST
155	0.0700	111143	870	3	0	0	0	5950	5950	2699.2	1.9	E 9TH ST
156	0.0690	109555	870							0.0	0.0	E 9TH ST
AVERAGE		**305352.0**	**2302.2**							**319.5**	**0.2**	
PARALLEL ON BOTH SIDES												
4	0.0660	109610	860							0.0	0.0	IOWA 197
9	0.1440	543996	2070	4	2500	0	1	3003	5503	735.3	1.1	BROADWAY ST
10	0.0860	177354	1130	8	0	0	0	19850	19850	4510.8	3.9	BROADWAY ST
13	0.0690	591848	4340							0.0	0.0	POPLAR ST
14	0.0690	591848	4340	1	0	0	0	1000	1000	183.0	0.1	POPLAR ST
15	0.0690	591848	4340							0.0	0.0	POPLAR ST
16	0.0690	793328	5100	1	10000	0	1	1000	11000	155.7	0.1	POPLAR ST
22	0.0700	608090	4760							0.0	0.0	WALNUT ST
25	0.0690	299702	2380	1	0	0	0	500	500	333.7	0.2	WALNUT ST
32	0.0650	212339	1700	1	150000	0	1	500	150500	495.9	0.3	1ST ST
33	0.0720	696420	5100							0.0	0.0	WASHINGTON ST
37	0.0740	413253	3060							0.0	0.0	JEFFERSON ST

59	0.0900	441833	2550							0.0	0.0	LAFAYETTE ST
60	0.0820	342644	2285	1	0	0	0	1000	1000	292.4	0.2	JACKSON ST
65	0.0760	140503	1013							0.0	0.0	FRANKLIN
83	0.0590	6676	118							0.0	0.0	BROOKS ST
85	0.0600	24090	220	1	0	0	0	1003	1003	4151.1	2.5	CENTRAL ST
113	0.0640	163520	1400							0.0	0.0	MAIN ST
114	0.0690	176295	1400							0.0	0.0	MAIN ST
124	0.0350	18460	289							0.0	0.0	VAN BUREN ST
135	0.0700	15330	120							0.0	0.0	MAIN ST
141	0.0800	321200	2200							0.0	0.0	MAPLE ST
142	0.0700	281050	2200							0.0	0.0	MAPLE ST
162	0.0650	57652	486							0.0	0.0	JEFFERSON ST
164	0.0650	532627	4250							0.0	0.0	HWY 149
165	0.0630	400113	3480							0.0	0.0	HILL AVE
AVERAGE		**328908.8**	**2353.5**							**417.6**	**0.3**	
DIAGONAL ON ONE SIDE												
66	0.0780	55653	410	2	0	0	0	2450	2450	3431.0	2.7	FRANKLIN
120	0.0550	129484	1290							0.0	0.0	FIRST ST
121	0.0550	129484	1290							0.0	0.0	FIRST ST
122	0.0480	113004	1290							0.0	0.0	FIRST ST
AVERAGE		**106906.3**	**1069.9**							**857.7**	**0.7**	
DIAGONAL ON BOTH SIDES												
11	0.0760	12483	90							0.0	0.0	3RD ST
12	0.0760	12483	90							0.0	0.0	3RD ST
18	0.0670	201553	2510	7	35000	0	5	7650	42650	2280.8	1.5	CHESTNUT ST
19	0.0710	334303	2580							0.0	0.0	CHESTNUT ST
20	0.0780	166550	1170	1	0	0	0	500	500	600.4	0.5	CHESTNUT ST
23	0.0700	502058	3620							0.0	0.0	WALNUT ST
24	0.0700	434350	3270							0.0	0.0	WALNUT ST
29	0.0700	191625	1500	3	0	0	0	5850	5850	1565.6	1.1	CHESTNUT ST
30	0.0700	191625	1500							0.0	0.0	CHESTNUT ST
31	0.0690	188888	1500	1	0	0	0	2400	2400	529.4	0.4	CHESTNUT ST
38	0.0690	385331	3060	6	10000	0	4	10000	20000	1557.1	1.1	JEFFERSON ST
39	0.0730	287766	2160							0.0	0.0	JEFFERSON ST
40	0.0680	228344	1840	1	0	0	0	500	500	437.9	0.3	MADISON
