MLR 81 4

RESEARCH SECTION
Office of Materials
Iowa Dept. of Transportation

A REVIEW OF THE FRICTIONAL CLASSIFICATION OF IOWA AGGREGATES

by

Bernard C. Brown
Testing Engineer

Office of Materials

Iowa Department of Transportation

March 1981

A REVIEW OF THE FRICTIONAL CLASSIFICATION OF IOWA AGGREGATES

Introduction

The Iowa D.O.T. has a classification system designed to rate coarse aggregates as to their skid resistant characteristics. Aggregates have been classified into five functional types, with a Type 1 being the most skid resistant. A complete description of the classification system can be found in the Office of Materials Instructional Memorandum T-203. Due to the variability of ledges within any given quarry the classification of individual ledges becomes necessary. The type of aggregate is then specified for each asphaltic concrete surface course.

As various aggregates become used in a.c. paving, there is a continuing process of evaluating the frictional properties of the pavement surface. It is primarily through an effort of this sort that information on aggregate sources and individual ledges becomes more refined. This study is being conducted to provide that needed up-to-date information that can be used to monitor the aggregate classification system.

Project Scope

All asphaltic concrete surface courses placed from 1975 through 1979 were reviewed. Notations were made of mix size, coarse aggregate, aggregate type, friction numbers, traffic volumes, and cumulative vehicle passes. One-hundred sixty projects are included in this study as detailed in Appendix A.

Eighteen of the projects have a sand-asphalt surface course and an additional seventeen projects have a sprinkle treatment aggregate applied. These types of surfaces are being investigated independently and, therefore, will not be evaluated in this study.

All friction testing was done with a two-wheel trailer in accordance with ASTM E274. Friction number (FN) is being used interchangeably with the more common terminology of skid number (SN).

Method of Analysis

The function of the aggregate in an a.c. surface course, among other things, is to provide sufficient microtexture that results in acceptable friction properties through the design life of the pavement. It is not acceptable to utilize polish susceptible aggregates that would result in a slippery pavement after 5 years, if the design life of that pavement was 10 years.

With the advent of high inflation and reduced revenues it becomes readily apparent that there are not sufficient funds available to resurface routinely at less than the full design life of the pavement. In the past, the design life of an a.c. resurfacing was considered to be 8 years. Currently, it is anticipated that a 3" a.c. resurfacing must serve for a 10-15 year interval.

Obviously, there will be twice the polishing action taking place on pavement that carries 3000 vehicles per day as the pavement that carries 1500 vehicles per day. The foregoing

statement assumes equivalent percentages of trucks and an equivalent number of lanes.

Assuming a 12-year design life, an acceptable friction level must be maintained for the following number of vehicle passes for various traffic categories:

Traffic Category Code	Traffic Category VPD	Avg. Volume VPD	Calculated Vehicle Passes (millions)
1	0- 499	250	$\frac{365 \times 250 \times 12}{2 \times 1{,}000{,}000} = 0.5$
2	500- 999	750	$\frac{365 \times 750 \times 12}{2 \times 1{,}000{,}000} = 1.6$
3	1000-1999	1500	$\frac{365 \times 1500 \times 12}{2 \times 1{,}000{,}000} = 3.3$
4	2000-5000	3500	$\frac{365 \times 3500 \times 12}{2 \times 1{,}000{,}000} = 7.7$
5	5000 +	Use Actual Volume	

On 4 lane roads assume 80% of the vehicles utilize the traffic lane and 20% utilize the passing lane. For example, the total vehicle passes for a traffic volume of 8,000 VPD with a 12-year design life would be:

$$\frac{365 \times 8000 \times 12}{2 \times 1{,}000{,}000} \times .80 = 14.0 \text{ million vehicle passes.}$$

The appendix shows the calculated vehicle passes from the time of construction to the time of the latest friction test.

