INVESTIGATION OF LIMESTONE COARSE AGGREGATE FROM THE WATERVILLE, OHIO, QUARRY OF THE FRANCE STONE COMPANY

C. D. Church
G. R. Cudney

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As a result of R. H. Vogler's comments on non-durability of certain pieces of laminated or striated limestone found in aggregate from the Waterville quarry, on February 4, 1964, W. W. McLaughlin initiated a research study for evaluation of limestone coarse aggregate from this source, with respect to frequency and size of concrete pavement popouts.

Evaluation Procedure

In order to establish a reference with regard to popout size and frequency, three additional coarse aggregate sources were selected--four pits in the Grand Rapids Area (Nos. 41-1, 41-16, 41-38, 41-56), the Oxford pit of American Aggregates (Nos. 50-15 and 63-4), and Davidson's Bundy Hill pit (30-35).

A list was compiled, giving the number and total mileage of pavement projects constructed with coarse aggregate from each of these sources for two construction years--1959 and 1962. The single exception was the Bundy Hill source, which was used in 1959, but not in 1962. This list included dual roadway projects ranging in length from 2.80 to 33.32 miles.

The survey procedure involved two-stage sampling. The first stage was selection of 100-ft long sections as the primary sampling units. Then, for the second stage, sub-units were chosen from each primary unit. The first primary unit for each project was selected in a random manner, and all subsequent units chosen systematically at fixed, regular intervals. The interval length depended on the project's length, and varied so that the desired number of primary units (50) could be obtained from each source. The unit selected was then partitioned into

20 equal sub-units, with 10 in each lane, of which 5 were selected at random. Within these sub-units the complete popout count was taken.

Results of Evaluation

The most salient feature of the survey is that the projects supplied from the Waterville source emerged with very few popouts. The projects constructed in 1959 using Waterville aggregate had no popouts at all, and in all size categories the 1962 Waterville projects had much fewer than those using the other sources. It would be interesting to investigate the aggregate composition used in the 1959 projects, to determine the reason for absence of popouts.

The Figure 1 frequency distributions display other useful information. It should be borne in mind that these frequencies are percentages of total popouts, including all sources and both years within a particular size class. One observation that can be made is that the ranking of sources varies among size classes. Considering the 1959 data, for example, Oxford has most popouts (38 percent) in the 1/2 to 1-1/4 in. class, but Oxford's percentage decreases with popout size, and is the smallest (14 percent) in the 4-in. class. Excluding Waterville, Bundy Hill is best in the small size class (8 percent), but worst (46 percent) in the large size class. No trend among size classes is evident for Grand Rapids, however.

Another comparison using this chart is between construction years. For the first two size classes, the 1959 projects had approximately three times as many popouts as the 1962 projects. In the other size categories the ratio is much greater. Of course, the most interesting comparison here is between years for a given source. For instance, in the 1/2- to 1-1/4-in. size class the ratio for Oxford is 4:1 while for Grand Rapids the approximate ratio is 2:1.

Figure 2 shows a series of frequency distributions of the percent of total popouts for a given source-year for the several sizes. This chart is less informative, but shows that for each source-year (except Bundy Hill in 1959) approximately 90 percent of the popouts are from 1/2 to 1-1/4 in. in diameter.

Actual popout frequencies for the various sources, years, and size classifications are given in the following tabulation:

Source		Diameter Size Classification, in.					Total
		1/2 to 1-1/4	1-1/4 to 2	2 to 3	3 to 4	4 +	
1959	Bundy Hill	3,556	831	483	341	183	5,384
	Grand Rapids	13,156	442	622	294	136	14,650
	Oxford	16,923	691	448	111	57	18,230
	Waterville	0	0	0	0	0	0
1962	Bundy Hill	– – not used in 1962 – –					
	Grand Rapids	6,288	343	113	12	11	6,767
	Oxford	3,935	424	121	58	7	4,545
	Waterville	831	30	8	1	0	870

Since equal areas of pavement were surveyed for each source-year combination (approximately 0.5 lane miles), it is possible to compare performance in terms of popouts, working directly from this table. It should be noted, however, that some sources exhibit relatively high frequencies of large popouts, which are more detrimental to the pavement surface.

