RESEARCH SECTION Office of Materials Towa Dept. of Transportation

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#### DEPARTMENT OF TRANSPORTATION

DIVISION OF HIGHWAYS

OFFICE OF MATERIALS

Geology Section

### Final Report R-264

## A LABORATORY INVESTIGATION OF AN ACCELERATED POLISHING METHOD FOR DETERMINING THE SKID RESISTANCE POTENTIAL OF AGGREGATES

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#### ABSTRACT

An initial feasibility study indicated that the "Purdue Accelerated Polishing Method" gave repeatable results when testing the skid resistance of laboratory specimens. The results also showed a rough correlation with the field performance of the same aggregate sources. The research was then expanded to include all available asphalt aggregates. The results of the expanded study indicated that the method is not presently capable of developing and measuring the full skid potential of the various aggregate sources. Further research in the area of polishing times and/or pressures is needed.

#### INTRODUCTION

Coarse aggregates contribute significantly to the skid resistant properties of an asphalt surface in several ways. For example, fine grained aggregates can polish easily under traffic, and thus possess poor skid resistant properties, while coarser grained aggregates polish less, thus providing a more skid resistant surface. Also, the use of aggregate sources containing particles of varying degrees of hardness or wearability can produce a pavement surface possessing good skid properties due to the macrotexture developed.

The field determination of skid numbers is a necessary operation from many standpoints, but when trying to assess an aggregate's skid characteristics it offers several limitations, i.e., the aggregate may not have been used in a project; the time required to obtain and analyze test data; construction variables; and post construction variables, such as daily traffic. Thus, a laboratory method is needed that can simulate the polishing action of traffic while holding the other variables to a minimum. If such a method can be developed, then skid numbers determined on laboratory specimens could be used to categorize the various aggregates as to their potential skid resistant properties when used in asphaltic construction.

#### PURPOSE AND SCOPE

The purpose of this investigation was to evaluate the "Purdue Accelerated Polishing Method" as a laboratory method for duplicating field conditions. The investigation was conducted on an open ended basis so that it could be terminated or expanded at any time. The initial phase was to determine the polishing characteristics of ten aggregate sources and correlate these charactieristics to field performance. If a significant ocrrelation was found, the investigation was to continue until all major geologic types or sources were evaluated. The research proposal for the project is found in Appenix A.

When this study began, no standardized laboratory procedures existed in the literature for the various aspects. Thus, much of the early part of the study was involved with developing procedures and methods.

#### MATERIALS

The materials used in the initial phase were selected from sources that had sufficient field usage to categorize them as to polishing susceptability. Ten sources were selected to represent a range of skid properties or polishing susceptibility. Since these factors depend upon aggregate characteristics, the sources selected also represented a range of mineralogies, texture, etc. After completion of the initial phase, all available aggregates were incorporated into an expanded study.

#### LAB PROCEDURE

The laboratory procedures developed and followed in the study are found in <u>Iowa State Highway Division</u>, <u>Materials Office</u>, <u>Labora-</u> <u>tory Manual</u>, <u>Vol. 1</u>. Specifically, Test Method No. Iowa 218-A, "Preparation of Specimens for Determining the Polishing Characteristics of an Aggregate" and Test Method No. Iowa 914-A, "Method of Test for Determining Surface Frictional Properties with the British Portable Skid Tester". As mentioned earlier, these procedures were developed in the Iowa Highway Division Materials Laboratory without the benefit of published guidelines. Thus, they differ in part from the procedure outlined in ASTM E 303-74 which was published after the study was well under way. The data supporting the differences are discussed and shown later in this report. Copies of the two Iowa procedures will be given here.

#### Specimen Preparation

Aggregate samples were evaluated by incorporating them into three six-inch diameter by two-inch high asphaltic concrete test specimens. The specimens were made to Type "A" asphalt specifications with a 1/2" mixture size and were compacted as closely as possible to Marshall densities.

#### Polishing Procedure

An accelerated polishing device was used to polish the surface of the test specimens to simulate the polishing action of

traffic. The device consisted of a drill press with a three-inch diameter rubber polishing pad mounted in the chuck. The specimens were placed on a ball bearing turntable and the polishing pad pressed against the surface of the specimen by applying a 3,000 gram load to the operating arm of the drill press. Water and abrasive dust were applied to the specimen surface while the polishing pad was rotating on it. The specimens were polished for ten minutes using #400 Carborundum grit and for ten minutes using #600 grit. Skid Testing Procedure

The BPN (<u>British Portable Tester Number</u>) values were determined for the various sources using the British Portable Tester. Numbers were obtained at various stages during the polishing procedure as reported in the data tables. The actual testing procedure was modified several times as discussed in the TEST RESULTS AND INTERPRETATION section of the report.

#### TEST RESULTS AND INTERPRETATION

#### Initial Phase

The initial phase of the investigation consisted of determining whether the polishing procedure could produce surfaces that varied in their skid resistant properties in the same relative proportion as their actual field performance. As the work progressed, several distinct areas of investigation evolved and will be reported on separately, although all are reflected in the final results and conclusions of the initial phase.

#### Mix Design

After reviewing the typical gradations for several mix sizes, it was decided that the 1/2 inch mix would be used for the study. The optimum asphalt content was determined for each individual aggregate source tested. Initially, the natural sand was prescreened to remove all plus No. 8 material and the quantity to be used was standardized. However, the preparation and testing of several trial specimens indicated that even with long periods of polishing the coarse aggregate was not being exposed. The coarse aggregate/fine aggregate proportions were changed to 70-30 and the polishing time and pressure were changed until coarse aggregate Two aggregates with widely different field skid was exposed. properties were tested but showed little difference in final polished values. Further specimens were made eliminating the natural sand and these had polished values that varied in proportion to their field values. On this basis, the natural sand fraction of the mixes was eliminated and the specimens prepared from all stone with the following grading:

<u>Sieve</u>	<u>% Passing</u>
0.525"	100
3/8"	80
#4	55
#8	37.5
#16	25
#30	20

#### Polishing Susceptibility

The first series of specimens tested had such large within source variation that a second set of specimens was prepared. While the second set was being polished, it was observed that aggregate particles were being dislodged. The laboratory procedure at this time involved the placing of the specimen's surface in solvent to remove the asphalt film from the specimen surface and the aggregate particles. Apparently, the solvent was softening the asphalt matrix too much for the specimen to be immediately subjected to polishing. By allowing the specimens to set overnight, enough solvent evaporated and the asphalt hardened to the point where the specimens could be polished without trouble. The within source variability dropped to acceptable levels after this procedural change. It was also necessary, due to plucking, to substitute limestone fines for quartzite fines when preparing the quartzite specimens. The BPN values for the aggregate sources tested are shown in Table 1. To arrive at the data shown in Table 1, each of the three specimens from a source was subjected to five determinations of its individual BPN value. The five determinations were averaged into a single value for a specimen, and the three specimens averaged for a value for the source.

			***************************************	Test Conditio After 10 Add	litional Min. #6	00 Grit
Aggregate		Before Polishing	After 10 Min. #400 Grit		30% Glycerol Lubricated	60% Glycerol Lubricated
Quartzite		74	53	43	43	43
Sedgewick	fine grained Dolomite	81	56	37	37	37
Ferguson (Eagle City)	fine to medium Limestone	79	56	40	40	38
Ferguson (Maynes Creek)	cherty, fine to medium grained Dolomite	78	55	39	38	37
Ft. Dodge	medium to coarse grained Limestone	74	52	36	34	33
Menlo	fine grained Limestone	74	47	31	31	31
Traprock		75	56	49	47	42
Davenport	very fine grained Limestone	75	47	30	30	30
Crushed Gravel		76	54	44	43	41
Logan	fine to medium grained Dolomite	82	61	48	46	43

Table 1BPN val	ues for the	various source	s and test	conditions	(second series)	

The within-specimen, between-determination variation was quite small as shown in Table 2.

Table 2 Frequency o	f wit	thin-specimen	variations	(second series)
Variation	bet	ween the five		
determinatio	ns oi	n a single sp	ecimen 1	requency
0	BPN	units		41
1	- 11	11		93
2	\$1	¥1		. 8
3	FI	H		6
4	0	н		2

The between-specimen, within-source variations are shown in Tables 3 and 4.

			Test Condi	tions	
	-		After 10 A	dditional Min.	#600 Grit
	Before	After 10 Min.	Water	30% Glycerol	60% Glycerol
ggregate	Polishing	#400 Grit	Lubricated	Lubricated	Lubricated
rtzite	1.	3	2	1	1
lgewick	2	2	4	3	3
rguson	1	5	1	1	2
agle City)					
rguson	2	1	2	3	3
aynes Creek)					
Dodqe	2	2	3	4	4
Lo	2	2	2	1	1
prock	2	6	7	7	6.
enport	3	5	2	2	0
ished Gravel	1	1	2	2	0
an	б	4	2	2	4

			~		
Table 3Between-specime	n variation	(three	specimens Test Cond	h source)	(second series)

ω				
		f between-spec between the th	cimen variations, 2nd series	
		hin a single s		
	0 B	PN units	1	
	1	fi fi	11	
	2	f7 f3	19	
	3	ti fi	7	
	4	fl II	5	
	5	11 11	2	
	6	11 Tf	3	-
	7	17 51	2	

The tabulations show that the variability encountered is within acceptable limits.

Tables 5 and 6 give the data arranged in two different ways, both are for the BPN values obtained on the water lubricated surface after polishing was completed.

Table 5 Sources	ranked by	change in BPN values	(second series)
	Change	Ranking from	Ranking from Lab.
Aggregate	in BPN	Field Evaluation	Textural Evaluation
Traprock	26	4	2
Quartzite	29	2	2
Crushed Gravel	32	1	1
Logan Q.	34	2	3
Ferguson	38	3	2
(Maynes Creek)			
Ft. Dodge	38	4	4
Ferguson	39	4	5
(Eagle City)			
Menlo	43	6	7
Sedgewick	44	Not Used	6
Davenport	45	5	7

Table 6 Sources		polished surface BPN	values (second series)
	Final	Ranking from	Ranking from Lab.
Aggregate	BPN	Field Evaluation	Textural Evaluation
Traprock	49	4	2
Logan	48	2	3
Crushed Gravel	44	1	1
Quartzite	43	2	2
Ferguson	40	4	5
(Eagle City)			
Ferguson	39	3	2
(Maynes Creek)		!	
Sedgewick	37	Not Used	б
Ft. Dodge	36	4	4
Menlo	31	6	7
Davenport	30	5	7

The field evaluation ranking was based on data obtained with the skid trailer. The lab textural evaluation is based on the visual identification of an aggregate's texture - both the individual particles and the composite sample representing the production from a source. A source may have received a high textural rating based on the coarseness of the individual grains in the particles and/or based on the presence of both hard and soft aggregate particles that could produce varying degrees of wearability in a pavement surface and thus promote the development of macrotexture.

The ranking of the aggregates in both tables was close enough to actual field performance to warrant further testing.

A third series of the same ten aggregates was molded to check on the reproducibility of the second series. The effect of various operators was also introduced at this time. Table 7 gives the results of the third series.

	Series 2		Series 3	
	Change	Change		Variation
Aggregate	<u>in BPN</u>	in BPN	<u>Operator</u>	from Series 2
Traprock	26	29	3	+3
Quartzite	29	30	2	+1
Crushed Gravel	32	34	2	+2
Logan	34	36	3	+2
Ferguson	38	37	1	-1
(Maynes Creek)				
Ft. Dodge	38	39	1	+1
Ferguson (Eagle City)	39	39	1	0
Menlo	43	44	3	+1
Sedgewick	44	44	3	0
Davenport	45	44	2	-1

#### Table 7. - Third series data

As the Series 3 specimens were being molded and polished, it was observed that certain aggregates which crushed into elongated particles tended to be orientated parallel to the specimen surface. Thus, their orientation relative to the pendulum slider could affect the aggregate particle contact time during testing, and, therefore, the BPN value obtained. To study this effect, a comparison was made of the variation of the Series 2 specimens (5 determinations) with the variation encountered with Series 3 specimens when determinations were made at the quarter points. Table 8 shows the results.

