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ENGINEERING STUDY AUTOMATING IOWA'S SPEED MONITORING PROGRAM

IOWA HIGHWAY RESEARCH BOARD HR-228 FINAL REPORT

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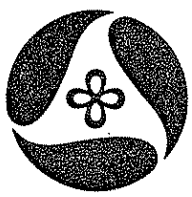

Iowa Department of Transportation

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INTRODUCTION

Excessive speed on State and County highways is recognized as a serious problem by many Iowans. Speed increases both the risk and severity of an accident. Studies conducted by the FHWA and NHTSA have concluded that if average speeds were increased by five MPH, fatalities would increase by at least 2,200 annually.

Along with the safety problems associated with excessive speed are important energy considerations. When the national speed limit was lowered to 55 MPH in 1974, a tremendous savings in fuel was realized. The estimated actual savings for automobiles amounted to 2.2 billion gallons, an average of 20.75 gallons for each of the 106 million automobiles registered in 1975.

These benefits prompted the Federal-Aid Amendment of 1974 requiring annual State enforcement certification as a prerequisite for approval of Federal-aid highway projects. In 1978, the United States D.O.T. recommended to Congress significant changes in speed limit legislation designed to increase compliance with the national speed limit. The Highway Safety Act of 1978 provides for both withholding Federal-aid highway funds and awarding incentive grants based on speed compliance data submitted annually.

To establish a valid statistical method of measuring speed limit compliance, the SPEED MONITORING PROGRAM PROCEDURAL MANUAL (SMPPM) was published by the U.S. D.O.T. in May, 1980. The SMPPM guidelines were used as the basis for this research project so that the data received could be included in Iowa's annual enforcement certification to the FHWA. The speed monitoring information can also be used by State and County officials to evaluate speed trends and the effectiveness of enforcement activities and public awareness programs.

PROBLEM STATEMENT

In the past, Iowa's speed monitoring program consisted of monitoring 14 sites on the Primary System on a quarterly basis. Radar was used to record the speeds of 400 vehicles during each session. The problems associated with this program

were as follows:

1. Inadequate representation of Secondary Road traffic - Approximately sixty percent of the highway miles currently under the 55 MPH speed limit are Secondary Roads, and at that time Secondary Roads were not included in the program.
2. High Costs due to labor intensive methods - The use of radar requires someone to be present at the monitoring site for however long it takes to record the speeds of 400 vehicles or 6 hours of traffic, whichever comes first. This is an expensive operation requiring two people for approximately 2 weeks each quarter if weather conditions are favorable.
3. Human error in high volume areas - Radar is unable to separate the speeds of two vehicles traveling close together. In high volume areas, it was impossible to obtain the speed of every vehicle passing the monitoring site. Since the speeds of some vehicles are unrecorded, a certain amount of error is introduced into the data.
4. Detection by motorists - With the advent of radar detection devices and the wide use of CB radios, it has become increasingly difficult for survey personnel to remain undetected. Once discovered, speeds at the monitoring site are no longer valid as motorists confuse the survey operation with enforcement activity.

These problems cause concern in regard to the validity of the data received. To derive any benefit from this information, there must be confidence in its accuracy.

OBJECTIVES

The objective of this study was to develop and make operational, an automatic speed monitoring system which would have flexible capabilities of collecting accurate speed data on all road systems in Iowa. With automatic equipment, the

speeds of all vehicles passing a site can be measured on a 24 hour, seven day per week basis with very little attention by survey personnel. The equipment can be used with either inductance loops imbedded in the pavement or pneumatic tube inputs. Due to cold temperatures and snow removal equipment used in the winter, permanent installations with inductance loops similar to automatic traffic recorder sites are required. The method of selecting these sites was very important to the success of the project, and was done by using a random process designed to provide a statistically acceptable level of accuracy.

Appendix A lists the monitoring sites used. They were selected as outlined in the FHWA Speed Monitoring Program Procedural Guide. Appendix A also includes an illustration showing the sites on an Iowa map.

CONSTRUCTION OF PERMANENT SITES

Permanent loops have been installed in the pavement at each of the 33 sites along with power hookups and cabinets. Due to poor pavement conditions at a few sites, new locations were chosen as close as possible to the original sites. These minor changes are reflected in the list of sites to be monitored. Appendix A)

AUTOMATIC EQUIPMENT

The automatic equipment purchased by the State of Iowa was the Luepold Stevens Print/Punch 3 in 1 Traffic Classifier.