45	0.0670	122275	1000							0.0	0.0	BENTON ST
48	0.0640	128480	1100	4	10000	0	1	8900	18900	3113.3	2.0	DAVIS AVE
49	0.0670	77033	630							0.0	0.0	DAVIS AVE
52	0.0600	107420	981	1	0	0	0	2150	2150	930.9	0.6	ADAMS ST
53	0.0680	121742	981							0.0	0.0	ADAMS ST
54	0.0600	318645	2510							0.0	0.0	DAVIS AVE
55	0.0680	361131	2510	1	0	0	0	1800	1800	321.0	0.2	DAVIS AVE
56	0.0600	148920	1360							0.0	0.0	BENTON ST
57	0.0680	168776	1360	1	0	0	0	1900	1900	592.5	0.4	BENTON ST
63	0.0840	354123	2310							0.0	0.0	FRANKLIN
81	0.0690	167480	1330							0.0	0.0	IOWA AVE
96	0.0690	289628	2300	2	0	0	0	2006	2006	690.5	0.5	BROADWAY AVE
97	0.0680	496400	4000							0.0	0.0	BROADWAY AVE
98	0.0680	310250	2500							0.0	0.0	BROADWAY AVE
99	0.0660	320397	2660	4	0	0	0	5000	5000	1248.5	0.8	MAIN ST
100	0.0680	434350	3500							0.0	0.0	MAIN ST
102	0.0680	210970	1700	1	10000	0	1	450	10450	474.0	0.3	COURT ST
103	0.0670	392503	3210	4	10000	0	4	6402	16402	1019.1	0.7	COURT ST
104	0.0680	434350	3500	1	0	0	0	1600	1600	230.2	0.2	COURT ST
106	0.0650	194545	1640	2	12500	0	2	12000	24500	1028.0	0.7	ROBINS AV
107	0.0650	194545	1640							0.0	0.0	ROBINS AV
108	0.0490	146657	1640	1	12500	0	2	2000	14500	681.9	0.3	ROBINS AV
109	0.0660	467346	3880							0.0	0.0	MAIN ST
110	0.0630	446103	3880							0.0	0.0	MAIN ST

111	0.0600	463185	3650	1	0	0	0	500	500	250.2	0.2	MAIN ST
112	0.0630	486344	3650							0.0	0.0	MAIN ST
118	0.0300	55462	1013							0.0	0.0	VAN BUREN ST
119	0.0400	73949	1013							0.0	0.0	VAN BUREN ST
123	0.0370	68403	1013							0.0	0.0	VAN BUREN ST
125	0.0720	189216	1440							0.0	0.0	EAST ST
127	0.0500	187063	2050							0.0	0.0	INMAN ST
128	0.0420	157133	2050							0.0	0.0	INMAN ST
129	0.0440	164615	2050	1	0	0	0	500	500	607.5	0.3	INMAN ST
130	0.0710	149011	1150	2	2500	0	1	2003	4503	1342.2	1.0	10TH ST
131	0.1010	1198113	6200	6	7500	0	3	5200	12700	525.0	0.5	S MAIN ST
136	0.0850	231136	1410							0.0	0.0	MAIN ST
137	0.0730	198505	1410							0.0	0.0	MAIN ST
138	0.1240	156147	690							0.0	0.0	MAIN ST
139	0.0940	118370	690	1	0	0	0	1000	1000	844.8	0.8	MAIN ST
145	0.0670	96597	740							0.0	0.0	GARFIELD ST
146	0.0690	99481	740							0.0	0.0	GARFIELD ST
147	0.0700	404968	3170	1	10000	0	1	500	10500	246.9	0.2	SHERIDAN AVE
149	0.0700	715400	5600	1	0	0	0	1000	1000	139.8	0.1	SHERIDAN AVE
150	0.0680	694960	5600							0.0	0.0	SHERIDAN AVE
151	0.0770	201934	1437	5	0	0	0	9750	9750	2476.1	1.9	3RD AV
152	0.0780	126692	890	1	10000	0	1	1000	11000	789.3	0.6	4TH AVE
153	0.0810	122695	830							0.0	0.0	4TH AVE
157	0.0010	2623	1437							0.0	0.0	THIRD AVE
158	0.0800	209802	1437	1	0	0	0	1000	1000	476.6	0.4	THIRD AVE