	Variation	Between Specimens
	Series 2	Series 3
<u>Aggregate</u>	5 Determinations	8 Determinations
Quartzite	2 BPN units	1 BPN unit
Menlo	3 " "	2 BPN units
Traprock	3 " "	3 " "
Davenport	2 " "	3 " "
Crushed Gravel	2 " "	1 BPN unit
Logan Q.	3 " "	<u>1</u> tr tr

Table 8. - Variation vs. number of determinations

Based on these results, future testing was done by making eight, quarter point determinations on each specimen.

To check on the aggregate source variability, additional samples were obtained from three sources. Table 9 shows the results.

Table 9 Variabil	ity within	aggregate source	
	Change	in BPN	Additional
Aggregate	Series 2	<u>Series 3</u>	Samples-
Ferguson	38	37	37
(Maynes Creek)			
Ferguson	39	39	36
(Eagle City)			
Ft. Dodge	38	39	41

#### Pad Preconditioning and Service Life

In Series 2, the pad was preconditioned by 10 passes over a dry concrete surface, as per the pendulum manufacturer's instructions. The pad to be used in Series 3 was preconditioned in a similar manner and a comparison test of the two was made on a set of specimens.

> Series 2 pad used 750 times previously Series 3 pad used 0 times previously Washed surface - Series 2 pad 79 BPN units " - Series 3 pad 86 BPN units Polished surface - Series 2 pad 42 BPN units " - Series 3 pad 41 " "

Assuming that continued use would bring the condition of the new pad (Series 3) close to that of the Series 2 pad, the test was continued on a different set of specimens.

> Series 2 pad used 825 times previously Series 3 pad used 75 times previously

Washed surface - Series 2 pad 80 BPN units
" " - Series 3 pad 81 " "
Polished surface - Series 2 pad 41 BPN units
" " - Series 3 pad 48 " "

The differences between the condition of the pads appeared to be diminishing on the washed surface, but not on the polished surface; so another set of specimens was tested.

Series 2 pad used 900 times previously Series 3 pad used 150 times previously

Washed surface - Series 2 pad 71 BPN units Wa" - Series 3 pad 74 " "

Polished surface - Series 2 pad 32 BPN units " - Series 3 pad 40 BPN units

Obviously the differences were persisting. The Series 2 pad had been on hand several years, while the Series 3 pad was a recent purchase. To check on possible hardening on the rubber, the Durometer hardness test was run on the Series 2 and 3 pads and on two others that were recently purchased. The test results were identical on all pads.

It was decided to go back to the preconditioning of the pads. A mortar block was prepared to serve as a standard surface with which to check the pads. A new pad was preconditioned by five passes over #50 sandpaper and then tested against the other pads on the standard surface. The condition of the new pad did not agree with the others - but the condition of the Series 2 and Series 3 pads did agree, hinting that the mortar block was responsible for some conditioning of the Series 3 pad. The new pad continued to be preconditioned by 10 passes over #150 sandpaper. After this second preconditioning, all pads agreed on the standard surface. It was decided to try the pads on actual specimens and the results were:

> Series 2 pad used 975 times previously Series 3 pad used 225 times previously New pad used 0 times previously

Washed surface - Series 2 pad 81 BPN units " " - Series 3 pad 82 " " " " - New pad 78 " "

Polished surface - Series 2 pad 37 BPN units " - Series 3 pad 43 " " " - New Pad 38 " "

At this time, a procedural change was made to eight determinations (2 at each quarter point) instead of five determinations; data present elsewhere shows that this reduces the test result variabilities.

Two new pads were conditioned by 10 passes over the mortar block that was originally made for a standard surface. These pads will be designated X-1 and X-2. The results were:

Series 2	pad u	sed	10	50	t	imes	prev	7ious	sly
Series 3	pad u	sed	3	<b>00</b>	t:	imes	prev	vious	sly
New pad	u	sed		75	ti	imes	prev	vious	sly
X-1 pad	u	sed		0	t	lmes	prev	7ious	sly
X-2 pad	u	sed		0	ti	lmes	prev	vious	sly
Washed s	urface		Seri	es	2	pađ	77	BPN	units
- 4 <b>1</b>	13	- 3	Seri	es	3	pađ	76	н	н
31	11	- 1	New	pac	l		75	68	<b>\$</b> 1
¥1		2	<b>x-1</b>	pać	l		49	11	11
Ħ	11		X-2	pac	l		49	11	\$\$

It appears that the standard mortar block can quickly condition new pads to the point where their results are compatible with previously used pads. Thus, all new pads will be conditioned by ten passes over a standard mortar block. To stay within reasonable wear tolerances, the pads will be replaced after 500 passes.

# Initial Phase Conculsions

1. The specimens should be prepared without natural sand

so as to maximize the effect of the aggregate being tested.

- 2. After having been placed in the solvent, the specimen should stand overnight to allow the matrix to reharden.
- 3. Lowered variability of test results and better reproduceability of test results occurred when the determinations on specimen were made at the quarter points.
- 4. A standard surface and procedure for preconditioning the pads is very necessary.
- 5. Wetting the polished surface with 30% glycerol solution - offers no advantage over water, and the 60% glycerol solution tends to override the skid resistance of the polished surface and become the dominant factor. Therefore, in any future testing, water is the recommended lubricant.
- The variability encountered was sufficiently low enough to warrant expansion of the study.
- 7. The ranking of the BPN results was sufficiently close enough to other evaluation rankings that expansion of the study was warranted.

#### Expanded Study

The aggregates used and their test results are shown arranged in several different ways in the Appendices.

Appendix C gives the results arranged according to the amount of difference between the initial and polished values. There was

some consideration given to using this value as a characterizing number after the initial phase was completed. However, the expanded study showed that quite often aggregates may possess a high initial value and an average final value, thus giving a large difference that does not truly reflect their skid properties. A case in point would be the dolomites, where as a group they have a very high initial and an above-average final resulting in a high difference.

An attempt was made to correlate the results with the skid trailer data. Since the trailer data includes pavements of many different ages, mix sizes, asphalt types, and different years of skid testing, only those 1/2-inch mixes which had been field tested in 1974 and 1975 were selected as being the most comparable with the specimens used in the polishing study. This resulted in the selection of thirteen sources. The correlation coefficient between the field skid data and the amount of change in BPN units was calculated as 0.1381, which indicates essentially no relationship.

Appendix D gives the results arranged according to the final or polished values.

Taking the same sources mentioned earlier, the coefficient of correlation between the field skid data and the final polished value was calculated at 0.601, which indicates that a degree of correlation exists - at least on the thirteen sources compared. It was noticed that several field proven skid resistant aggregates

(not included in the thirteen sources in the correlation) fall into the lower end of the ranking shown in Appendix D.

In examining Appendix D, it will be noticed that the final values have a normal distribution. This would indicate: (1) that no differences exist in polishing susceptibility between the specimens, (2) the polishing method is not presently capable of developing the varying degrees of skid resistance of the various aggregates, or (3) the differences in skid resistance of the various aggregates are being masked by grouping all aggregates together for analysis.

Situation 1 is not supported by field evidence. Skid trailer data indicate that differences do exist in polishing susceptibility.

Situation 2, the inability of the method to develop the varying degrees of skid resistance is an area that deserves more attention. The present procedure calls for polishing all aggregates the same amount of time, and it is a distinct possibility that some of the aggregates are being overpolished, tending to group the data too close together.

Situation 3, the gouping of data for analysis was investigated by dividing the aggregates in this study into rock texture groups. This was done since the textural classification of an aggregate is an easy visual procedure, and many reports mention the correlation between texture and skid resistance. The grouping of the different samples and their test results are shown in Appendix E. The six groups used were:

Type 0 Misc. (Crushed Gravels, Traprock, Quartzite) Type 1 Siliceous Carbonates (Cherty-Sandy) Type 2 Micritic Limestone (Microcrystalline-Lithographic) Type 3 Clastic Limestone (Oolitic-Crinoidal-Fossil Clastic) Type 4 Dolomite (Fine to Coarse Crystalline) Type 5 Mixed Limestone and Dolomite

The average BPN for each aggregate type is as shown in Table 10.

<u>Table 1</u>	0 Average	BPN for	rock	texture	group
		Original	_		Final
Type 0		81.0			43.9
Type 1		80.3			44.8
Type 2		75.4			38.1
Type 3		76.9			39.8
Type 4		82.0			44.2
Type 5		77.9			39.4

Observation of Table 10 indicates that the different types can be combined into two groups. Subsequent statistical analysis indicated that only these two groups existed, and they represented two significantly different BPN results. The two groups would be:

Group I Highest Final Values

Type 0 Crushed Gravels, Quartzite, Traprock

Type 1 Siliceous Carbonates

Type 4 Dolomites

#### Group II

Type 2 Micritic Limestones

Type 3 Clastic Limestones

Type 5 Mixed Limestone & Dolomite

It thus appears that the polishing method can develop surfaces of differing skid properties, and data grouping has an effect on interpretation. However, based on field performance, the above grouping does not appear definitive enough. Most clastic limestones, and mixed limestone and dolomite, aggregate sources have good skid resistant properties, based on field usage and they should not normally be classed with the poorer performing micritic or very fine grained limestone.

#### Conclusions and Suggestions

The "Accelerated and Polishing Method" can produce surfaces of varying skid properties, but is not presently capable of developing and measuring the full skid potential of the various sources. It is suggested that additional study be done in the area of varying polishing times to prevent potential overpolishing of specimens.

# APPENDIX A

#### RESEARCH PROPOSAL

#### R-264

# LABORATORY INVESTIGATION OF THE EFFECT OF VARIOUS COARSE AGGREGATES ON THE SKID RESISTANCE OF ASPHALT SURFACE MIXTURES

#### Introduction

It has long been recognized that coarse aggregates play a significant role in the skid resistance of asphalt surface course mixtures. Fine grained limestones polish very rapidly under traffic and are therefore unacceptable for surface course mixtures where a high degree of skid resistance is required. Some dolomitic limestones with coarser grain structures are less susceptible to polishing and tend to provide an adequate skid resistance for longer periods of time. There are, however, many sources of crushed stone within the state of Iowa where no definite chemical or physical parameter identifies it as having polishing or non-polishing characteristics.

An accelerated polishing test is needed that can adequately establish the susceptibility of an aggregate to polish in an asphaltic surface course under traffic.

#### Purpose

It is the purpose of this investigation to attempt to identify polishing characteristics of coarse aggregates by an accelerated laboratory method.

#### Scope

This investigation shall initially be limited to determining the polishing characteristics of ten (10) aggregate sources and correlating these characteristics to field performance. If such a correlation does exist the project shall continue until all major geologic types or sources are evaluated.

#### Test Procedure

#### A. Specimen Preparation

Three 6 in diameter and 2 in high specimens shall be prepared for each coarse aggregate. They shall be compacted in such a maner as to be as close to Marshall densities as possible.

Each set of three specimens shall be of a Type "A" surface course mixture, and shall have the same grading and percentage of coarse aggregate as well as the same source and percent of asphalt cement.

#### B. Polishing Procedure

All specimens shall be polished by mounting them in a mold positioned on a polishing turntable. A 3 in. diameter rubber polishing pad attached to a drill press shall be used to apply pressure to the specimen. Each specimen shall be polished utilizing commercial abrasives. The polishing shall be accomplished in three stages of five minutes each with contact pressures of 3, 4 and 5 psi. for the first through the third stage respectively.

#### C. Skid Testing Procedure

Each specimen shall be tested with a British Portable Tester in accordance with ASTM E 303 prior to polishing and after polishing. After polishing and testing with water, the frictional properties will be again determined with the British Portable Tester using a 30% glycerol solution as the lubricant. D. Aggregate Testing

Each aggregate under investigation shall be examined and tested for Los Angeles abrasion and any geologic parameter deemed to be applicable.