If an aggregate has a consistently high level of performance for a few years at a high traffic volume, confidence may be increased that it will perform adequately for the entire

design life on a road of lower traffic volume. As an example, if an acceptable friction number is maintained for 5 years on a road with 3500 VPD it will have had the polishing action of 3.2 million vehicle passes which is very close to the 3.3 million vehicle passes design life of the pavement carrying 1500 VPD.

Results and Discussion

All data from this study is shown in Appendix A. As was mentioned previously, the projects that have sand asphalt surface courses or have been treated with a sprinkle treatment will not be used in comparing aggregate performance.

Direct comparisons of aggregate performance is difficult due to the fact that the pavements are relatively young and traffic volumes are variable. If, however, one was to assume that a given FN is desirable for the deisgn life of the pavements general observations can be made. For the purposes of discussion a FN=35 or greater will be considered desirable.

The general level of performance is very good; however, there are instances where the data suggests an investigation of aggregate source classifications is warranted. The following should be reviewed:

1. Johnson FN-218-4(18) has a FN of 30 after 3 years and 1.9 MVP. The aggregate is Type 4 from the Conklin quarry.
2. Polk MP-1318-69 has a FN of 28 after 3 years and

4.0 MVP. The aggregate is Type 4 from the Ferguson quarry. There is conflicting data on this source as evidenced by the higher friction numbers on other projects.

We intend to continue to update the information yearly on these projects to assist in the evaluation of aggregate sources.

MVP = Million Vehicle Passes
TVC = Traffic Volume Category
1 = 0 - 499 VPD 3 = 1000 - 1999 VPD
2 = 500 - 999 VPD 4 = 2000 - 4999 VPD
5 = 5000 + VPD