This is a self contained unit used to count vehicles in one of seven speed categories. The unit is used with inductance loops imbedded in pavement, but will also accommodate pneumatic tube inputs. The vehicle counts are stored in electronic memory and then printed and punched on paper tape at predetermined intervals. It can be powered by a 12 volt DC battery or a 115 volt AC power pack.

Six of these units were purchased for maximum scheduling efficiency while maintaining a minimum number of back up units.

The speed categories are below 45 MPH, 46 to 50 MPH, 51 to 55 MPH, 56 to 60 MPH, 61 to 65 MPH, 66 to 70 MPH, 71 MPH and above. A computer program for data analysis

is available to analyze the data recorded during the sampling sessions. The 'raw data' on data collection forms are coded and sent to data processing for reduction into usable speed statistics.

The speed statistics obtained are average, median and 85th percentile speed along with percent exceeding 55, 60 and 65 MPH. This information is used to provide data for Iowa's annual certification of the 55 MPH speed limit enforcement. In addition, State and County officials can use this information as an administrative tool to evaluate various enforcement strategies and public awareness programs.

DATA COLLECTION

The data collection schedule was developed to account for the day of the week and each quarter of the year. At control locations one session of data was obtained each quarter. At standard locations one session of data was obtained each year. Appendix B shows how the sampling sessions were distributed.

Within each quarter, both standard and control sessions were evenly distributed by day of the week. There were a total of 72 sessions during the year of which 52 were control and 20 were standard.

A schedule was provided for the radar crew prior to any speed monitoring activity. It specified the exact locations that required sampling, the day of week and the direction of travel.

When the field crew arrived at the study location, a survey of existing road and weather conditions was made. The field technician then installed the recording device in the cabinet, entered the appropriate information on the tape and calibrated the loops. The machine was left to operate for a minimum of 24 hours on the day indicated in the schedule. For monitoring purposes the sample period is midnight to midnight.

EVALUATION

The performance of the automatic speed monitoring program was evaluated on the basis of equipment reliability, data accuracy and the operating cost compared

to the manual system. Accuracy was determined by comparing the data from the automatic equipment with that of radar and manual speed measurements at 6 low volume sites. The results of this study are shown in Table I-A through Table I-F. As shown in the tables the recorded data by the two methods did not vary to any significant amount in most cases. Speeds in categories 51-55 and 56-60 of Table I-A did show some variation. However, this probably was due more to human error than machine error. In fact, if these two categories are combined, the total difference becomes only 3 vehicles. Somewhat larger differences were found in the lowest speed categories at two locations (Tables I-B and I-C). In both cases, the machine has recorded less vehicles than actually observed. The field observers have indicated that there were several slow moving vehicles during the study period at these locations. The equipment manufacturer has also indicated that the machines would not record vehicles moving less than 10 miles per hour. These were the probably reasons for the difference in the recorded data.

Two of the most commonly used statistics of a speed study are the 85th percentile speed and the percent exceeding 55 MPH. Comparisons were made on these for the six test sites. The results as shown in Table I-A through Table I-F indicate the difference to be very insignificant.

It is quite apparent from the above analysis, that the automatic speed monitoring system is reliable in terms of data accuracy. This equipment has been in use now for over a year and has proved to be quite reliable with very little difficulty encountered.

TABLE I A

SITE NO. 3 LOCATION: I-35,N. or Iowa 175

SPEED CATEGORY (MPH)	RECORDED DATA		DIFFERENCE	
	MANUAL	MACHINE	NO.	PERCENT
45 & Below	0	0	0	0
46 - 50	5	4	1	20.0
51 - 55	59	66	7	11.9
56 - 60	78	74	4	5.1
61 - 65	8	6	2	25.0
66 - 70	0	0	0	0
71 & Above	0	0	0	0
TOTAL	150	150	0	0
85%	59.6	59.4	0.2	0.37
PERCENT EXCEED. 55	57.3	53.3	6	4.0

TABLE I B

SITE NO. 9 LOCATION: I-35, N. of Iowa 2

SPEED CATEGORY (MPH)	RECORDED DATA		DIFFERENCE	
	MANUAL	MACHINE	NO.	PERCENT
45 & Below	2	2	0	0
46 - 50	6	3	3	50.0
51 - 55	37	33	4	10.8
56 - 60	41	44	3	7.3
61 - 65	16	17	1	6.3
66 - 70	2	2	0	0
71 & Above	1	1	0	0
TOTAL	105	102	3	2.9
85%	61.5	61.9	0.4	0.71
PERCENT EXCEED. 55	57.1	62.7	4	5.6