## Responsibilities

The Geology Section shall be responsible for selecting and obtaining the aggregates to be studied.

The Special Investigations Section shall be responsible for conducting the tests.

The Materials Administration Section shall be responsible for analyzing the data and preparing the final report.

# APPENDIX B

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#### IOWA STATE HIGHWAY COMMISSION

Materials Department

#### PREPARATION OF SPECIMENS FOR DETERMINING THE

#### POLISHING CHARACTERISTIC OF AN AGGREGATE

#### Scope

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This method is intended to describe the preparation of test specimens to be used for evaluating the polishing characteristics of coarse aggregate with the British Portable Skid Tester.

#### Procedure

- A. Apparatus
  - The following sieves: 0.525", 3/8", #4, #8, #16 and #30.
  - Oven capable of maintaining a constant temperature of 275 ± 5°F.
  - Balance with a capacity of at least 5000 grams and accurate to 1 gram.
  - Mechanical mixer, capable of mixing a 12,000 gram batch.
  - Mold, base and compaction plate, capable of molding a specimen 6 inches in diameter and 2 inches in height.
  - 6. Compacting apparatus as described in Test Method No. Iowa 502.
  - 7. Drillpress, capable of approximately 720 rpm.
  - 8. Turntable, consisting of a base, table top and an adjustable braking system. The 9-1/2 x 9-1/2 x 1/2 in. base is securely attached to the drillpress table. The base has a 0.6 inch centering hole and the top of the base is grooved to center and hold a 5 inch diameter ball bearing system. The 9 inch diameter table top rests on the ball bearing system and is centered with a 0.6 inch diameter shaft 15/16 inch in length. The table top should spin freely. The braking system is mounted to the base and adjusted to the table top to obtain the desired rpm during the polishing operation.
  - 9. 6 inch inside diameter polishing mold and collar, made of brass or other suitable material. The mold and collar shall be made so that the top of the 1-1/2 inch deep mold, when fitted to the bottom of the 2-1/2" deep collar gives an overall depth

of 3-1/2 inches. This fitting is obtained by a tongue and groove joint, with a 1/4 inch tongue on the mold fitting into a 1/4 inch groove on the collar.

- 10. Rubber polishing shoe, made with the same quality rubber as automobile tires. The shoe shall be 3 inches in diameter and 2 inches thick. Three grooves 1/4 inch wide and 1/2 inch deep are cut into the 3 inch diameter polishing surface, dividing the surface into 6 segments of approximate equal area. The shoe is attached to a metal plate of the same diameter having an attached shaft for fitting the drill press chuck.
- 11. Silicone Carbide Grit, size #400 and #600.
- B. Test Procedure
  - Separate the aggregate sample into particle sizes by using the sieves described in A, 1 and dry in an oven for approximately 12 hours at 275°F.
  - Determine the absorption by Test Method No. Iowa 201 on the aggregate built up to the following grading:

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Sieve	% Passing
.525"	100
3/8"	80
#4	55
#8	37.5
#16	25
#30	20

- Build up a 10,000 gram portion of aggregate to the same grading as described above in B, 2. From the results of the absorption test calculate an effective asphalt content of 5.25%. Add this amount of asphalt to the aggregate and mix for not less than 1-1/2 minute.
- 4. From the mixture, mold a specimen by using the mold, base and compaction plate described in A, 5 and the procedure in Test Method No. Iowa 502, except the compaction apparatus strikes the plate a total of 200 times. (100 times on each side of the specimen) Carefully extrude the specimen from the mold and allow to

#### cool for not less than 8 hours.

- 5. Wash the surface of the specimen to be tested in the following manner: place it in a pan containing about 1/2 inch of 1,1,1 trichlorothane for 2 minutes, remove the specimen, brush the surface with a brass or wire brush, and return it to the pan of solvent, repeating this 5 times. Upon completion of this procedure the specimen is removed and its surface is washed with solvent, alcohol, water, brushed and allowed to dry at room temperature for not less than 8 hours.
- 6. Place the specimen in the polishing mold. If a tight fit is not attained, place a strip of paper around the edge of the specimen and insert it in the polishing mold so that a tight fit is attained.
- Determine the initial BPN of the specimen according to Test Method No. Iowa 914.
- Place the collar on the polishing mold and position this assembly in the polishing device. Place the polishing shoe in the drillpress chuck and adjust the base so that the shoe, in polishing position, is approximately 1/16 inch from the edge of the collar.
- 9. Maintain a contact pressure of 15 psi. on the specimen's surface from the polishing shoe by applying a load of 3000 grams to the end of the drillpress arm. Add 25 ml. of #400 silicone carbide grit and 300 ml. of water on the surface to be polished. Polish the specimen for 10 minutes at a mold speed of 50 rpm. Upon completion of the polishing, remove the specimen and assembly from the turntable, disassemble the collar, wash the test surface with water, and brush with a fiber brush.
- Perform the final polishing by repeating Step 9 with the exception that the silicone carbide grit, size #400 is replaced with size #600.
- Determine the final BPN of the specimen according to Test Method No. Iowa 914.

Test Method No. Iowa 218-A May 1974

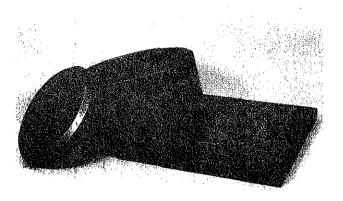


Fig. 1 Mold, Base and Compaction Plate

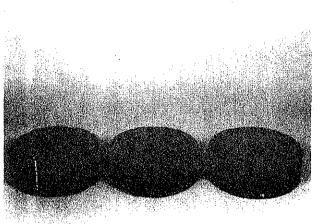


Fig. 2 Test Specimens for Polishing

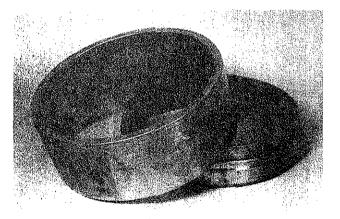


Fig. 3 Polishing Mold and Collar

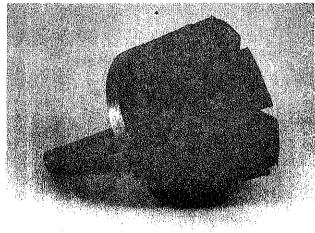


Fig. 4 Rubber Polishing Shoe

#### IOWA STATE HIGHWAY COMMISSION

#### Materials Department

#### METHOD OF TEST FOR DETERMINING SURFACE

#### FRICTIONAL PROPERTIES WITH THE BRITISH PORTABLE

#### SKID TESTER

#### Scope

This method is intended to describe the procedure for performing a frictional test on specimens made in the laboratory with the British Portable Skid Tester. This apparatus and procedure are identical to that specified in ASTM E 303-69 with the following exceptions:

A. Apparatus

- 1. New sliders shall be conditioned prior to use in the following manner. Adjust the tester as in Section 4, "Preparation of Apparatus" and make 10 swings on a dry surface of a mortar block. The mortar block shall have a surface that is at least 3-1/2 x 6 inches. The mortar block shall be made with portland cement, concrete sand and when cured the surface shall be polished with No. 60 grit until the aggregate is exposed.
- B. Test Specimen
  - 1. The test specimen shall have a test surface of approximately 6 inches in diameter.
- C. Preparation of Apparatus
  - 1. Slide Length Adjustment
    - a. Make the adjustment with either one of the pair of head movement knobs and never with the front leveling screws.

- 1. Pour water over the specimen until the surface is thoroughly saturated and the excess runs off.
- 2. Perform at least 1 determination at each quarter point on the diameter of the specimen. Prior to each determination recheck the contact length as in C, pour water on the surface as in D 1, and adjust the slider to make complete contact at the beginning of the test path. Make the adjustment by carefully lowering the pendulum so the slider rests on the surface at the beginning of the test path and return it to the original test position. Without delay complete the test and record the result.

E. Report

- Report the average of the determinations and express as BPN units.
- Notes: Perform the test with the apparatus and specimen positioned on a firm foundation.

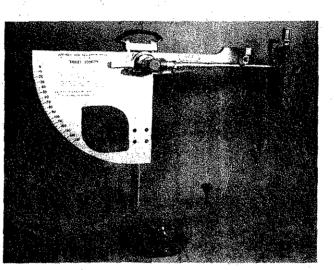
Due to the great importance of the apparatus being level, check and adjust it at least after every 4 determinations.

Replace the rubber slider after being used 500 times, or before, if excessive wear is noted.

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#### D. Procedure

#### Test Method No. Iowa 914-A May 1974



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Fig. 1 British Portable Skid Tester With A Test Specimen in Place

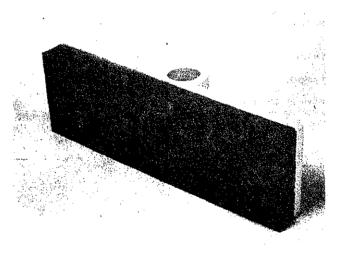


Fig. 2 Rubber Slider

# APPENDIX C

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BRITISH PORTABLE SKID TEST

JAN. 14. 1976

PAGE 1

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APPENDIX C

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<b>•</b>	QUARRY	UNIT	ZP G	ABS	ABR	WASHED	POLISHED	DIFF	COMMENTS
$\sim$	JOHNSTON	CPUSHED GR	2.791	0-60	57	FT	43	57	
	STURTZ	CPUSHED GP	2.708	1.48	85	69	47	22	
	STUCK PIT	CRUSHED GR	2+640	1.51	25	63	40	53	
$\sim$	PITSOR PIT	CPUSHED GR	2-676	1.16	85	64	40	24	
	BROMLEY	CRUSHED GR	5.636	7°03	29	65	37 .	28	
	FPANKLIN	SPERGEN	2+575	5.44	27	84	55	28	BED 12
<b>(</b> )	DOUDS MINE	SPERGEN	2.644	5.97	uŋ	83	54	28	BEDS LOA THRU 15
· · ·	EDDYVILLE	ST GEN	5-7-27	0.90	36	75	48	28	· · · · · · · · · · · · · · · · · · ·
	YOUNG AMCA	WASSONVLE	2+667	5•9P	33	87	58	29	CHERTY
•	FARMINGTON	ST L-SPERG	5-664	2-14	30	81	51	30	BEDS 13 THRU 16
• •	SMITH QR	ST LOUIS	2+664	0.70	35	72	42	30	
-	GRAND RIV	BETHANY F	2.687	0.94	28	70	39	37 .	BED2 75-72
<i>•</i> ٦	ROBINS	SOLON	5+668	1-00	37	75	44	ЭГ	
Ð	BAGUS	GOWER	2+895	0.27	57	80	ųŋ	37	
	CEDAR CR	SPERGEN	2.663	5•55	30	77	46	IE.	
0	FARNSUORTH	WORLAND	2+299	0-91	56	73	42	31 .	BED 1 (*
5	LANSING	HOPKINTON	2.776	0-75	3 <u>5</u>	83	52	31	CHERTY
	CRAWFORD	RAPID-SLN	5.279	0-83	54	76	ųų	32	
6	CORNING	ERVINE CR	2.624	0.93	29	83	51	35	BEDS 3-5
43	COMANCHE	SPERGEN	2-568	4-16	35	81	49	32	