APPENDIX A

MVP	TVC	Road No.	Year Built	County and Project	Year Tested	Fric. No.	Mix Size(")	Course Aggregate	Agg. Type
0.6	4	Ia 92	1978	Adair MP-4609-69	79	41	3/8	Asphalt Sand Peters-W. Des M.	-
6.7	5	I 80	1976	Adair I-RFI-80-2(57)	80	38	1/2	35% Quartzite 35% Cr. gravel-Adel	2 4
0.3	3	Ia 25	1977	Adair FN-25-3(6)	78	42	1/2	60% Lst. Mt. Etna Qr. Adams Co.	4
0.3	3	Ia 25	1978	Adair MP-4609-69-D4	79	58	3/8	Asphalt Sand Peters-W. Des M.	-
1.4	3	Ia 34	1975	Adams MP-4371-69-02	80	50	3/8	Asphalt Sand Shenandoah Pit-Page	-
0.3	3	Ia 9	1979	Allamakee FN-9-9(18)	80	40	1/2	60% Lst. Churchtown Qr. Allamakee Co.	4
0.6	4	Ia 2	1977	Appanoose MP-5733-69-D4	78	57	3/8	45% Lst. Nedrow-Van Buren 20% Haydite	4 3
0.3	3	Ia 2	1979	Appanoose FN-2-7(13)-21-04	80	42	3/8	45% Lemley East-Appanoose 20% Haydite	5 3
3.2	4	Ia 5	1975	Appanoose FN-5-1(10)-21-04	80	45	3/8	50% Lemley East-Appanoose 20% Haydite	5 3
2.6	4	US 71	1975	Audubon MP-4369-69-05	79	58	3/8	Asphalt-Sand Oakfield Twnship Pit	-
0.6	4	US 71	1977	Audubon FN-21-4(9)--21-5	78	47	3/8	Asphalt-Sand Brayton Pit	-
2.6	4	US 30	1976	Benton FN-30-6(30)	80	48	1/2	70% Lst. Garrison Qr. Benton Co.	4
4.8	5	US 30	1976	Benton RF-30-6(32)	80	40	1/2	70% Lst. Garrison Qr. Benton Co.	4
0.3	3	Ia 101	1979	Benton FN-101-1(12)	80	44	1/2	60% Lst. Vinton Qr. Benton Co.	4
0.3	3	Ia 200	1977	Benton TQFS-200-0(1)	78	46	1/2	65% Lst. Garrison Qr. Benton Co.	4
2.6	4	US 218	1976	Benton FN-218-6(18)	80	43	1/2	70% Lst. Garrison Qr. Benton Co.	4
0.6	4	US 218	1979	Benton FN-218-6(20)	80	42	1/2	65% Lst. Garrison Qr. Benton Co.	4 *
0.1	1	Ia 198	1976	Benton FN-198-1(1)	77	50	1/2	70% Lst. Garrison Qr. Benton Co.	4
0.3	3	Ia 279	1978	Benton P-279-0(2)	79	55	1/2	65% Lst. Garrison Qr. Benton Co.	4
0.3	3	Ia 175	1978	Black Hawk F-175-9(6)	79	50	1/2	75% Lst. Waterloo So. Qr. Black Hawk Co.	4
0.6	4	Ia 58	1979	Black Hawk FN-58-1(16)	80	52	1/2	50% Lst. Pints Qr. Black Hawk Co.	4
1.1	5	US 218	1979	Black Hawk FN-218-7(39)	80	47	1/2	65% Lst. Pints Qr. Black Hawk Co.	4 *
0.3	3	Ia 297	1978	Black Hawk FN-297-1(2)	79	53	1/2	65% Lst. Pints Qr. Black Hawk Co.	4
0.3	3	Ia 89	1978	Boone FN-89-2(2)	79	50	1/2	30% Cr. gravel-Hallett Pit Story Co.	4 *
1.1	3	Ia 144	1976	Boone RF-144-2(2)	80	47	1/2	60% Cr. gravel-Messerschmidt Pit Dallas Co.	4
0.6	4	Ia 3	1979	Bremer FN-3-6(21)	80	48	1/2	65% Lst. Pints Qr. Black Hawk Co.	4 *
4.9	5	US 218	1976	Bremer MP-2245-69	80	49	1/2	20% Lst. Chips-Waterloo South 45% Lst. Pints Qr.	4 4
0.1	2	Ia 336	1976	Buchanan RF-336-1(1)	77	49	1/2	65% Lst. Jesup Qr. Buchanan Co.	4
3.2	5	US 20	1977	Buchanan FN-20-7(10)	80	48	1/2	65% Lst. Jesup Qr. Buchanan Co.	4 *
2.6	4	Ia 150	1976	Buchanan RF-150-5(11)	80	46	1/2	65% Lst. Jesup Qr. Buchanan Co.	4
0.2	2	Ia 187	1978	Buchanan FN-187-1(6)	79	52	1/2	50% Lst.Weston/Lamont Qr. Buchanan Co.	4
0.6	4	US 71	1978	Buena Vista MP-3889	79	37	3/8	Asphalt Sand Sacton Pit - Sac Co.	-
0.6	4	US 20	1978	Butler FN-20-5(20)	79	54	1/2	65% Lst. Pints Qr. Black Hawk Co.	4
2.6	4	US 20	1976	Calhoun MP-3744	80	44	3/8	65% Lst.-Ft. Dodge Mine Webster Co.	4
0.6	4	US 30	1978	Carroll MP-3891	79	44	3/8	65% Lst.-Gilmore City Pocahontas Co.	4
0.3	3	US 71	1977	Carroll FN-71-5(12)	78	54	3/8	Asphalt Sand-Brayton Pit Audubon Co.	-
0.5	3	Ia 83	1975	Cass FN-83-2(8)	77	48	1/2	50% Lst. Atlantic Qr. Cass Co.	4
4.7	5	I 80	1977	Cass I-IR-80-2(64)	80	51	1/2	35% Quartzite 35% Cr. gravel-Adel	2 4
9.9	5	I 80	1976	Cedar I-RF-80-7(34)	80	49	1/2	35% Quartzite 35% Lst. Moscow Qr.	2 4
0.6	4	Ia 38	1979	Cedar FN-38-2(15)	80	47	1/2	65% Lst. Lowden Qr. Cedar Co.	4
1.3	4	Ia 38	1977	Cedar FN-38-2(11)	79	55	1/2	65% Lst.-Ballou Qr. Jones Co.	4 *