159	0.0680	279225	2250	1	0	0	0	500	500	358.1	0.2	WASHINGTON ST
160	0.0660	122016	1013	1	10000	0	1	3140	13140	819.6	0.5	ELM ST
166	0.0630	407012	3540							0.0	0.0	HILL AVE
167	0.0560	397558	3890	3	0	0	0	16600	16600	754.6	0.4	HILL AVE
168	0.0760	539543	3890	3	2500	0	1	2506	5006	556.0	0.4	HILL AVE
169	0.0630	187409	1630	2	0	0	0	6500	6500	1067.2	0.7	BROADWAY
170	0.0620	181040	1600							0.0	0.0	BROADWAY
171	0.0620	181040	1600							0.0	0.0	BROADWAY
201	0.0390	145909	2050							0.0	0.0	INMAN ST
202	0.0860	216591	1380	1	0	0	0	500	500	461.7	0.4	10TH ST
	0.2430		3670	2	0	0	0	1500	1500	122.9	0.3	MAIN ST
	0.0680		880	1	2500	0	1	500	3000	915.7	0.6	1ST ST
	0.3290		3630	6	7500	0	3	4000	11500	275.3	0.9	MAIN ST
AVERAGE		**260841.3**	**2100.2**							**403.0**	**0.3**	
EITHER ON BOTH SHOULDERS												
115	0.0700	45990	360							0.0	0.0	MAIN ST
DIAGONAL CENTER AND PARALLEL ON SIDES												
132	0.0980	613455	2510	1	0	0	0	500	500	222.8	0.2	W JEFFERSON ST
133	0.0980	320142	4160	4	10000	0	1	3978	13978	537.6	0.5	W WASHINGTON ST
134	0.1010	713338	3870							0.0	0.0	N FILLMORE ST
AVERAGE		**548978.3**	**3513.3**							**253.5**	**0.2**	
UNKNOWN												
148	0.0430	11680000	6400	3	7500	0	3	3400	10900	597.3	0.3	SHERIDAN AVE

Table A.2. Data

SEG. #	CITY_NAME	1990 POP.	2000 POP.	ANGLE OF PKG.	WIDTH	SPD. LIMIT	85%	LNS.	CTRL. w/ 250 FT of PKG.?	DIST. FROM CTRL. TO BEG. OF PKG.	LENGTH OF PKG.	X DIST.
NO PARKING												
17	ATLANTIC	7432	7257	NA	41	20	20	2				
21	ATLANTIC	7432	7257	NA	61	20	20	2				
58	CORYDON	1675	1591	NA	44	25	25	2				
87	ESTHERVILLE	6720	6656	NA	44			2				
88	ESTHERVILLE	6720	6656	NA	44			2				
89	ESTHERVILLE	6720	6656	NA	48			2				
90	ESTHERVILLE	6720	6656	NA	44			2				
91	ESTHERVILLE	6720	6656	NA	48			2				
93	ESTHERVILLE	6720	6656	NA	48			2				
94	ESTHERVILLE	6720	6656	NA	48			2				
140	ROLAND	1035	1324	NA	32			2				
143	ROLAND	1035	1324	NA	32			2				
144	ROLAND	1035	1324	NA	32			2				
200	ESTHERVILLE	6720	6656	NA	44			2				
PARALLEL ON ONE SIDE ONLY												
35	BLOOMFIELD	2580	2601	0	56	25	25	2	YES	123	218	11
50	CORNING	1806	1783	0	53							
51	CORNING	1806	1783	0	53							
PARALLEL AND DIAGONAL												
26	ATLANTIC	7432	7257	45	61	20	20	2	NO		234	11
36	BLOOMFIELD	2580	2601	45	55	25	25	2	NO		220	8
42	BLOOMFIELD	2580	2601	45	58	20	20	2	YES	89	295	8
44	BLOOMFIELD	2580	2601	45	53	20	20	2	YES	55	120	7
47	CORNING	1806	1783	45	79	25	25	2	NO		269	8
82	ESSEX	916	884	60	56	20	20	2	YES	94	278	10
86	ESSEX	916	884	45	48	20	20	2	YES	94	188	4
95	FAIRFIELD	9768	9509	60	57			2	NO		272	10
101	FAIRFIELD	9768	9509	60	50			2	YES	72	263	7
105	FAIRFIELD	9768	9509	60	50			2	YES	69	282	7