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· ·	BRIT	ISH POPTABL	E SKID	TEST				JAN+	14. 1976	PAGE 2
Ĵ.	PRESTON	HOPKINTON	2.737	1+29		<del>3</del> 5	\$3	32	CHERTY	
	SWALEDALE	OWEN	2.413	J•70	31	63	48.	33	HIGH F&T A	
	VINTON	SOLON	2•999	1.53	27	77	45	35		
	MILLER	OWEN	2-532	1-15	25	78	45	33		
<i></i>	GARNER	OWEN	5:409	0+30	25	74	4],	33	FULL FACE	
	NIBHEIM	HOPKINTON	2.747	C-LO	Зб	8B	50	33	CHERTY	
	GARDNER	ZT LOUIS	5-699	9+67	53	74	40	34	,	·
· * .	ATLANTIC	BETHANY F	2.640	1.59	56	77	43	34	3 & 2 25 Z 438	
	EARLHAM	BETHANY F	2+614	1.76	53 E 5	75	41.	34		· · · · · · · · · · · · · · · · · · ·
	LOGAN	HOPKINTON	2.754	1.06	35	83	49	. зч		
0	RICEVILLE	CEDAR VAL	5•P95	5•12	34	80	46	34	35FT FACE	
0	MEDIAPOLIS	WASSONVLE	5+623	2.05	38	79	45	34	BEDS 15-18	
	OSAGE	CEDAR VAL	2•753	0.40	27	79	45	34	· • • • • • • • • • • • • • • • • • • •	
'n	LEWIS	SPERGEN	2.734	0•53	56	77	43	34	8EDS 6 2 7	
cił;	FARMERS	HOPKINTON	2+734	0.93	35	84	S0	34	• • • •	· · · · · · · · · · · · · · · · · · ·
	KURT	HOPKINTON	2.799	0•33.	30	£3	49.		_CHERTY	· · · · · · · · · · · · · · · · · · ·
0	EDGEWOOD	HOPKINTON	2+780	0+70-	3P	81	47	34		
. 1	DECATUR CY	BETHANY F	2+634	1-41	30	73	38	35	8EDS 11-14	· · · · ·
	MONTOUR	HAMPTON	2+721	1.15	43 .	83	.45	35		· · · · · · · · · · · · · · · · · · ·
9	WARNHOLTZ	CORALVILLE	2+674	1-P5	63	81	46	35	TOP LEDGE	
9	PLANO	EXLINE	2+673	0-30	53	71	36	35 [		· · · · · · · · · · · · · · · · · · ·
Ċ.	STENNETT	CLAY CREEK	5+629	1+40	55	75	40	35	8ED 13	
0	MAXIN	CORALVILLE	5.249	0.34	55	75	40	35	•	
9	OLLIE	BURLINGTON	5-222	0.13	36	75	40	35	BED 15-18	artematikar or
9				.* .					······································	
3									· · · · · · · · · · · · · · · · · · ·	• · ·
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<u>.</u>	8°17:	ISH POPTABL	E ZKID	TEST				JAN.	14. 1976	PAGE 3
`	WALNUT CTY	COOPER CR	5-570	0.27	25	75	40	35	BED 6	. · · · · · · · · · · · · · · · · · · ·
	20UIH C ©	GOWER	2.754	7.80	22	85	53	35	ANAMOSA-HOPKINTN	
	STANZEL	APGENTINE	P.631	1.75	36	83	цц	36		
	BEDFORD	ERVINE CR	2.377	5.65	33 -	56	46	36		
- 4	DANVILLE	SPERGEN	5-692	1.10	56	77	41	36	D2-E1 2038	
	WINTEPSET	BETHANY F	2.614	5•30	29	78	42	36		······································
	THAYER	BETHANY F	5+600	3•03	25	76	40	36		·
~	QUINBY	SHELL ROCK	2.726	0•73	29	77	4 L	36	BEDS 1 THRU 10	
~	BROWN	SVILLE	2.764	0.93	33	83	47	36		
	WEEP WATER	PLATTSMTH	2+691	0.37	25	74	38	36		· · · · · · · · · · · · · · · · · · ·
<b>.</b>	HAWKEYE	ST LOUIS	2.178	0.68	27	73	37	36		
	KENDALLVLE	STE JARTVLE	8•733	C•83	27	78	42	36	BEDZ 687	· · · · · · · · · · · · · · · · · · ·
	LECLAIRE	GOWER	2+783	0.33	37	87	51	36 .	ANAMOSA	
• .	VERNON	GOWER	2.740	1.09	31	84	48	36	ANAMOSA	·•
۰.	MAR-JO HIL	SVILLE	2.766	0.57	' <b>4</b> 0	85	49	36		······································
	FESTINA	EDGWOOD	2.659	1-65	33	80	44		BULLERMAN Q	· · · · · · · · · · · · · · · · · · ·
2	MALCON M	FAGLE CITY	2.716	7.59	35	81	45	36		
×.	DURHAM	ST LOUIS	2+580	1.78	25	85	50	36	ARENACEOUS	
•	BLOOM	SOLON .	2+685	0.64	25	78	42	35	z	· · · · · · · · · · · · · · · · · · ·
	FERGUSON	HAMPTON	5.695	5.06	38	85	48	37	κ.	•
	MCCABE	PROSSER	5.691	0.74	30	79	42	37	49 FT FACE	······································
	CPSNT-QRTZ	BFALLS-@TZ				76	39	37	70/30	· · · · · · · · · · · · · · · · · · ·
• ر•	DIXON	CEDAR VAL	2.713	1.52	37	74	37	37	FULL LOFT FACE	
Ę,	WRAGE	CORALVILLE	2+748	0.44	PE	75	8E	37	····· ø.	

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	84141	ISH PORTABLE	E SKID	TEST				JAN-	14. 197L	PAGE 4
DOUS		MAYNES CR			7.0	<b>?</b> L		37		· ·
							39			· · · · ·
		EXLINE	2.693			72	35	37 	BEDS 1-4	
FLOP		CORALVILLE				73	36	37		
		ST GEN	2.724			70	33	37		
BOON		ONEOTA	2.770	0.73	34	81 -	44	37		
JEFF	ERSON	BETHANY F	2.654	].42	28	81	цц	37		
HEIN	HOLD	ST LOUIS	5-696	1.13	25	78	41	37	a para na sa ang ang ang ang ang ang ang ang ang an	
. COLUI	WBNZ 1	WASSENVLE	2.698	3-0F	37	<del>8</del> 7	50	37	ÇHERTY	
ALDE	N	GIL CITY	2.656	0+67	37	90	42	38	· · · · · ·	
_ BEHR-	-LUBBN	GOWER-CVLL				74	35	38		
LEGR	AND	HAMPTON	5•307	0-80	33	80	42	38		
WEPK:	ING	COPALVILLE	2.600	0.30	55	77	39	38 · · · ·	BED 4	ар баулаан алаан ал у у у у наубау байна наун то со того на на того
KOHL	ER	SHELL ROCK	2.799	0.34	23	75	38	38	BEDS 1 THRU 8	
KESW.	ICK	HAMPTON	2.739	7-53	85	84	46	38	IA FALLS E CITY	
BALL	0U	GOWER	2+779	0.30	34	87	49	38		
HAUK	EYE	SPERGEN	2.685	1.91	. 29	55	44	38		و مەربىلىرىكى بىرىكى ب
SMITI	H QR	SPERGEN	5.697	1-39	25	82	44	38	BEDS 13-164	•
CONF	IDENCE	COOPER CR	2.690	0.85	25	7l	43	38 	85D 6	
WEST	SHOP	PROSSER	2.679	0.47	56	78	40 .	38		
PINT	5	CORALVILLE				83	45	- 86	8EDS 5-13.	
ARGY		ST LOUIS				77		38	<b>V</b>	anna an
		ST LOUIS				77			8EDS 3-5	
		STEWARTVLE			_	82	44	38		
GARN		OWEN	2.790			78	39	39	· · · · · · · · · · · · · · · · · · ·	
	۰ د <u>م</u>	√, աններ էար էար	un - 1 1 V	- 184	- <del>-</del>	هبه ۱	40° T	<b>uf</b> *		

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-	BRIT	ISH PORTABLE	E SKID	TEST				JAN	. 14. 1976	PAGE 5
	MCGUIPE	GOWER	2.767	C•59	27	77	38	39	NE BOFT FACE FLR	,
	LÓGAN	BETHANY F	2.674	0.60	25,	77	38	39		
	FERTILE	CORALVILLE	2.741	0•93	30	93	4].	39		
	LEGPAND	HAMPTON	2.640	1.95	30	83	ųų	39	· ·	
	FT DODGE	GIL CITY	2.678	0.37	33	75	36	39		
	BOWSER	GOWER	<b>∂</b> •773	0.87	38	8 <b>b</b>	47	39		· · · · · · · · · · · · · · · · · · ·
	FERTILE.	CORALVILLE	2.781	0•93	30	<b>8</b> 0	4]	39	8ED2-10-17	·
	WILDE OR	COPALVILLE	2.735	0.44	85	80	4],	39	•	
	RANDALL	CEDAR VAL	2.746	0×37	33	75	371	39	FULL FACE	
	BBUNZ	OWEN	5.770	0+64	30	79	40	39		· · · · · · · · · · · · · · · · · · ·
	RANDALL	CEDAR VAL	2-769	0•53	55	75	36	40	PCC LEDGE	· .
	CHRISTOFSN	STEWARTVLE	2.654	1.19	29	77	37	40		nanasise su ta a a a a a a a a a a a a a a a a a a
	CHRISTOFSN	STEWARTVLE	5.660	1.00	25	<b>?</b> Ь	36	40	BEDS 1.2.3 TOP 4	
	BEHR	GOWER	2.734	1.69	42	84	44	40	· .	
	SHAFFTON	GOWER	2.798	0.40	30	81	41,	40	ANAMOSA	ант и ст. т. ул. т. т. т. и слов и слов андили андили ст. ск. от
	GARRISON	CORALVILLE	2.732	D • 57.	25	81 .	4]	40	s 	1100-110
	DUBUQUE ST	SVILLE-PSR	2•786	0-83	35	84	44	40		مر •
	DOMZ	EAGLE CITY	2-717	0.27	30	77	37	40	مند به بد <u>مسرد ان </u>	
	CONKLIN	CORALVILLE	2.699	0.13	29	81	4]	. 40	· · · · · · · · · · · · · · · · · · ·	
	ALDEN	GIL CITY	5.668	0.40	35	77	39	40 .	÷ 2	•
	LUBBEN	COPALVILLE	2.700	0.40	25	74	33	4].		
	SULIVAN S	MCCRANEY	a.702	0.37	85	75	34	4]	8ED 68	 
	KUENNEN	CEDAR VAL	2+800	0.57	29	81	40	41 <u>.</u>	•	
	MEDIAPOLIS	MCCRANEY	2.654	0.43	25	77	36	ųl	850 20	

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<b>N</b> .	8°1*1	CH POPTABLE	SKIÐ TE	2T				JAN -	14. 1976	PAGE L
,	DUENOW	CORALVILLE	2.771 0.	e de	a	76	35	41.	BEDZ P 10 TO	• 
• •	MONTI	HOPKINTON	2.769 0.	FO 3	P	<u>e 1</u>	40	4]		
		ARGENTINE	5.668 0.	5 07	4	75	35	41.		
•		BETHANY F	2.673	54 Z	5	75	34	41	BED 25 E	- and a second
~	LOGAN	BETHANY F	2.674 0.	P0 5	7	75	34	41	BED 25E	
		CORALVILLE				80	- PE	41	BEDS 18-23	, and a set of the set
~		CORALVILLE				81	40	41	<u></u>	
	MOSCOW	UAPSI	2.796 0.	. 30 3	10	79	38	4 <u>1</u>		
	LANGSTRATT		2.695 0.	•73 Z	28	75	34	ų].		
<b>^</b> .	WEPKING	CORALVILLE	2.741 0.	•84 Z	24	75	35	41	BEDS 1 THRU 3	enterinanteentering of the state of an an analysis and a state of the
	KEZMICK	HAMPTON	5.683 3.			83	41	. 42	8EDZ 13-15	
•	HODGES	GILMORE C				75	36	42	PCC LEDGE	
$\gamma$	DANNATT	HOPKINTON				83	4].	42	NEW OPENING 35FT	
~.		GILMORE C				77	35	42	BLFT NU	• •
		BURLINGTON				80	37	43	BED 18	
$\hat{}$	BAGUS	GOWER	2.793 D			83 E8	40 .		REEF	a the adjustment of the second s
	MITCHELL	GOWER	2.784 0			77	36	43	REEF	•
	LINWOOD	DAV-SP GR				74	31	43	· · · · · · · · · · · · · · · · · · ·	
	FINROOD	DAV-SP GR				74	31		and a second sec	a gygen an an a gygen gyf a a a a a a a a a a a a a a a a a a a
	LILLYBRIDG	,	2.717 0			81	38	43		
	UOZCOM	DAVENPORT				77	33	44	BEDS 10-15	
`,		GOUER	2.749 1			81	37	44 <u></u>	SCHNECKLOTH	a namet discontinues and a single sector manifold for the sector of the
		COWER C DAVPT-STVL		t - 44 w£	<i>- •</i>	80	36	ųų	50/50	
.*						83	36	47	50/50	anga kana ana ana ana ana ana ana ana ana a
()	ALUN-SEDGE	E GILCTY-HOP				~ -			₹ 	
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## APPENDIX D