	MVP	TVC	Road No.	Year Built	County and Project	Year Tested	Fric. No.	Mix Size(")	Coarse Aggregate	Agg. Type
	2.9	5	US 18	1977	Cerro Gordo FN-18-5(27)	80	48	1/2	65% Lst.-Quimby Qr. Cerro Gordo Co.	4 *
	1.3	4	US 65	1977	Cerro Gordo FN-65-8(17)	79	47	1/2	65% Lst. Quimby Qr. Cerro Gordo Co.	4
	1.3	4	US 65	1977	Cerro Gordo FN-65-8(17)	79	46	1/2	65% Lst. Quimby Qr. Cerro Gordo Co.	4
	2.2	5	US 65	1977	Cerro Gordo FN-65-8(17)	81 79	42 43	1/2	65% Lst. Quimby Qr. Cerro Gordo Co.	4
	1.9	4	US 65	1977	Cerro Gordo FN-65-8(16)	80	46	1/2	65% Lst. Quimby Qr. Cerro Gordo Co.	4
	0.3	3	Ia 3	1979	Cherokee EACF-3-2(5)	80	38	1/2	30% Cr. gravel 23-92-40 Cherokee	Not shown
	0.9	5	I 35	1979	Clarke I-IR-35-2(157)	81 80	49 46	1/2	65% Lst.-Ferguson Marshall Co.	4 *
	0.3	3	US 69	1977	Clarke FN-69-2(6)	78	52	1/2	70% Lst.-Osceola Qr. Clarke Co.	4
	0.2	2	Ia 10	1979	Clay FN-10-3(6)	80	47	1/2	30% Cr. gravel-Railroad Pit Buena Vista Co.	4
Co. Rd.	0.1	1	Ia 374	1976	Clay FN-374-1(14)	77	47	3/8	30% Cr. gravel-Cornell Pit Clay Co.	4
	2.6	4	US 71	1976	Clay MP-3743	80	54	3/8	Asphalt Sand Spencer Pit	-
	0.3	3	Ia 13	1979	Clayton F-13-3(22)	80	49	1/2	65% Lst. Bente Qr. Clayton Co.	4
	0.1	1	Ia 340	1976	Clayton FN-340-1(1)	81 77	42 49	3/4	60% Lst.-Oswald Qr. Wisconsin	5
	0.3	3	US 59	1979	Crawford MP-3936	80	43	3/8	65% Lst.-Gilmore City Pocahontas Co.	4 *
	0.3	3	US 169	1979	Dallas FN-169-4(25)	80	48	3/8	Asphalt Sand Sand - Adel Pit	-
	0.2	2	Ia 202	1979	Davis FN-202-1(1)	80	50	1/2	50% Lemley East 20% Haydite	5 3
	0.1	1	Ia 957	1977	Davis P-20(15)	78	50	1/2	65% Lst. Gardner Qr. Van Buren Co.	4
	0.1	1	Ia 957	1977	Davis P-2-0(15)	78	43	1/2	65% Lst. Gardner Qr. Van Buren Co.	4
	0.3	3	Ia 3	1979	Delaware FN-3-8(10)	80	54	1/2	70% Lst.-Logan Qr. Delaware Co.	4
	0.5	4	US 20	1978	Delaware FN-20-8(17)	79	47	1/2	70% Lst. White Qr. Delaware Co.	5