TABLE I C

SITE NO. 11 LOCATION: U.S. 18, E. of I-35

SPEED CATEGORY (MPH)	RECORDED DATA		DIFFERENCE	
	MANUAL	MACHINE	NO.	PERCENT
45 & Below	27	17	10	37.0
46 - 50	48	50	2	4.2
51 - 55	69	65	4	5.8
56 - 60	38	39	1	2.6
61 - 65	0	2	2	100
66 - 70	0	0	0	0
71 & Above	0	0	0	0
TOTAL	182	173	9	4.9
85%	56.9	57.4	0.5	0.97
PERCENT EXCEED. 55	20.9	23.7	3	2.8

TABLE I D

SITE NO. 12 LOCATION: U.S. 34, E. of Afton

SPEED CATEGORY (MPH)	RECORDED DATA		DIFFERENCE	
	MANUAL	MACHINE	NO.	PERCENT
45 & Below	22	13	9	40.9
46 - 50	33	32	1	3.0
51 - 55	56	56	0	0
56 - 60	39	37	2	5.1
61 - 65	5	7	2	40.0
66 - 70	1	1	0	0
71 & Above	0	0	0	0
TOTAL	156	146	10	6.4
85%	58.3	58.6	0.3	0.56
PERCENT EXCEED. 55	28.8	30.8	0	2.0

TABLE I E

SITE NO. 17 LOCATION: U.S. 169, S. of Iowa 92

SPEED CATEGORY (MPH)	RECORDED DATA		DIFFERENCE	
	MANUAL	MACHINE	NO.	PERCENT
45 & Below	10	11	1	10.0
46 - 50	18	14	4	22.2
51 - 55	46	46	0	0
56 - 60	36	34	2	5.6
61 - 65	5	6	1	20.0
66 - 70	1	0	1	100
71 & Above	0	0	0	0
TOTAL	116	111	5	4.3
85%	58.9	58.9	0	0
PERCENT EXCEED. 55	36.2	36.0	2	0.2

TABLE I F

SITE NO. 22 LOCATION: U.S. 30, W. of Ames

SPEED CATEGORY (MPH)	RECORDED DATA		DIFFERENCE	
	MANUAL	MACHINE	NO.	PERCENT
45 & Below	0	0	0	0
46 - 50	6	5	1	20.0
51 - 55	46	50	4	8.7
56 - 60	66	63	3	4.5
61 - 65	19	20	1	5.3
66 - 70	2	3	1	50.0
71 & Above	0	0	0	0
TOTAL	139	141	2	1.4
85%	65.5	66.0	0.5	0.9
PERCENT EXCEED. 55	62.6	61.0	1	1.6

TABLE II

QUARTERLY SPEED MONITORING

	TIME SPENT (HOURS)	OUT OF POCKET EXPENSE
MANUAL MONITORING	168	$332
AUTOMATIC MONITORING	187	$710

Table II shows the operating cost comparison for the two systems. Travel costs associated with the above work could not be conveniently identified especially for the manual monitoring system as other field work was being performed at the same time. As shown in Table II, the out-of-pocket expense is higher for the automatic system than the manual system. This is primarily due to the federal requirement of data collection by certain days of the week for each site which necessitates a higher number of trips for the collection of data. Although the direct cost of operation is somewhat higher with the automatic system, the actual cost, when expressed in terms of cost per vehicle recorded, would be lower as we have 24 hour samples compared to 6 hour samples. Also, the statistical validity of the results obtained from the data is much better due to the larger sample size.

CONCLUSIONS

Automatic speed monitoring equipment has been in use for over a year now. Several advantages have been realized with the new system. Human error has been eliminated especially in high volume areas. Detection of survey personnel by motorists, thereby affecting the results, is no longer a problem and much better representation of true speeds is obtained due to 24 hour sampling.

Variables such as inclement weather, which could adversely affect any manual data collection effort, does not present any problem with automatic equipment. Also, in terms of safety, the hazard of being exposed to high speed, high volume traffic for long periods of time has been eliminated. The surveyor can now set the equipment in a matter of minutes, usually at an off-peak hour, and the required data can be retrieved very conveniently at a later time.

A minor limitation of automatic equipment is lack of data from very slow moving traffic. However, this has not caused any real problem and the effect on speed statistics has been very insignificant.

It could be concluded from the foregoing discussion that the Automatic Speed Monitoring Program in Iowa has been successful and needed data is being collected in the most economical manner possible.