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BRITISH POPTABLE SKID TEST

JAN. 14. 1976

PAGE 1

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APPENDIX D

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	QUARRY	UNIT	Sb C	ABS	ABR	WASHED	POLISHED	DIFF	CONMENTS
	LINWOOD	DAV-SP GR	5-676	0.67	4 L	- 74	31	43	
	FARMINGTON	ST GEN .	2+724	1.69	57	79	33	37	·
	LUBBEN	COPALVILLE	2.735	0.40	25	74	33	4].	
	MOSCOM .	DAVENPORT	2.700	0-13	29	77	33	44	BEDS 10-15
	LOGAN	BETHANY F	2.674	0.60	27	75	34	41	BED 2SE
	SULIVAN S	MCCRANEY	2.707	0•37	28	75	34.	41	BED LB
	CRESCENT	BETHANY F	8+673	0.54	25	. 75	.34	41	BED 25 E
	LANGSTRATT	ST LOUIS	2-695	0.73	59	75	34	41	
	CONFIDENCE	EXLINE	5•643	0.34	25	72	35	37	BEDS 1-4
	GILMORE C	GILMOPE C	P.668	0.90	32	77	35	42	36FT NW
	DUENOW	CORALVILLE	2.771	0.30	28	76	35	4 <u>]</u>	BEDZ F 10 TD
	WEPKING	CORALVILLE				76	35	41	BEDS 1 THRU 3
	MENLO	APGENTINE				76		41	
-	FT DODGE		2.678			75	36	39	
		GOWER-CVLL				74		38	50/50
		DAVPT-STVL				80	36	44	
		GILCTY-HOP			-	. 63 63	36	47	50/50 (č
				<b>0 7</b> 7			-		
	RANDALL	CEDAR VAL				76	36	40	PCC LEDGE
	HODGES	GILMORE C				78	36		PCC LEDGE
	PLANO	EXLINE	2.673			71	36	35	
	FLORRY	CORALVILLE	5•257	0.67	56	73	36	37	

	BRITISH	PORTABLE	SKID	TEST				JAN -	14. 1976 PAGE 2
CHRIST	TOFEN ST	FUARTVLE	5.220	1.00	25	76 -	36	40.	4 40T E.S. 2 2038
MEDIAF	POLIS MC	CRANEY	2+654	0+43	29	77	36	41	BED 20
МІТСНЕ	ELL GO	jur e	2.784	0.43	32	79	36	43	REEF
DIXON	CE	DAR VAL	5•573	1.25	31	74	37	37	FULL LOFT FACE
RANDAL	LE CE	DAR VAL	2.746	0•37	33	76	37	39	FULL FACE
SULIV	AN SE BU	IRLINGTON	2.64	9.20	42	80	37	43	BED 18
BROML	E <b>Y</b> CR	USHED GR	2+676	7-03	29	65	37	85	
HAUKE	YE ST	LOUIS	2+678	0 <b>.6</b> 8	27	73	37	36	
CHRIS	TOFSN ST	EWARTVLE	2+654	1-19	29	77	37.	40	. <u>,</u>
DOMZ	EA	GLE CITY	5.717	0.27	30	77	37	40	
LOWDE	N . GO	WER	2.749	1.30	29	81	37	ųų	SCHNECKLOTH
WEEP (	WATER PL	HTM2TTA.	5-691	8-37	25	74	38	36	
WRAGE	co	RALVILLE	2.748	0.44	39	75	38	37	
KOHLEI	R SH	IELL ROCK	2.799	<b>D+34</b>	53	76	38	38	BEDS 1 THRU 8
LOGAN	BE	THANY F	2.674	0.60	25	77	38	39	ан на н
MCGUI	RE GO	WER	2.787	0.60	27	77	38 <u>.</u> .	39	NE 20FT FACE_FLR
DECATI	UR CY BE	THANY F	2.634	1.41	30	73	38	35	8EDS 11-14
M02C0	u ua	PSI	2.796	0.30	30	79	38	4 <u>1</u> ,	an a
LILLY	BRIDG DW	JEN	5•272	0.99	30	81	38	.43	
WEPKI	NG CO	RALVILLE	2-800	0.30	22	77	PE	38	BED 4
<b>TEAI2</b>	QR ST	. FONIZ	2-685	0 • F0	29	77	39	38	8-E 2038
DOMZ	MA	YNES CR	2.685	1.27	34	76	39	37	· · · · · · · · · · · · · · · · · · ·
WATERI		RALVILLE				80	PE	4]	E2-81 2038
ARGYL	т . sт	LOUIS	2.201	n.a7	50	77	39		BEDS 8-13

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•	, 85 I.	ISH PORTABL	e skid	TEST				JAN.	14. 1976	PAGE 3	
	GRAND PIV	BETHANY F	2.587	0.94	85	71	39	37	8EDS 12-12	· · ·	-
	GARNER	OWEN	2•790	0.17	53	78	PE	39			
	CRSNT-QRTZ	BFALLS-QTZ				76	39	37	70/30	, uur, • • • • • • • •	
	ALDEN	GIL CITY	5.679	5.40	35 .	79	39	40		•	
	GARDNER	ST LOUIS	2.688	0.67	23	74	40	34			-
	OLLIS	BURLINGTON	2.F9P	9•13	ЗЬ	75	43 '	35	8ED 15-18		
	JOHNSTON	CRUSHED GR	5•30F	0.60	51	61	40	51			
	WEST SHOP	PROSSER	2.679	0.47	56	78	40	38			•
	PITSOR PIT	CRUSHED GR	2.676	1.16	28	64	40.	24		······································	
	STUCK PIT	CRUSHED GR	2.640	1.61	25	63	. 40	23			
	WALNUT CTY	COOPER CR	2.710	0-27	25	75	40	35	BED L	·	•• • Adder • •
	STENNETT	CLAY CREEK	2.658	1.40	22	75	40	35	BED 13		
	MAYIN	COPALVILLE	2.668	0.84	52	75	40	35			
	THAYER	BETHANY F	s.rjo	3•03 ·	25	76	40	36			
	BRUNS	OWEN	2.710	0.64	30	79	40	39	ويو مو و در وورو اور ويو و المورو ويو الم المراجع الم المراجع الم المراجع الم المراجع الم المراجع الم المراجع ا		
	KUENNEN	CEDAR VAL	2+800	0.57	29	81	40	41			
	MONTI	HOPKINTON			ЗЬ	Al	40	4]	· .		
	FERTILE	CORALVILLE			5J	81	40	4]			
<del>.</del> .	BAGUS	GOWER		0.63		83	40	43	REEF		
	CONKLIN	CORALVILLE				81	41	40			· ·
•	GARRISON	CORALVILLE				81	41	40			
	SHAFFTON	GOWER	2.708	0.40	30	81	41	40	ANAMOSA		
	DANNATT	HOPKINTON				83	41		NEW OPENING 35FT		
	KEZMICK	HAMPTON				83	41		8EDS 13-15 "		
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BRIT	ISH PORTABL	E ZKID	TEST				.JAN•	14. 1976 PAGE 4	
GARNER	OWEN	2-809	0•30	25	74	41	33	FULL FACE	
DANVILLE	SPERGEN	2.695	<b>7 - 7</b> 0	56	77	41	36	05-Ef 2038	
WILDE QR	CORALVILLE	2•735	6.44	85	80	4]	96		
EARLHAM	BETHANY F	2+614	1.76	53	<b>75</b> °	41	34		
QUINBY	SHELL ROCK	2.726	0.73	54	77	41	36	BEDS 1 THRU 10	
HEINHOLD	ST LOUIS	5.646	<b>J•</b> J3	25	78	41	37		
FERTILE	CORALVILLE	2.781	0.93	30	80	41_	39	BEDS-10-17	
FERTILE	CORALVILLE	2-781	0+93	30	80	41	39		
LEGRAND	HAMPTON	2.701	0.80	3 3	80	42.	38		
FARNSWORTH	WORLAND	5•644	0.91	56	73	42	31	BED_1	
SMITH OR	ST LOUIS	2.584	0.73	35	72	42	30		
 KENDALLVLE	STEWARTVLE	2+703	E8+0	27	78	42	36	BEDS 427	••
ALDEN	GIL CITY	2.656	0-67	37	80	42	38		
MCCABE	PROSSER	5•937	0.74	30	79	42	37	49 FT FACE	
WINTERSET	BETHANY F	5.614	5•30	29	78	42	36	· · · · · · · · · · · · · · · · · · ·	
 BLOOM	SOLON	2.682	0+64_	56	.78	.42	36		
<b>FEMI2</b>	SPERGEN	2-704	0+53	56	77	43	34	BEDS L & 7	
ATLANTIC	BETHANY F	2.640	1.59	56	77	43	34	BEDS 25 C & E	
 CONFIDENCE	COOPER CR	5.693	0.85	25	_71	43	38	_BED_6	
ROBINS	SOLON	5.668	1.00	31	75	ដុម្	31 .		
ELKADER	STEWARTVLE	5•237	1.03	39	58	44	38		
CRAWFORD	PAPID-SLN	2.718	C•83	29	76	44	55		<i>.</i>
STANZEL	ARGENTINE	5.657	1.75	36	80	44	36		
JEFFERSON	BETHANY F	2+654	1-45	85	81	44	37		

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Sec. Sec.