	2.2	5	US 61	1977	Des Moines MP-5731	79	50	3/8	10% Lst. Comanche-Van Buren 55% Lst.-Hawkeye Qr.-Lee Co.	4 4
	0.2	2	US 71	1978	Dickinson TQF-71-9(13)	81 79	54 53	1/2	30% Cr. gravel 28-100-34 Emmet Co.	Not shown
	1.1	3	Ia 966	1976	Dubuque MP-6563	80	46	3/8	65% Lst.-Dubuque Stone Dubuque Co.	4
	0.3	3	Ia 136	1979	Dubuque FN-136-3(5)	80	50	3/4	70% Lst.-Hermson Qr. Dubuque Co.	4
	0.2	2	Ia 15	1975	Emmet FN-15-4(4)	81 77	48 56	3/4	30% Lst. Gilmore City Pocahontas Co.	5
	0.3	3	US 18	1976	Fayette FM-18-8(14)	81 77	50 54	1/2	65% Lst. Patterson Qr. Fayette Co.	4
	0.1	1	Ia 193	1978	Fayette P-193-0(2)	79	57	1/2	50% Lst.-Miller Qr. Fayette Co.	4
	0.6	4	US 18	1979	Floyd FN-18-6(14)	80	54	1/2	65% Lst.-Carlson Qr. Floyd Co.	4 *
	0.6	4	US 218	1978	Floyd TQF-218-9(26)	79	59	1/2	65% Lst. Carlson Qr. Floyd Co.	4
	2.6	4	Ia 3	1976	Franklin FN-3-5(26)	80	52	1/2	65% Lst. Dows Qr. Franklin Co.	4
	0.6	4	US 65	1979	Franklin FN-65-7(7)	80	48	1/2	65% Lst. Lillybridge Qr. Cerro Gordo Co.	5 *
Co. Rd.	0.6	3	Ia 263	1976	Franklin FN-263-1(2)	78	47	1/2	65% Lst.-Dows Qr. Franklin Co.	4
Co. Rd.	0.1	1	Ia 971	1976	Fremont FN-971-1(1)	77	48	1/2	50% Lst. Malvern Qr. Mills Co.	5
	0.3	3	Ia 144	1976	Greene RF-144-3(4)	81 77	47 49	1/2	60% gravel-Dallas Co. 40% Lst.-N. River Qr.-Madison	4 5
	0.2	2	Ia 144	1978	Greene P-144-0(5)	79	51	3/4	30% Lst. Ft. Dodge Mine Webster Co.	4
	0.3	3	Ia 175	1978	Grundy F-175-9(6)	79	49	1/2	75% Lst. Waterloo S. Qr. Black Hawk Co.	4
	0.6	4	US 20	1978	Grundy FN-20-6(22)	79	49	1/2	75% Lst. Waterloo S. Qr. Black Hawk Co.	4
	0.6	4	Ia 14	1979	Grundy MP-1446-69	80	51	3/8	65% Lst. LeGrand Qr. Marshall Co. (Hot Scarify)	4 *
	0.2	2	Ia 175	1977	Hamilton F-175-6(12)	78	49	1/2	15% Lst.-Alden Qr. 15% Lst.-Moberly Mine	4 4
	0.3	3	Ia 39	1978	Crawford FN-39-1(3)	79	49	3/8	50% Cr. gravel-Sacton Pit Sac Co.	4