APPENDIX A

SITES TO BE MONITORED

URBAN INTERSTATE

SITE NO.	*	LOCATION (CONTROL SITES)
1	N	I-235, south of the Guthrie Ave. Exit - Des Moines
2	S	I-380, .25 mi. south of Wilson Ave. Exit - Cedar Rapids

RURAL INTERSTATE

SITE NO.		LOCATION (CONTROL SITES)
3	S	I-35, 2 mi. north of the Iowa 175 Exit
4	E	I-80, 2 mi. west of the Shelby Exit
5	S	I-29, 4 mi. south of the Jct. of Iowa 385 and U.S. 34

SITE NO.		LOCATION (STANDARD SITES)
6	W	I-80, 2 mi. west of the Durant Exit
7	E	I-80, 2 mi. east of the Iowa 149 Exit
8	E	I-35/I-80, 1.7 mi. west of the Iowa 415 Exit
9	N	I-35, 1 mi. north of the Iowa 2 Exit

RURAL PRINCIPAL AND MINOR ARTERIALS

SITE NO.		LOCATION (CONTROL SITES)
10	N	Iowa 117, 2 mi. north of Mingo
11	W	U.S. 18, 1.5 mi. east of I-35
12	W	U.S. 34, 2.7 mi. east of Afton
13	S	Iowa 149, 1.5 mi. north of Iowa 78
14	S	Iowa 148, 4 mi. south of Anita
15	S	U.S. 59, 2.5 mi. north of U.S. 18

SITE NO.		LOCATION (STANDARD SITES)
16	S	Iowa 196, 4 mi. north of U.S. 71
17	S	U.S. 169, 3.6 mi. south of the West Jct. of U.S. 169 and Ia. 92
18	E	U.S. 18, 2 mi. east of U.S. 169 (Algona)
19	E	U.S. 18, 2.3 mi. west of West Union
20	S	Iowa 12, 8.8 mi. north of north limits of Sioux City
21	N	Iowa 143, 3.3 mi. south of the Jct. of Iowa 10
22	W	U.S. 30, 2 mi. west of Elwood Rd. Exit at Ames
23	W	Iowa 78, 1.5 mi. east of County Road W66
24	N	Iowa 110, 5 mi. north of Schaller
25	E	Iowa 273, .5 mi. west of Drakesville
26	E	Iowa 105, 1.3 mi. east of County Road S56
27	S	U.S. 218, 8 mi. north of U.S. 34