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BOONIES       ONEOTA       2-770       7.72       34       81       44       37         SNITH AR       SPERGEN       2-143       1.33       25       82       44       38         HAMKCYE       SPERGEN       2-162       1.43       23       62       44       36         LEGRAND       HAMPTON       2-1640       1.45       30       63       44       37         FESTINA       EDGWOOD       2-1657       1.63       35       84       44       40         BEMR       GOUCR       2-734       1.64       25       84       44       40         PINTS       CORALVILE       2-6475       1.65       33       83       45       36       BEDS 5-13         MONTOUR       HAMPTON       2-721       1.54       43       83       45       36         VINTON       SOLON       2-1642       1.75       37       77       45       32         MALCON R       2-642       1.12       35       74       45       34         MEDIAPOLIS       MASONVE       2-122       36       74       45       34         MEDIAPOLIS       MASONVE       2-163       2.64<	BRIT	ISH PORTABL	E SKID	TEST				٠	JAN. 14. 1976	PAGE 5
HAWKEYE       SPERGEN       2-4.82       1-91       29       82       44       36         LEGRAND       HANPTON       2-4.00       1-95       30       63       44       39         FESTINA       EDGWOOD       2-4.57       1-65       33       60       44       34         DUBUAUE ST       SVILEE-PSR       2-734       1-49       42       44       40         BEHR       GOWER       2-734       1-49       42       44       40         PINTS       CORALVILE       2-155       1-58       33       43       45       36       BEDS 5-13         NONTOUR       HAMPTON       2-721       1-16       43       49       45       35         VINTON       SOLON       2-162       25       76       45       33         MALCON IN       ZAGLE CITY       2-116       2-5       76       45       34         MALON IN       ZAGLE CITY       2-116       2-7       74       45       34         MALON IN       ZAGLE CITY       2-116       2-7       74       45       34         MALON IN       ZAGLE CITY       2-116       2-7       74       45       34 <th>BOONIES</th> <th>ONEOTA</th> <th>2.770</th> <th>n•73</th> <th>34</th> <th>81</th> <th>44</th> <th>37</th> <th></th> <th>;</th>	BOONIES	ONEOTA	2.770	n•73	34	81	44	37		;
LEGRAND       HANPTON       2-640       1-95       30       63       44       34         FESTINA       EDGWOOD       2-659       1-65       33       80       44       36         DUBLQUE ST       SVILLE-PSR       2-764       0-83       35       A4       44       40         BEHR       GOWER       2-734       1-64       42       64       44       40         PINTS       CORALVILE       2-645       3-3       63       45       36       BEDS       5-13         MONTOUR       HAMPTON       2-721       1-36       43       45       35         VINTON       SOLON       2-162       25       76       45       33         MALCON IN       EAGLE CITY       2-714       1-5       32         OSAGE       CEDAR VAL       2-753       0-40       27       77       45       34         MALON IN       EAGLE CITY       2-112       25       76       45       34       BEDS       1-5-18         CEDAR VAL       2-53       0-40       27       77       45       34       BEDS       1-5-18         CEDAR VAL       2-53       2-05       34       <	SMITH OR	SPERGEN	2.691	1.39	25	- 82	<b>44</b>	BB	BEDS 13-164	•
FESTINA       EDGWOD       2.659       1.65       33       80       44       36       BULLERMAN 4         DUBUAUE ST       SVILLE-PSR       2.736       0.83       35       84       44       40         BEHP       GOWER       2.734       0.54       42       84       44       40         PINTS       CORALVILLE       2.655       5.3       33       83       45       36       BEDS       5-13         MONTOUR       HAMPTON       2.721       1.16       43       80       45       35         VINTON       SOLON       2.662       1.22       27       77       45       32         MALCON IN       ZAGE CITY       2.716       1.25       78       45       35         OSAGE       CEDAR VAL       2.753       0.42       77       45       34         MEDIAPOLIS       MASSONUE       2.652       2.05       36       79       45       34         MEDIAPOLIS       MASSONUE       2.652       2.05       36       79       45       34         WAPNHOLTZ       CORALVILLE       2.647       2.22       30       77       45       34       35FT FACE <t< td=""><td>HAUKEYE</td><td>SPERGEN</td><td>5•P95</td><td>1.91</td><td>29</td><td>82</td><td>44</td><td>38</td><td></td><td>· · ·</td></t<>	HAUKEYE	SPERGEN	5•P95	1.91	29	82	44	38		· · ·
DUBUQUE ST SVILLE-PSR 2-736 0-83 35       A4       44       40         BEHR       GOWER       2-734 1-64       42       64       44       40         PINTS       CORALVILLE 2-645 1.58       33       63       45       36       BEDS 5-13         MONTOUR       HAMPTON       2-721 1.54       43       60       45       35         VINTON       SOLON       2-642 1.52       27       77       45       32         MALCON N       Z-642 1.52       27       74       45       33         MALCON N       Z-642 1.52       25       74       45       33         MALCON N       Z-642 1.52       25       74       45       34         MALCON N       Z-642 1.52       25       74       45       35         OSAGE       CEDAR VAL       2-753 0.40       27       71       45       34         MEDIAPOLIS       MASSONVLE       2-553 2.05       36       71       45       34       BEDS 15-18         CEDAR CR       SPERGEN       2-674 2.22       30       77       45       34       35       TOP LEDGE         RICEVILLE       CORALVILE       2-674 1.42       34       35	LEGRAND	HAMPTON	2.640	1.95	30	Eð	44	PE		
BEHR       GOWER       2-734       1.54       42       64       44       40         PINTS       CORALVILLE       2-543       1.54       33       63       45       36       BEDS       5-13         MONTOUR       HAMPTON       2-721       1.56       43       60       45       35         VINTON       SOLON       2-642       1.12       25       76       45       33         MALCON IN       ZAGLE CITY       2-736       1.12       25       76       45       34         OSAGE       CEDAR       VAL       2-537       0.40       27       79       45       34         MEDIAPOLIS       WASSONVLE       2-122       30       77       45       34       BEDS       15-14         CEDAR       VAL       2-753       0.40       27       79       45       34       BEDS       15-14         CEDAR       VAL       2-557       0.40       27       79       45       34       BEDS       15-14         CEDAR       VAL       2-152       30       77       45       31       34       BEDS       15-14         GEDAR VAL       2-162       21	FESTINA	EDGWOOD	2-659	1.65	33	80	44	36	BULLERMAN 4	
PINTS       CORALVILLE       2.645       1.58       33       43       45       36       BEDS       5-13         MONTOUR       HAMPTON       2.721       116       43       AD       45       35         VINTON       SOLON       2.666       1.23       27       77       45       32         MILLER       OWEN       2.622       1.12       25       78       45       33         MALCON       EA6LE       CITY       2.716       1.27       35       A1       45       34         OSAGE       CEDAR       VAL       2.753       0.40       27       79       45       34       BEDS       1.5-1.8         OSAGE       CEDAR       VAL       2.753       0.40       27       79       45       34       BEDS       1.5-1.8         CEDAR       VAL       2.653       2.05       36       77       45       31	DUBUQUE ST	SVILLE-PSR	2.786	C-83	35	ይዛ	44	40		
MONTOUR       HAMPTON       2.721       1.16       43       60       45.       35         VINTON       SOLON       2.666       1.23       27       77       45       32         MILLFR       OWEN       2.662       1.12       25       76       45       33         MALCON       H       EAGLE CITY       2.714       1.29       35       81       45       35         OSAGE       CEDAR, VAL       2.753       0.40       27       73       45       34       BEDS 15-18         OSAGE       CEDAR, VAL       2.753       0.40       27       73       45       34       BEDS 15-18         CEDAR CR       SPERGEN       2.467       2.22       30       77       45       34       BEDS 15-18         CEDAR CR       SPERGEN       2.467       2.22       30       77       45       31         WARNHOLTZ       CORALVILE       2.453       2.05       34       45       35            RICEVILE       CEDAR VAL       2.452       2.33       82       45       34       35FT FACE         BEDF FORD       ERVINE CR       2.377       2.62	BEHR	GOWER	2•734	1-69	42	84	ųų	40		
VINTON       SOLON       2+662       1.23       27       77       45       32         MILLER       OWEN       2+62       1.22       25       78       45       33         MALCOR       EAGLE CITY       2-7.16       1.22       25       78       45       34         OSAGE       CEDAR       VAL       2-753       0.40       27       79       45       34         OSAGE       CEDAR, VAL       2-753       0.40       27       79       45       34         MEDIAPOLIS       WASSONVLE       2-653       2.05       36       77       45       34         MEDIAPOLIS       WASSONVLE       2-653       2.05       77       45       31         WAPNHOLIZ       CORALVILLE       2-647       2.16       34       35	PINTS	CORALVILLE	2.695	1-58	33	83	45	Зð	8205 5-13	
MILLER       OWEN       2+662       1+12       25       78       45       33         MALCOM M       EAGLE CITY       2+716       1+23       35       81       45       36         OSAGE       CEDAR VAL       2+753       0+40       27       73       45       34         MEDIAPOLIS       WASSONVLE       2+653       2+05       34       77       45       31         MEDIAPOLIZ       CORALVILE       2+657       2+22       30       77       46       31         WARNHOLTZ       CORALVILE       2+674       1+22       45       45       35	MONTOUR	HAMPTON	2.721	1.16	43	80	45.	35		· · · · · · · · · · · · · · · · · · ·
MALCON H       EAGLE CITY 2-716 1-27       35       81       45       36         OSAGE       CEDAR, VAL       2-753       0-40       27       79       45       34         MEDIAPOLIS       WASSONVLE       2-653       2-05       36       77       45       34       BEDS 15-18         CEDAR, CR       SPERGEN       2-657       2-22       30       77       46       31         WAPNHOLTZ       CORALVILLE       2-647       1-62       63       45       35	VINTON	SOLON	5.666	7•53	27	77	45	32	· · · · · · · · · · · · · · · · · · ·	
OSAGE       CEDAR VAL       2-753 0.40       27       73       45       34         MEDIAPOLIS       WASSONVLE       2-653 2.05       36       71       45       34       BEDS 15-18         CEDAR CR       SPERGEN       2-667 2.22       30       77       46       31         WAPNHOLTZ       CORALVILLE       2-647 1.42       53       45       35       TOP LEDGE         RICEVILLE       CEDAR VAL       2-662 2.16       34       40       46       34       35FT FACE         BEDFORD       ERVINE CR       2-377 2.62       33       82       46       36         KESWICK       HAMPTON       2-731 1.23       26       84       46       34         EDGEWOOD       HOPKINTON       2-730 0.70       36       81       47       34         STURTZ       CRUSHED GR       2-704 1.48       26       147       32         BROWN       SVILLE       2-730 0.47       36       84       47       35         BROWN       SVILLE       2-730 0.47       36       84       47       34	MILLER	OWEN	5.695	<b>7•75</b>	25	78	45	33		
MEDIAPOLIS       WASSONVLE       2.653       2.657       2.657       2.657       2.657       2.657       30       77       46       31         WARNHOLTZ       CORALVILLE       2.657       2.62       30       77       46       35	MALCOM M	EAGLE CITY	2.716	1.54	35	81	45	36	. <u> </u>	
ICDIA FOLIS       WASSONALCE       ELBS       EL	OSAGE	CEDAR, VAL	2.753	0.40	27	79	45	эų		and a state of the
WARNHOLTZ       CORALVILLE       2+674       1+62       35       TOP LEDGE         RICEVILLE       CEDAR VAL       2+682       2+16       34       35FT FACE         BEDFORD       ERVINE CR       2+377       2+62       33       82       46       34         KESWICK       HAMPTON       2+739       1+23       28       84       46       34       IA FALLS       E CITY         EDGEWOOD       HOPKINTON       2+730       0+70       35       81       47       34       44         STURTZ       CRUSHED GR       2+708       1+48       28       64       47       22         BROWN       SVILLE       2+754       0-93       33       83       47       35         BOWSER       GOWER       2+773       0-83       84       47       34       47	MEDIAPOLIS	WASSONVLE	2-653	2.05	38	79	45	34	8EDS 15-18	
RICEVILLE       CEDAR VAL       2.682       2.16       34       35FT FACE         BEDFORD       ERVINE CR       2.377       2.62       33       A2       46       36         KESWICK       HAMPTON       2.737       2.62       33       A2       46       34       IA FALLS       E CITY         EDGEWOOD       HOPKINTON       2.730       1.23       28       A4       45       34       IA FALLS       E CITY         EDGEWOOD       HOPKINTON       2.730       0.70       34       A1       47       34	CEDAR CR	SPERGEN	2.667	5•55	30	77	46	31		
BEDFORD       ERVINE CR 2.377 2.62 33       B2       46       36         KESWICK       HAMPTON       2.739 1.23       28       84       46       38       IA FALLS       E CITY         EDGEWOOD       HOPKINTON       2.730 0.70       36       81       47       34       47       34         STURTZ       CRUSHED GR 2.708 1.48       28       64       47       32       34       47       34         BROWN       SVILLE       2.754 0.93       33       83       47       34	WARNHOLTZ	CORALVILLE	2.674	7.65	63	81	. 46	Э5.	TOP LEDGE	• • • • • • • • • • • • • • • • • • •
KESWICK       HAMPTON       2.739       1.23       28       84       45       38       IA FALLS_E CITY         EDGEWOOD       HOPKINTON       2.730       0.70       35       81       47       34	RICEVILLE	CEDAR VAL	5•P95	5-12	34	80	46	34	35FT FACE	
EDGEWOOD HOPKINTON 2.780 0.70 35 81 47 34 STURTZ CRUSHED GR 2.708 3.48 28 59 47 32 BROWN SVILLE 2.754 0.93 33 83 47 35 BOWSER GOWER 2.773 0.67 38 85 47 39	BEDFORD	ERVINE CR	2-377	5.65	ΞΞ	58	46	36		annan ann an an an ann an an an an an an
STURTZ       CRUSHED GR 2.708 1.48 28 69 47 22         BROWN       SVILLE       2.754 0.93 33 63 47 35         BOWSER       GOWER       2.773 0.47 38 85 47 39	KEZMICK	HAMPTON ,	2.739	1-53	58	84	46	ΒĒ	IA FALLS E CITY	
STURTZ     CRUSHED GR 2.708 1.48 28 69 47 22       BROWN     SVILLE       2.754 0.93 33     83 47 35       BOWSER     GOWER       2.773 0.47 38     85 47 39	EDGEWOOD	HOPKINTON	2.730	0.70	36	81	47		<b>x</b> .	
BROWN SVILLE 2.764 0.93 33 63 47 36 BOWSER GOWER 2.773 D.67 36 66 47 39	STURTZ	CRUSHED GR	2.708	1-48	28	69	47	22	•	anna a chlanna anna an a' chlanna an an a chlanna an an a
	BROWN	SVILLE	2.764	0.93	EE	83.	47	ЭЬ		· · · · · · · · · · · · · · · · · · ·
EDDYVILLE ST GEN 2+656 0+90 36 76 48 28	BOWSER	GOWER	2•773	0.37	ΒĒ	86	47			
	EDDYVILLE	ST GEN	5.626	0.90	36	75	48	59	· · · · · · · · · · · · · · · · · · ·	, , , , , , , , , , , , , , , ,