MVP	TVC	Road No.	Year Built	County and Project	Year Tested	Fric. No.	Mix Size(")	Coarse Aggregate	Agg. Type
0.3	3	US 69	1978	Hamilton MP-1297	79	57	3/8	30% Cr. gravel-Meineke Pit Wright Co.	4
0.6	4	US 18	1977	Hancock MP-2315-69	81 78	52 50	3/8	65% Lst.-Hodges Qr. Humboldt Co.	5
0.2	2	Ia 175	1977	Hardin F-175-7(12)	78	47	1/2	15% Lst.-Alden Qr. 15% Moberly Mine	4 4
0.6	3	Ia 175	1977	Hardin MP-1295	79	52	3/8	30% Cr. gravel-Meineke Pit Wright Co.	4
2.6	4	US 30	1975	Harrison MP-3678	79	47	3/8	Asphalt Sand Sand-Woodbine-Harrison Co.	-
0.1	1	Ia 44	1978	Harrison FN-44-(22)	80	48	1/2	60% Lst.-Logan Qr. Harrison Co.	5
0.6	4	US 20	1979	Ida FN-20-2(13)	80	40	1/2	65% Cr. Lst.-Gilmore City Pocahontas Co.	4
0.2	2	Ia 62	1975	Jackson FN-62-1(4)	81 77	52 48	3/8	65% Lst.-Brown Qr. Dubuque Co.	3
0.6	3	Ia 225	1975	Jasper FN-225-1(1)	81 77	52 51	1/2	60% Lst.-New Sharon Qr. Poweshiek Co.	5
0.6	3	US 6	1975	Jasper FN-6-4(39)	81 77	52 51	1/2	70% Lst.-Ferguson Qr. Marshall Co.	4
0.3	3	US 65	1978	Jasper FN-65-4(23)	79	49	1/2	55% Cr. Lst.-Malcom Mine Poweshiek Co.	4 *
0.3	3	Ia 22	1977	Johnson F-22-3(3)	78	51	1/2	65% Lst.-Moscow Qr. Muscatine Co.	4
1.9	4	US 218	1977	Johnson FN-218-4(18)	81 80	32 30	1/2	70% Lst.-Conklin Qr. Johnson Quarry	4
2.6	4	Ia 1	1976	Jones FN-1-6(4)	80	46	1/2	70% Lst. Anamosa Qr. Jones Co.	4
1.4	3	Ia 38	1975	Jones FN-38-3(20)	80	45	1/2	70% Lst. Monte Qr. Jones Co.	4
2.6	4	US 63	1976	Keokuk FN-63-3(17)	80	42	1/2	70% Lst. Ollie Qr. Keokuk Co.	4
0.3	3	Ia 149	1976	Keokuk RF-149-1(10)	81 77	48 51	1/2	70% Lst. Ollie Qr. Keokuk Co.	4
0.3	3	US 169	1976	Kossuth MP-2246	81 77	53 53	3/8	Asphalt Sand Sand-Emmetsburg-Palo Alto Co.	-
0.2	2	US 169	1977	Kossuth FN-169-8(17)	79	37	1/2	70% Lst.-Northrop Qr. Humboldt	Combination 4 & 5