116	KEOSAUQUA	1020	1066	60	47			2	NO		295	7
117	KEOSAUQUA	1020	1066	60	47			2	NO		295	7
126	LYNNVILLE	393	366	45	50			2	NO		294	7
155	SIBLEY	2815	2796	30	50			2	NO		257	10
156	SIBLEY	2815	2796	30	50			2	NO		272	10
PARALLEL ON BOTH SIDES												
4	ALBERT CITY	779	709	0	65	25	25	2	NO		288	15
9	ARNOLDS PARK			0								
10	ARNOLDS PARK			0								
13	ATLANTIC	7432	7257	0	41	20	20	2	NO		294	7
14	ATLANTIC	7432	7257	0	41	20	20	2	NO		294	7
15	ATLANTIC	7432	7257	0	41	20	20	2	NO		294	7
16	ATLANTIC	7432	7257	0	41	20	20	2	NO		282	7
22	ATLANTIC	7432	7257	0	61	20	20	2	NO		234	11
25	ATLANTIC	7432	7257	0	61	20	20	2	NO		234	11
32	BATTLE CREEK	818	743	0	57							
33	BLOOMFIELD	2580	2601	0	80	20	20	2	NO			
37	BLOOMFIELD	2580	2601	0	58	20	20	2	YES	77	258	7
59	CORYDON	1675	1591	0	54	20	20	2	YES	90	140	6
60	CORYDON	1675	1591	0	68	20	20	2	YES	94	160	6
65	CORYDON	1675	1591	0	68	20	20	2	YES	59	176	9
83	ESSEX	916	884	0	63	20	20	2	NO		88	7
85	ESSEX	916	884	0	38	20	20	2	NO	188	4	
113	HAMBURG	1248	1240	0	38			2	NO		300	4
114	HAMBURG	1248	1240	0	38			2	NO		300	4
124	KEOSAUQUA	1020	1066	0	57			2	NO		143	8

135	PLOVER	101	95	0	63	25	20	2	NO			
141	ROLAND	1035	1324	0	32			2	NO		263	7
142	ROLAND	1035	1324	0	32			2	NO		263	7
162	SIGOURNEY	2111	2209	0	58			2	YES	94	235	10
164	SIGOURNEY	2111	2209	0	25			2	NO		285	7
165	SPIRIT LAKE	3872	4261	0								
DIAGONAL ON ONE SIDE												
66	CORYDON	1675	1591	50	41	20	20	2	NO		156	5
120	KEOSAUQUA	1020	1066	45	24			1	NO		183	6
121	KEOSAUQUA	1020	1066	45	24			1	NO		183	6
122	KEOSAUQUA	1020	1066	45	24			1	NO		183	6
DIAGONAL ON BOTH SIDES												
11	ASHTON	462	461	45	62			2	NO		357	10
12	ASHTON	462	461	45	62			2	NO		332	10
18	ATLANTIC	7432	7257	45	67	20	20	2	NO		160	14
19	ATLANTIC	7432	7257	45	67	20	20	2	YES	115	217	14
20	ATLANTIC	7432	7257	45	67	20	20	2	YES	80	250	14
23	ATLANTIC	7432	7257	45	61	20	20	2	YES	23	255	11
24	ATLANTIC	7432	7257	45	61	20	20	2	NO	381	234	11
29	ATLANTIC	7432	7257	45	67	20	20	2	YES	80	249	14
30	ATLANTIC	7432	7257	45	67	20	20	2	YES	80	247	14
31	ATLANTIC	7432	7257	45	67	20	20	2	YES	75	246	14
38	BLOOMFIELD	2580	2601	45	78	20	20	2	YES	77	271	8
39	BLOOMFIELD	2580	2601	45	58	20	20	2	YES	77	271	8
40	BLOOMFIELD	2580	2601	45	58	20	20	2	NO		296	7
45	CORNING	1806	1783	45	79	25	25	2	YES	46	282	11
48	CORNING	1806	1783	45	68	25	25	2	NO		262	12
49	CORNING	1806	1783	45	68	25	25	2	YES	61	266	12
52	CORNING	1806	1783	45	53	25	25					
53	CORNING	1806	1783	45	53	25	25					
54	CORNING	1806	1783	45	68	25	25	2	NO		256	12
55	CORNING	1806	1783	45	66	25	25	2	NO		269	8
56	CORNING	1806	1783	45	79	25	25	2	NO		287	11
57	CORNING	1806	1783	45	79	25	25	2	NO		290	8