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FERGUSON	HAMPTON	5•735	5+66	38	85	48	37		1
SWALEDALE	OWEN	5-913	1-10	31	80	43	32	HIGH FET A	
VERNON	GOWER	2+740	1.69	31	84	45	36	ANAROSA	2000 - 100 -
BAGUS	GOWER	2+895	0.27	51	80	49	31		
COMANCHE	SPERGEN	2+538	4.16	35	81	49	32		
KURT	HOPKINTON	2.799	0•33	30	83	49	34	CHERTY	-
LOGAN	HOPKINTON	2+754	1-06	35	83	49	34		
MAR-JO HIL	SVILLE	2.766	8 - 57	40	85	49	36	•	
BALLOU	GOWER	2.779	0.30	34	87	49.	38		
SUNDHEIM	HOPKINTON	2•787	0-60	38	83	50	. 33	CHERTY	
FARMERS	HOPKINTON	2.784	0-93	35	84	50	34		·
DURHAM	ST LOUIS	2.580	1.78	55	85	50	36	ARENACEOUS	
COLUMBUZ 1	WASSENVLE	2.698	3•0F	ЭГ	87	50	37	CHERTY	
FARMINGTON	ST L-SPERG	5-669	2.14	30	81	51	30	BEDS 13 THRU 16	
CORNING	ERVINE CR	2.654	0•93	29	83	51,	32	BEDS 3-5	·····
LECLAIRE	GOWER	2•783	0.33	.37	87	51	.36	ANAMOSA	
LANSING	HOPKINTON	2.776	0.75	35	83	52	31	CHERTY	•
PRESTON	HOPKINTON	2.737	1.29		85	53	32	CHERTY	· - ·····
SOUTH C R	GOWER	2+754	0•80	27	88	53	35	ANAMOSA-HOPKINTN	· · · ·
DOUDS MINE	SPERGEN	2.644	5.97	40	58	54	- 65	BEDS LOA THRU LS	
FRANKLIN	SPERGEN	2+576	5+44	27	84	56	28	8ED 12	tanan mangana aliyofa da da a a a a a a a a a a a a a a a a
YOUNG AMCA	WASSONVLE	2.587	2.86	77	87	58	29	CHERTY	· ·

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- $(A_{ij}) = \frac{1}{2} \left( \frac{1}{2} \left( \frac{1}{2} - \frac{1}{2} \right) \right)^{-1} \left( \frac{1}{2} - \frac{1}{2} - \frac{1}{2} \right)^{-1} \left( \frac{1}{2} - \frac{1}{2} \right)^{-1}$ 

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APPENDIX E

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BRITISH PORTABLE SKID TEST

JAN- 14- 1976

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APPENDIX E

QUARRY	UNIT	3P 6	284	ABR	WASHED	POLISHED	DIFF	COMMENTS
÷ .	TYPE 0 M	12C .		•				
BROMLEY	CRUSHED GR	R 2.676	<b>1=0</b> 3	29	65	37	59	
JOHNSTÓN	CRUSHED G	R 2.70]	6.60	57	61	43	51	
PITSOR PI	T CRUSHED G	R 2+676	. l.16	85	64	40	54	
STUCK PIT	CRUSHED G	R 2.640	) ]*8]	25	63	40.	23	
	CR GRAVEL				76	44	35	
DELL RPDS	QUARTZITE				74	45	29	
DELL RPDS	QUARTZITE				75	46	30	
	CR GRAVEL				80	46	34	
STURTZ	CRUSHED G	R 2.79	3 3.48	85	63	47	22	
DRESSER	TRAPROCK				75	49	26	
DRESSER	TRAPROCK				78	49	29	•
	TYPE L ST	ιιιτεοι	JS CAR	BONAT	ES (CHE	RTY-SANDY	)	
LANGSTRAT	T ST LOUIS	2+645	5 0.73	85 1	75	ЭЧ	41.	
HAUKEYE	ST LOUIS	2.676	8 C.68	27	. 73	37	36	
ZEDGMICK	HOPKINTON				ô1	37.	44	
SEDGWICK	HOPKINTON				81	37	44	
LEWIS OR	ST LOUIS	5.193	5 8.63	54	77	39	38	BEDS 3-5
ARGYLE	ST LOUIS	2.703	1 0.87	· 50	77	39	38	BEDZ 8-J3
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BRIT	ESH PORTABLE	SKID	TEST	-				JAN. 14. 1976	PAGE 2
DOMZ	MAYNES CR	8+585	1-22	34	75	39	Э7		
 FERGUSON	MAYNE'S CR			•	79	40	39		
WEST SHOP	PROSSER	2.679	0.47	55	78	40	38		
GARDNER	ST LOUIS	5.699	0-67	53	74	40	34		· · · · · · · · · · · · · · · · · · ·
DANVILLE	SPERGEN	2.683	1-10	56	77	41	36	8ED2 13-20	
HEINHOLD	ST LOUIS	2-696	1.13	75	78	41	37	···· • • • • • • • • • • • • • • • • •	// 11/1/
 FERGUSON	MAYNES CR				79	41	38		
SMITH @R	ST LOUIS	2-684	0•70	32	72	42	30	•	
LEGRAND	HAMPTON	5•401	0.80	33	80	42 -	38		····
 LEWIS	SPERGEN	2.774	0-53	56	7?	43	34	· · · · · · · · · · · · · · · · · · ·	
BOONIES	ONEOTA	2.770	0•73	34	81	ųų	37		
SMITH QR	SPERGEN	5.647	1-39	25	83	44	8E		······································
HAWKEYE	SPERGEN	5-295	1-91	29	82	44	38		
LEGRAND	HAMPTON	2.640	1.95	30	83	ųų	39	· · · · · ·	· · · · · · · · · · · · · · · · · · ·
DUBUQUE ST	SVILLE-PSR	2.785	0+83	35	84	44	40		· • • • • • • • • • • • • • • • • • • •
MONTOUR	HAMPTON	5.457	1.16	_43	80	45 .	35		
WARNHOLTZ	CORALVILLE	2+674	1.75	63	81 	46	35	TOP LEDGE	
CEDAR CR	SPERGEN	2+667	5•55	30	77	46	Эſ		
EDGEWOOD	HOPKINTON	2-780	0-70	36	81	47	34		
FERGUSON	HAMPTON	5-695	5+0P	38	<del>8</del> 5	48	37		
COMANCHE	SPERGEN	R+588	4.16	32	81	49	32	жа, , , , , , , , , , , , , , , , , , ,	
KURT	HOPKINTON	2.799	0.33	30,	83	49	34		
SUNDHEIM	HOPKINTON	2.787	0.60	38	83	50	33	,	
DURHAM	ST LOUIS	2.580	1.78	25	85	ŝo	36	, <b>na ar na</b> ann a na an I	ana an ann an

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	ISH PORTABL	E ZKID 1	TEST		•		, J	AN. 14. 1976			PAG	<b>3</b>	
COFAMBAZ 1	WASSENVLE	3-698	3+05	31	87	50	37		· •				۰ -
FARMINGTON	ST L-SPERG	8+69 8	2.14	30	81	51	30			,			
LANSING	HOPKINTON	2.776 5	3-75	35	83	52	37						
PRESTON	HOPKINTON	2.737	1-29		35	53	35	•		- / • • •			
DOUDS MINE	SPERGEN	з <b>.</b> гия з	2.81	48	82	54	85						
FRANKLIN	SPERGEN	2.576 5	5-44	27	84	56	85					-	
YOUNG AMCA	WASSONVLE	2.587 8	<b>2∙8</b> ⊾	33	37	58	54	,				······································	
							2						
	TYPE 2 MI	CRITIC L	IMES	TONE (	MICROCA	YSTALL	INE-LITH	OGRAPHIC)	۰ ۰			· ·	· · · ·
MOSCOW	DAVENPORT				75	30	. 45			**			
MENLO	ARGENTINE	·			74	31	43		·				
FARMINGTON	ST GEN	2.724 ]	1.68	51	70	33	37	۱۹۹۵ - ۱۹۹۹ کی میں میں میں میں میں ایک ایک ایک		m- · m			
			n inn	36	74	33							
LUBBEN	CORALVILLE	-2.700 0	3 • 40	ti, al	17	33	43.						
	- DAVENPORT	-2•700 0		с. <b>.</b> Э	77	33	<u>ч</u> ы. Чч	· · · · · · · · · · · · · · · · · · ·				-	
	•	-2+700 0		u		33	-	· · · · · · · · · · · · · · · · · · ·			•		······································
MOSCOW	DAVENPORT				77	33	44	· · · · · · · · · · · · · · · · · · ·			•		
MOSCOW	DAVENPORT	2.700 (	)•13	. 54	77 77	33	44 44	· · · · · · · · · · · · · · · · · · ·			• •	-	······································
MOSCOM MENFO MOSCOM	DAVENPORT ARGENTINE DAVENPORT	2.700 C	)•13 ]•54	29 .	77 77 77	33 33 33	44 44 44	BED 2SE			• •		
MOSCOU MENLO MOSCOU CRESCENT	DAVENPORT ARGENTINE DAVENPORT BETHANY F BETHANY F	2.700 C	0•13 0•54 0•60	29 . 25 27	77 77 77 75	33 33 33 33	44 44 44 43 43	BED 25E			•		
MOSCOU MENLO MOSCOU CRESCENT LOGAN	DAVENPORT ARGENTINE DAVENPORT BETHANY F BETHANY F EXLINE	2.543 C	0•13 0•54 0•60 0•34	. 29 25 27 25	77 77 77 75 75	33 33 39 34 34 34 34	44 44 44 43	BED 25E			· · · · · · · · · · · · · · · · · · ·		
MOSCOU MENLO MOSCOU CRESCENT LOGAN CONFIDENCE	DAVENPORT ARGENTINE DAVENPORT BETHANY F BETHANY F EXLINE ARGENTINE	2.700 ( 2.673 ( 2.674 ( 2.693 ( 2.643 (	0 • 13 0 • 54 0 • 54 0 • 34 1 • 70	29 25 27 25 24	77 77 75 75 75 72	33 33 33 34 34 34	44 44 44 41 41 37	BED 25E					
MOSCOU MENLO MOSCOU CRESCENT LOGAN CONFIDENCE MENLO PLANO	DAVENPORT ARGENTINE DAVENPORT BETHANY F BETHANY F EXLINE ARGENTINE EXLINE	2.5700 ( 2.573 ( 2.574 ( 2.543 ( 2.553 ( 2.553 (	0 • 13 0 • 54 0 • 54 0 • 34 0 • 34 1 • 70 3 • 30	29 25 27 25 24 23	77 77 75 75 72 76 71	33 33 34 34 34 35 35 35	44 44 41 41 37 41 35			· · · · · · · · · · · · · · · · · · ·			
MOSCOU MENLO MOSCOU CRESCENT LOGAN CONFIDENCE MENLO PLANO FLORRY	DAVENPORT ARGENTINE DAVENPORT BETHANY F BETHANY F EXLINE ARGENTINE	2.700 ( 2.673 ( 2.674 ( 2.693 ( 2.653 ( 2.653 ( 2.673 ( 2.673 ( 2.673 (	0 • 13 0 • 54 0 • 54 0 • 34 0 • 34 0 • 30 0 • 57	29 25 25 24 23 25 24	77 77 75 75 72 76	33 33 39 34 34 34 35 35	44 44 41 41 41 37 41		Ċ	· · · · · · · · · · · · · · · · · · ·	•		