0.3	3	Ia 103	1977	Lee FN-103-1(3)	78	55	1/2	70% Lst.-Hawkeye Qr. Lee Co.	4
0.2	2	Ia 16	1976	Lee RF-16-4(3)	81 77	51 49	1/2	70% Lst.-Hawkeye Qr. Lee Co.	4
Co. Rd. 0.3	3	Ia 88	1976	Lee RF-88-1(2)	77	49	1/2	70% Lst.-Hawkeye Qr. Lee Co.	4
2.2	5	US 61	1977	Lee MP-5732	81 79	49	3/8	65% Lst.-Hawkeye Qr. Lee Co.	4
5.6	5	US 30	1976	Linn RF-970-2(2)	81 79	38 40	1/2	65% Lst.-S. Cedar Rapids Qr. Linn Co.	4
1.1	5	Ia 150	1977	Linn FN-150-1(18)	81 78	41 46	1/2	65% Lst.-Robins Qr. Linn Co.	4
0.4	2	Ia 99	1977	Louisa MP-5729	80	55	3/8	60% Lst.-Mediapolis Qr. Des Moines Co.	4
2.6	4	US 34	1975	Lucas HHS-34-6(16)	79	48	1/2	50% Lst.-Lemley East 20% Haydite	5 3
0.3	3	US 75	1976	Lyon MP-3746	81 77	50 51	3/8	Asphalt Sand Sioux Center Pit	-
Co. Rd. 0.2	2	Ia 400	1978	Madison P-400-01(1)	79	46	1/2	60% Lst.-Osceola Qr. Clarke Co.	4
3.2	4	Ia 92	1975	Mahaska FN-92-7(17)	80	43	1/2	55% Lst.-Langstrat-Mahaska 10% Keswick-Keokuk	5 4
0.6	4	Ia 14	1978	Marion HHS-14-3(11)	81 79	46 48	1/2	60% Lst. Ferguson Qr. Marshall Co.	4
0.4	2	Ia 233	1977	Marshall F-233-1(2)	80	39	3/4	55% Lst.-LeGrand Qr. Marshall Co.	4
0.6	3	Ia 96	1975	Marshall FN-96-1(1)	81 77	53 56	3/4	50% Lst.-Legrand Qr. Marshall Co.	4
0.7	4	Ia 14	1978	Marshall MP-1403	79	52	3/8	65% Lst.-Ferguson Qr. Marshall Co.	4
0.3	3	Ia 146	1976	Marshall FN-146-4(5)	81 77	51 48	3/4	55% Lst.-LeGrand Qr. Marshall Co.	4
0.8	3	Ia 949	1977	Mills P-949-0(1)	80	45	3/8	Asphalt Sand Shenandoah Pit-Page Co.	-
Co. Rd. 0.1	1	Ia 177	1978	Mitchell P-177-0(2)	79	60	1/2	35% Lst. Cedar Qr.-Mitchell 15% gravel-Osage Pit-Mitchell	4 4
0.3	3	US 218	1978	Mitchell TQF-218-9	79	58	1/2	65% Lst. Bruening, Carlson Qr. Floyd Co.	4
0.3	3	Ia 22	1977	Muscatine F-22-4(24)	78	47	1/2	65% Lst.-Moscow Qr. Muscatine Co.	4
0.3	3	US 69	1978	Hancock FN-69-8(6)	79	47	1/2	75% Lst. Garner Qr. Hancock Co.	4