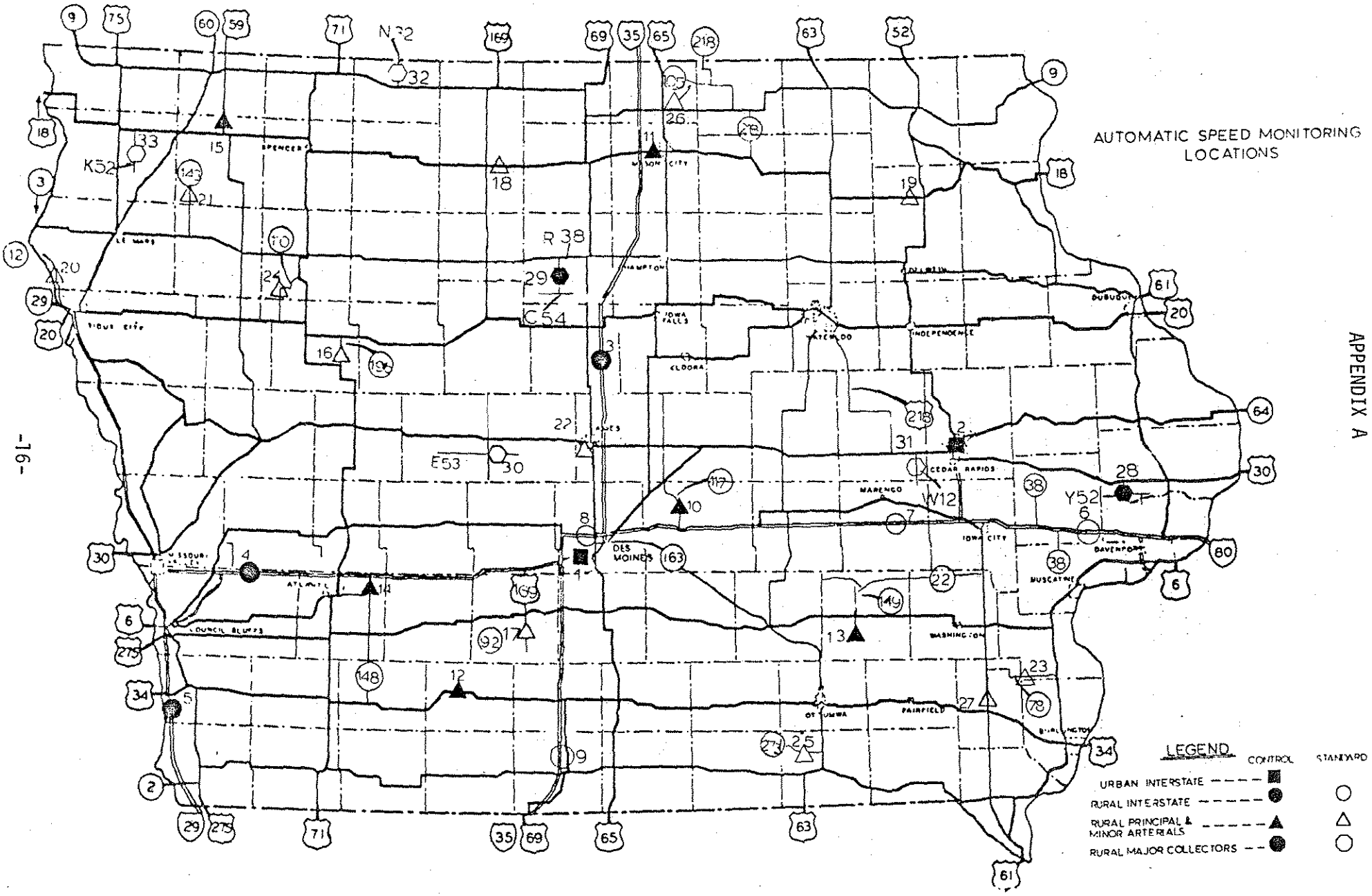
* Direction of Travel to be Monitored

APPENDIX A

RURAL MAJOR COLLECTORS

SITE NO.	*	LOCATION (CONTROL SITES)
28	S	On County Road Y52, 1.5 mi. south of U.S. 30 - Clinton Co.
29	S	On County Road R38, 2 mi. north of R38 and C54 - Wright Co.

SITE NO.		LOCATION (STANDARD SITES)
30	E	On County Road E53, 1.9 mi. east of Iowa 25 - Greene Co.
31	S	On County Road W12, .5 mi. north of W12 and E66 - Benton Co.
32	N	On County Road N32, 1.7 mi. north of Iowa 9 - Emmet Co.
33	S	On County Road K52, 1.7 mi. south of U.S. 18 - Sioux Co.


AUTOMATIC SPEED MONITORING LOCATIONS
LEGEND
CONTROL
STANDARD
URBAN INTERSTATE
RURAL INTERSTATE
RURAL PRINCIPAL & MINOR ARTERIALS
RURAL MAJOR COLLECTORS
K52
N32
R38
C54
E53
W12
Y52
DES MOINES
CEDAR RAPIDS
IOWA CITY
DAVENPORT
COUNCIL BLUFFS
SIOUX CITY
MASON CITY
FORT DODGE
OTTUMWA
FAIRFIELD
MUSCATINE
MARENGO
INDEPENDENCE
HAMPTON
ATLANTIC

APPENDIX A

SCHEDULE FOR DATA COLLECTION DURING FISCAL YEAR 1983

	4TH QUARTER 1982		1ST QUARTER 1983		2ND QUARTER 1983		3RD QUARTER 1983	
	STANDARD	CONTROL	STANDARD	CONTROL	STANDARD	CONTROL	STANDARD	CONTROL
MONDAY	(S) 17	(N) (S) 1,29		(S) (S) 2,15	(N) 32	(S) (S) 15, 2	(E) 25	(S) (S) 14,15
TUESDAY	(E) 30	(S) (S) 14,15	(S) 16	(S) 28		(W) (S) 11,13	(S) 27	(W) (E) 11, 4
WEDNESDAY		(E) 4	(S) 33	(S) (S) 13,14	(E) 18	(S) (S) 28,29	(W) 23	(S) (S) 3,29
THURSDAY		(S) (W) 5,11	(N) 21	(N) (N) 1,10	(E) 26	(N) (S) 1, 3	(W) 6	(S) (S) 5,13
FRIDAY	(N) 9	(W) (S) 12, 2	(S) 20	(W) (S) 12, 5	(E) 19	(S) (E) 5, 4		(S) 28
SATURDAY	(E) 8	(N) (S) 10,28	(N) 24	(W) (S) 11, 3		(N) (W) 10,12		(W) (S) 12, 2
SUNDAY	(W) 22	(S) (S) 3,13		(E) (S) 4,29	(S) 31	(S) 14	(E) 7	(N) (N) 10, 1
TOTAL	5	13	5	13	5	13	5	13

(N) DIRECTION OF TRAVEL TO MONITOR