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<u>.</u>	BRIT	ISH PORTABL	E SKID	TEST				JA:	N. 14. 1976		PAG	E 4	
4	LOGAN	BETHANY F	2.624	D.60	25	77	35	39		•		;	
<b>۰</b> , -	GRAND RIV	BETHANY F	2.687	0.94	65	73	PE	31	8EDS 12-15	5			
	STENNETT	CLAY CREEK	3-658	1.40	22	75	40	35					
3	WALNUT CTY	COOPER CR	2.710	9.27	25	75	40	35		·			
٦.	THAYER	BETHANY F	2.630	3•03	25	76	40	36					
	EARLHAM	BETHANY F	2.534	1.76	53	75	41	34			. <u> </u>		
r	WINTERSET	BETHANY F				78	42	36				-	
<b>`</b>		WORLAND				73	42	31	BED 1				
		COOPER CR				71	43	38	· <u> </u>		• 	· · · ·	
<b>٦</b>	ATLANTIC	BETHANY F				77	43	34					
۰. ۲		BETHANY F				81	44	37	., <u>,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,</u>	A ANNA ANNA ANNA ANA ANA ANA ANA ANA AN		· · ·	
, -	STANZEL	ARGENTINE				80	44	36	а. — фалага с маанын санын тт Нуло	······································			
3	BEDEORD	ERVINE CR				93	46	36	•				
٦	CORNING	ERVINE CR				63	51	32	•				
,	Contra			<b>L</b> - 13	C /					and and a constant			
•		TYPE 3 CL	DITZA	LIMEST	ONE (	00LITIC	-BIOCLA	STIC}		•			
a	FT DODGE	GIL CITY				71	32	39				·	
	GILMORE C	GILMORE C	2.648	0.90	35	77	35	42	36FT NW				
2	FT DODGE	GIL CITY	2.678	0.37	33	75	36						
1		GOWER		0.43		79	36	43.	i	÷*			
-	FT DODGE	GIL CITY				74	36		· · · · · · · · · · · · · · · ·	,			
9		GILMORE C	8+167	1.81	42	78	35		PCC LEDGE	-			
0 		BURLINGTON				80	37	43	BED TB	•		•	
		GIL CITY				79	39	40				-	
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4								-		- <u></u> - 14 - 24.5			
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8911	ISH PORTABL	E SKID	TEST					JAN. 14. 1976	PAGE 5
OLLIF	BURLINGTON	3.686	0-13	32	75	40	35		
BRUNS	OHEN	5•370	0-64	зo	79	40	39		
ALDEN	GIL CITY	2.626	0.67	37	87	42	38		
BLOOM	SOLON	2.685	C+64	SP	78	42	36	· · · · · · · · · · · · · · · · · · ·	
CRAUFORD	RAPID-SLN	5.718	0-83	29	76	կկ	35		
ROBINS	ZOLON	2+658	1-00	31	75	44	37	− veterseetings + ter tagge under to t − t − to t + t + t + t	
VINTON	SOLON	5.666	1.53	27	77	45	35	a - an an a succession and	14. 1. 17. 19. 19. 19. 19. 19. 19. 19. 19. 19. 19
MILLER	OWEN	5•P95	1.15	25	78	45	33	•	
EDDYVILLE	ST GEN	5-626	0-90	36	76	48	28	n mar an an ann an	······································
	TYPE 4 DOI	LONITE	(FINE	TO CO.	ARSE CR	YSTALLIN	IE)		Annen - Antonio - Anto
LOUDEN	GOWER	2.749	1.30	29	81	37	44	nn a sanna a san a san ann an an an ann an	ng maa amaan ka
MOSCOW	WAPSI	2.796	0•30	30	79	38	41	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·
MCGUIRE	GOWER	2.787	0.60	27	?7	38	39		
GARNER	OWEN	2.790	0.17	23	78	PE	39	t na ing maganin ni ni mithandana, ni inanggana in	1.5 - 1.1 - Main (1.889)
WEPKING	CORALVILLE	2.800	0+30	<b>5</b> 5 °	77	_39	38		
KUENNEN	CEDAR VAL	2-800	0.57	29	81	40	41		م. م
FERTILE	CORALVILLE	2.770	C•83	51	81	40	41	· ·	· · · · · · · · · · · · · · · · · · ·
BAGUS	GOWER	2•793	0.63	25	EB	40	. 43		-
MONTI	HOPKINTON	2.759	0.60	36	81	40	41		• • •
GARNEP	OWEN	2-809	0.30	25	74	41.	33	FULL FACE	
DANNATT	HOPKINTON	2•755	1.53	29	83	41	42		
FERTILE	CORALVILLE	2-781	0+93	30	80	41	٩E		
SHAFFTON	GOWER	2.704	0.40	30	81	41	40		

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	84111	SH PORTABLE	ZKID	TEST					JAN. 14. 1976	PAGE 6
KES	WICK	HAMPTON	2.683	3-13	35	83 <u>.</u>	ń Ĵ	42		· · · · · · · · · · · · · · · · · · ·
ELK	ADER	STEWARTVLE	5-237	1-03	39	52	44	36		
8EH	IR	GOWER	2.734	1.69	42	84	՝ կկ	40		
KES	WICK	NOTEMAN	2.739	1-53	65	84	46 -	βĘ		* · · · · · · · · · · · · · · · · · · ·
BRO	) WN	SVILLE .	2.764	0.93	33	83	47	36		
80 a	ISER	GOWER	2.773	<b>₽+87</b>	38	86	47	39	······································	aran a an
LOG		HOPKINTON				83	ų7	36		
LOG		HOPKINTON				58	48	34		
	• .	OWEN	5•973	1.10	71	80	48.	32	HIGH F&T A	
		GOWER		1.09		84	48	. 36 .		
BAG		GOWER	2-805		57	80	49	37		analananana gangananana an manakanananana a ununya ya anaya ya a anaya ya a anaya a a a
		GOWER	2+779		34	67	49	38		
	-J0 HIL			0+57		85	49	36		
		•	2.754			83 -	49	34	, , , , , , , , , , , , , , , , , , ,	
LOC		HOPKINTON							· · · · · · · · · · · · · · · · · · ·	
		HOPKINTON	2-784			84	50	34		·
		GOWER		0•33 <u>.</u>		87	51.	. 36	· · · · · · · · · · · · · · · · · · ·	
10 2	JTH C R	GOWER	2-754	0-80	27	88	53	35	n an an an airtean airtean an an an an an an	
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		TYPE 5 MI	KED LI	MESTON	E AND D	OLOMIT	E)			
LI	NMO OD	DAV-SP GR	2+676	0.67	41	74	31	43	× *	-
201	LIVAN S	MCCRANEY	5+705	9•37	85	.75	34	41		· · · · · · · · · · · · · · · · · · ·
DU	ENOW	CORALVILLE	2+771	0•30	85	75	35	41		
<b>WE</b> I	PKING	CORALVILLE	5.243	0+84	24	76	<b>3</b> 5	41		•
ĊH	RISTOFSN	STEWARTVLE	5*220	1.00	25	75	ЭР	40	· · · · · · · · · · · · · · · · · · ·	a a fan a fan annen ann an a' a' an an a' fangarail dhafangallan a con a' ann an a' a' a' a a' a' a' a' a' a' a

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	BRITI	ISH PORTABLE	E SKID	TEST				JAN.	14. 1976	PAGE ?	
	RANDALL	CEDAP VAL	2.759	<u>.</u>	<b>ت</b> ت	75	36	40	PCC LEDGE		
	MEDIAPOLIS		2.654			77	36	43		·	
	DOM2	EAGLE CITY				77	37	40			
	DIXON	CEDAR VAL				74	37	37	FULL JOFT FACE	a a la actuar e constancemente e constancemente e constancemente e constancemente e constancemente e constancem	
	RANDALL	CEDAR VAL			33	76	37	39	FULL FACE	· · · · · · · · · · · · · · · · · · ·	, -
		STEWARTVLE				7?	37	40		•	
	LILLYBRIDG	OWEN	5•272	0-99	30	<u>81</u>	38	43	na an an an anna an an an an an an an an	an - maaa aa a	
	URAGE	CORALVILLE	2-748	0.44	39	75	38	37		• • • • • • • • • • • • • • • • • • • •	
	KOHLER	SHELL ROCK	2.799	0•34	E 5	75	BE .	38		· · · · · · · · ·	
	FERGUSON	EAGLE CITY				75	39	39		· · · · · · · · · · · · · · · · · · ·	
	WATERLOO S	CORALVILLE	2.719	0-86	25	80	39	41	8ED2 78-53		
	MAXIN	CORALVILLS	5.679	0.84	52	75	40	35		K. K. J. FRANK ANALYSING STREAM S STREAM STREAM ST STREAM STREAM ST STREAM STREAM ST STREAM STREAM ST STREAM STREAM ST	
-	WILDS OR	CORALVILLE	2•735	0.44	85	80	41	39		· · · · · · · · · · · · · · · · · · ·	
	QUIMBY	SHELL ROCK	2+726	0.73	29	77	41	36			•
	CONKLIN	CORALVILLE	5.639	0.13	29	81	41	40		د المراجع المر المراجع المراجع	
	FERGUSON	EAGLE CITY				80	4].	39			
	GARRISON	CORALVILLE	2.732	0.57	25	81	41	40		· .	
	MCCABE	PROSSER	5.647	0-74	30	79	42	37	49 FT FACE	ал ба — маниманиција и мунија и минија и како и како и маниманија — " са — " — " М. — "	
	KENDALLVLE	STEWARTVLE	2.703	0-83	22	78	42	.36	······································		• ···
	FESTINA	EDGWOOD	2+659	1.65	ЭЗ	80	44	36 <sub>.</sub>	BULLERMAN .a.		
	OSAGE	CEDAR VAL	2.753	8.40	27	79	45	34			
	MALCOM M	EAGLE CITY	2.716	7•53	35	81	45	36		······································	<b></b>
	MEDIAPOLIS	WASSONVLE	2.653	2.05	ΒE	79	45	34			
	·	CORALVILLE				83	45	38	BEDS 5-13	· · · · · · · · · · · · · · · · · · ·	- · ·
								•	· · · · · · · · · · · · · · · · · · ·	· · · · · · · · · · · · · · · · · · ·	<b>-</b> .
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<b>`</b> . ·	,' BRITISH POR	TABLE SKID	TEST			JAL	N. 14. 1976	PAGE 8
<u>`</u>	RICEVILLE CEDAP	VAL 2.542	2.16 34	80	46	34	35FT FACE	
<b>~</b>	BEHP-LUBBN GOWER-	CVLL	********	74	35	38	50/50	
	MOSCOW-ELK DAVPT-	STVL	•	80	36	4 <b>u</b>	50/50	
<b>م</b>	ALDN-SEDGE GILCTY	-HOP		83	36	47	50/50	
3	CRSNT-QRTZ BFALLS	-QTZ		75	39	37	06/07	
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