MVP	TVC	Road No.	Year Built	County and Project	Year Tested	Fric. No.	Mix Size(")	Coarse Aggregate	Agg. Type
1.4	3	US 6	1975	Muscatine HHS-6-8(11)	80	46	3/8	65% Lst.-Moscow Qr. Muscatine Co.	4
0.2	2	US 59	1978	O'Brien FN-59-8(12)	79	43	1/2	30% Cr. gravel-Kappes Pit Osceola Co.	4
1.1	3	Ia 60	1976	Osceola RF-60-4(11)	80	53	3/8	30% Cr. gravel-Milford Pit Dickinson Co.	4
0.2	2	US 59	1978	Osceola FN-59-9(10)	79	46	1/2	30% Cr. gravel-Kappes Pit Osceola Co.	4
0.3	3	Ia 4	1976	Palo Alto FN-4-5(13)	81 77	50 53	3/8	30% Cr. gravel-Boggess Pit Palo Alto Co.	3
0.3	3	Ia 4	1978	Palo Alto FN-4-5(16)	79	50	1/2	30% Cr. gravel-Maudlin Palo Alto Co.	4
4.0	5	Ia 401	1977	Polk MP-1318-69	81 80	50 28	3/8	65% Lst.-Ferguson Qr. Marshall Co.	4
6.8	5	US 69	1977	Polk MP-1319-69	81 80	37 35	1/2	65% Lst.-Ferguson Qr. Marshall Co.	4 *
3.9	5	Ia 28	1977	Polk MP-5718-69	80	41	3/8	Sand Asphalt White Pit-Polk	-
4.5	5	I 29	1977	Pottawattamie I-IR-29-4(19)	81 80	55 55	1/2	35% Quartzite 35% Cr. gravel-Hartford-Nebr.	2 4
4.3	5	I 29	1977	Pottawattamie I-IR-29-4(19)	81 80	55 55	1/2	35% Quartzite 35% Cr. gravel-Hartford-Nebr.	2 4
0.5	4	Ia 183	1977	Pottawattamie P-183-0(9)	81 78	51 44	1/2	50% Lst.-Crescent Qr. Pottawattamie Co.	5
0.6	3	US 59	1977	Pottawattamie MP-4531	79	59	1/2	60% Lst.-Atlantic Qr. Cass Co.	4 *
0.6	3	US 6	1975	Pottawattamie FN-601(34)	77	54	1/2	50% Lst.-Macedonia Qr. Pottawattamie Co.	4
0.6	3	US 6	1975	Pottawattamie FN-6-1(35)	77	55	1/2	50% Lst.-Macedonia Qr. Pottawattamie Co.	4
3.2	4	US 6	1975	Poweshiek FN-605(3)	80	45	1/2	70% Lst.-Ferguson Qr. Marshall Co.	4
0.5	2	Ia 25	1976	Ringgold FN-25-1(7)	80	39	1/2	60% Lst.-Corning Qr. Adams Co.	4
0.2	2	US 169	1978	Ringgold MP-4608-69	79	51	3/8	Sand Asphalt Cainsville, Mo.	-
0.3	3	US 20	1979	Sac FN-20-2(13)	80	40	1/2	65% Lst.-Gilmore City Pocahontas Co.	4
0.6	4	US 20	1977	Sac MP-3810-69	81 78	50 51	3/8	Asphalt Sand Hallett-Sac Co.	-
0.5	3	US 71	1977	Sac MP-3812-69	79	47	3/8	Asphalt Sand Hallett-Sac Co.	-
5.5	5	US 61	1975	Scott FN-61-5(33)	81 79	36 41	1/2	70% Lst.-Leclaire Qr. Scott Co.	4
1.3	4	US 18	1977	Sioux MP-3813-69	79	52	3/8	Sand Asphalt Hallett-Osceola Co.	-
0.3	3	Ia 210	1978	Story FN-89-3(1)	79	49	1/2	35% Cr. gravel-Hallett Pit Story Co.	4 *
0.3	3	US 65	1978	Story FN-65-5(12)	79	50	1/2	65% Lst.-Alden Qr. Hardin Co.	4
0.6	3	Ia 96	1975	Tama FN-96-2(3)	81 77	46 47	3/4	50% Lst. LeGrand Qr. Marshall Co.	4
0.2	2	Ia 25	1976	Union FN-25-2(11)	81 77	52 49	1/2	60% Lst.-Corning Qr. Adams Co.	4
0.2	2	Ia 25	1977	Union FN-25-1(9)	81 78	52 52	1/2	60% Lst.-Mt. Etna Qr. Adams Co.	4
0.3	3	Ia 1	1977	Van Buren FN-1-1(7)	78	52	1/2	65% Lst.-Douds Mine Van Buren Co.	4
1.4	3	Ia 23	1975	Wapello HHS-23-1(2)	80	46	1/2	65% Lst.-Gardner Qr. Van Buren Co.	4
0.2	2	Ia 207	1978	Warren FN-156-1(1)	79	49	1/2	60% Lst.-Osceola Qr. Warren Co.	4
0.2	2	US 69	1977	Warren FN-69-3(15)	78	47	3/8	Asphalt Sand Thayer Pit-Union Co.	-
0.6	4	US 218	1978	Washington FN-218-3(10)	79	42	1/2	60% Lst.-Columbus Jct. Qr. Louisa Co.	4 *
0.2	2	Ia 144	1978	Webster P-144-9(5)	79	54	1/2	30% Cr. Gravel-Laube Pit Boone Co.	4
1.0	4	US 20	1977	Webster FN-20-3(30)	81 79	44 38	1/2	65% Lst.-Ft. Dodge Mine Webster Co.	4
1.3	4	US 69	1977	Winnebago FN-69-9(13)	79	44	1/2	70% Lst.-Wepking Qr. Cerro Gordo Co.	4
0.6	3	US 69	1977	Winnebago FN-69-9(13)	79	49	1/2	70% Lst.-Wepking Qr. Cerro Gordo Co.	4
0.8	3	US 69	1976	Winnebago MP-244-69	79	48	3/8	65% Lst.-Fertile Qr. Worth Co.	4
0.3	3	Ia 3	1976	Wright FN-3-4(13)	81 77	55 59	1/2	65% Lst.-Dows Qr. Franklin Co.	4