Summary

The results of this survey and evaluation showed that projects constructed with the Waterville aggregate had relatively few popouts. The projects constructed in 1959 using this source had no popouts at all of any size, and in all size categories the 1962 projects had much fewer popouts than any of the control sources. Based on the results of this comparative survey, the Waterville aggregate source was significantly superior to each of the other three sources with respect to popout quantity and size.
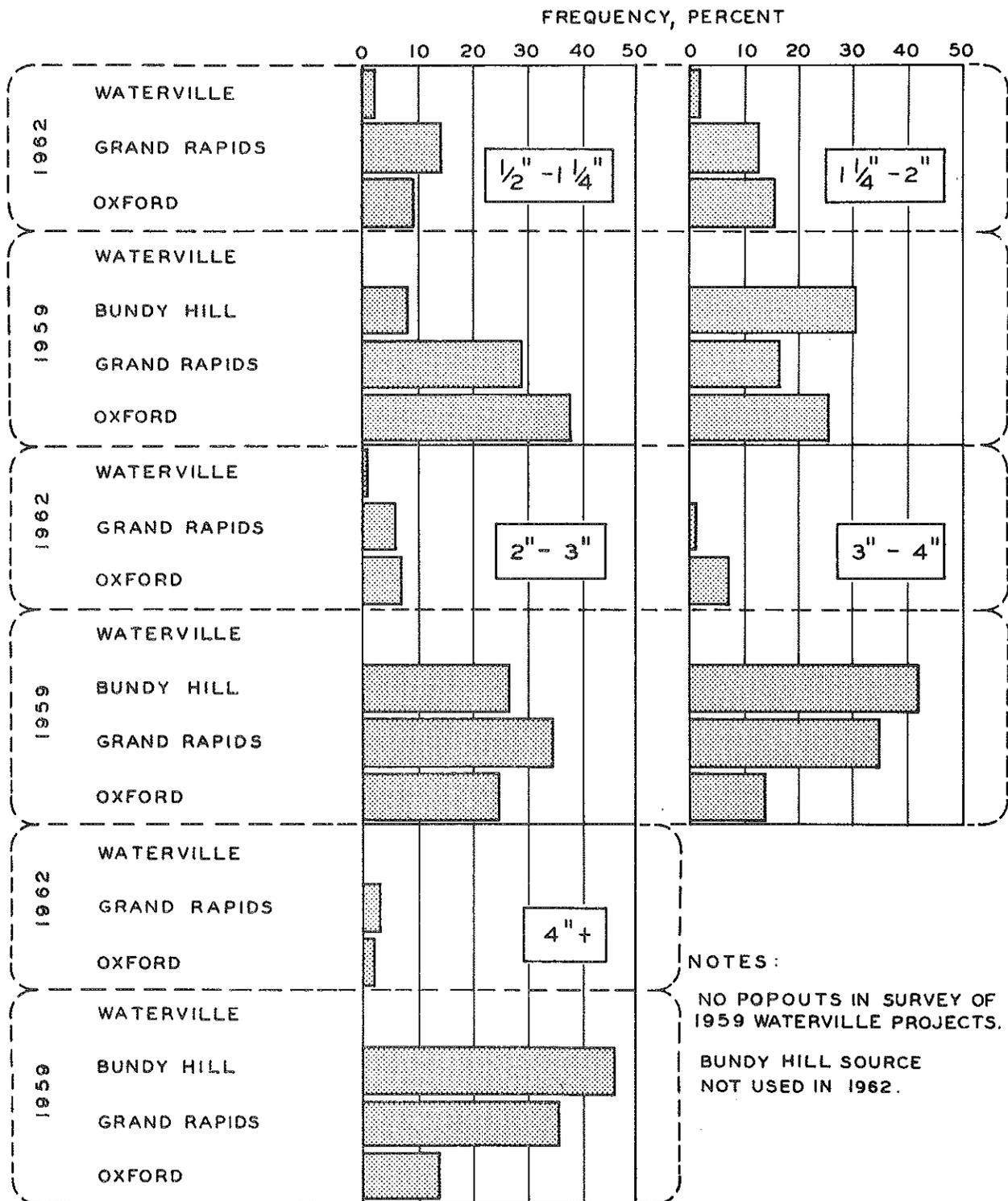
Figure 1. Frequency distributions of percent of total popouts in five diameter size classes.
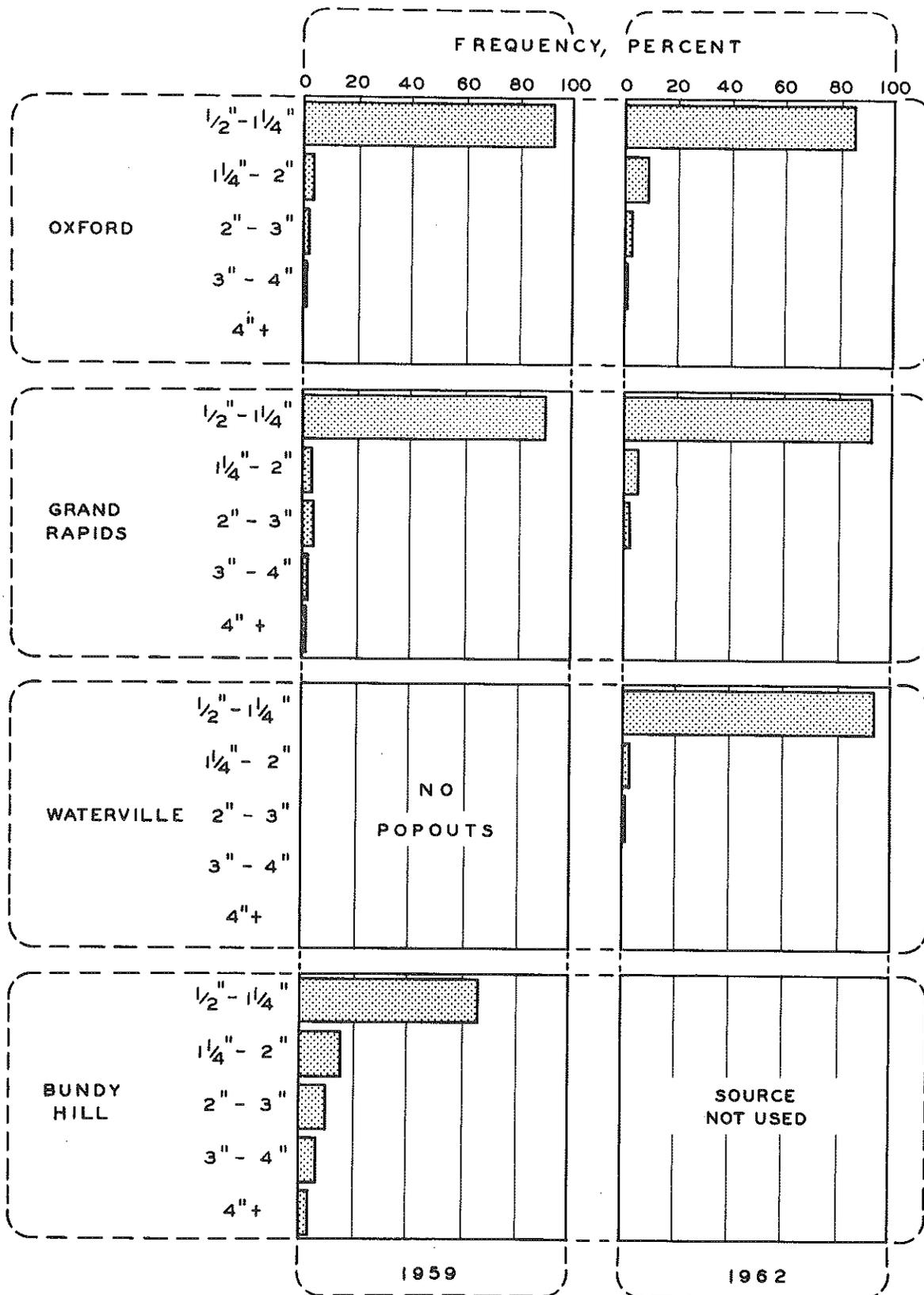
Figure 2. Frequency distributions of percent of total popouts for given source years in five diameter size classes.