63	CORYDON	1675	1591	50	68	20	20	2	NO		134	6
81	ESSEX	916	884	60	49	20	20	2	YES	94	278	10
96	FAIRFIELD	9768	9509	60	57			2	YES	100	285	7
97	FAIRFIELD	9768	9509	60	79			3	YES	79	285	4
98	FAIRFIELD	9768	9509	60	57			2	NO		285	7
99	FAIRFIELD	9768	9509	60	63			2	NO		272	10
100	FAIRFIELD	9768	9509	60	75			3	YES	82	285	3
102	FAIRFIELD	9768	9509	60	60			2	YES	79	288	7
103	FAIRFIELD	9768	9509	60	75			3	YES	88	263	7
104	FAIRFIELD	9768	9509	60	53			2	YES	94	282	4
106	GRAETTINGER	813	900		67							
107	GRAETTINGER	813	900		67							
108	GRAETTINGER	813	900		67							
109	HAMBURG	1248	1240	45	63			2	NO		300	7
110	HAMBURG	1248	1240	45	63			2	NO		300	7
111	HAMBURG	1248	1240	45	63			2	NO		300	7
112	HAMBURG	1248	1240	45	63			2	NO		300	7
118	KEOSAUQUA	1020	1066	45	50			2	NO		119	7
119	KEOSAUQUA	1020	1066	45	50			2	NO		144	7
123	KEOSAUQUA	1020	1066	45	57			2	NO		138	7
125	LYNNVILLE	393	366	45	50			2	NO		294	7
127	MALLARD	360	298	30	61	20	30	2	NO		185	8
128	MALLARD	360	298	30	61	20	30	2	NO		169	8
129	MALLARD	360	298	30	61	20	30	2	NO		169	8
130	MILFORD	2170	2474	45	54			2	NO		272	7
131	OSCEOLA	4164	4659	45	43			2	NO		407	16
136	ROLAND	1035	1324	60	63	25	25	2	NO		550	7
137	ROLAND	1035	1324	60	63	25	25	2	NO		363	7
138	ROLAND	1035	1324	60	72	25	25	2	YES	50	375	10
139	ROLAND	1035	1324	60	72	25	25	2	NO		269	7

145	ROLFE	721	675	45	62	25	25	2	NO		263	9
146	ROLFE	721	675	45	62	25	25	2	NO		275	9
147	SHENANDOAH	5572	5546	45	58	25	25	2	NO		137	6
149	SHENANDOAH	5572	5546	45	58	25	25	2	YES	112	230	6
150	SHENANDOAH	5572	5546	45	58	25	25	2	YES	76	230	6
151	SIBLEY	2815	2796	45	50			2	YES	125	67	10
152	SIBLEY	2815	2796	30	52			2	YES	82	300	7
153	SIBLEY	2815	2796	30	52			2	YES	95	125	7
157	SIBLEY	2815	2796	30	50			2	YES	88	300	7
158	SIBLEY	2815	2796	30	50			2	NO		294	7
159	SIGOURNEY	2111	2209	45	52			2	YES	88	244	10
160	SIGOURNEY	2111	2209	45	51			2	YES	88	263	10
166	SPIRIT LAKE	3872	4261									
167	SPIRIT LAKE	3872	4261									
168	SPIRIT LAKE	3872	4261									
169	WEST BEND	862	834	45	59	25	21	2	YES	70	262	10
170	WEST BEND	862	834	45	59	25	21	2	NO		235	10
171	WEST BEND	862	834	45	59	25	21	2	YES	71	249	10
201	MALLARD	360	298	30	61	20	30	2	NO		169	8
202	MILFORD	2170	2474	45	54			2	YES	91	363	7
	GRISWOLD	1049	1039									
	PISGAH	268	316									
EITHER ON BOTH SHOULDERS												
115	HARRIS	170	200	0	28							
DIAGONAL CENTER AND PARALLEL ON SIDES												
132	OSCEOLA	4164	4659	45	72	20	20	2	NO		375	7
133	OSCEOLA	4164	4659	45	72	20	20	2	NO		375	7
134	OSCEOLA	4164	4659	45	72	20	20	2	NO		407	7
UNKNOWN												
148	SHENANDOAH	5572	5546		58	25	25	2				

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