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REPORT ON THE ALLWOOD QUARRY

by

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for

A. P. MUNNING & COMPANY

Allwood Quarry

The examination of this quarry was made, November 11, 1920 at the request of Mr. Guy S. Warren. In conference with him it was decided to make a brief study of the quarry paying especial attention to two types of rock, the Vienna and the milk of magnesia stone. These formations wereto be sampled with the idea of determining whether or not these formations are confined to this quarry. From the evidence at hand an estimate was to be made regarding the precentages of the various types of stone. In addition to the above Mr. Warren roquested any information that would have a bearing on the present and future value of the property.

As a result of this study the following conclusions were reached.

1. As nearly as can be determined by comparing analyses, the Vienna and milk stones are not confined to the Allwood quarry.
2. Unless their hydrating process is valuable, Allwood has no advantage, in composition of stone, over many other Wisconsin quarries.
3. Figures from county highway commissioners indicate that quarry land favorably situated as is the Allwood is worth from $750.00 to $1,000.00 per acre.

Description of Quarry

This quarry is located in the NW of section 36, T 20N, R 23E, on the Chicago and North Western Railway about

7 miles N and W of Manitowoc. At present about 2 acres of the total 32 acres are exposed by quarrying. In the western part about 16 feet of limestone is exposed, in the eastern 26 feet. Hence a study of the quarry gives a very inadequate idea of the total amount of each type of stone available on the property. I shall base my estimates on the assumption that the upper beds will continue to develop on the property in about the same proportion now shown in the quarry.

There are three types of stone, the Vienna, milk, and building stone, all types of Niagara limestone. The following sections will indicate the proportion of these formations at the four places in quarry indicated on the accompanying sketch, Plate I.

Section No. 1

1' stripping
8' building stone
3' Vienna stone
5' milk stone

Section No. 2

5' fair building stone
2½' fair Vienna stone

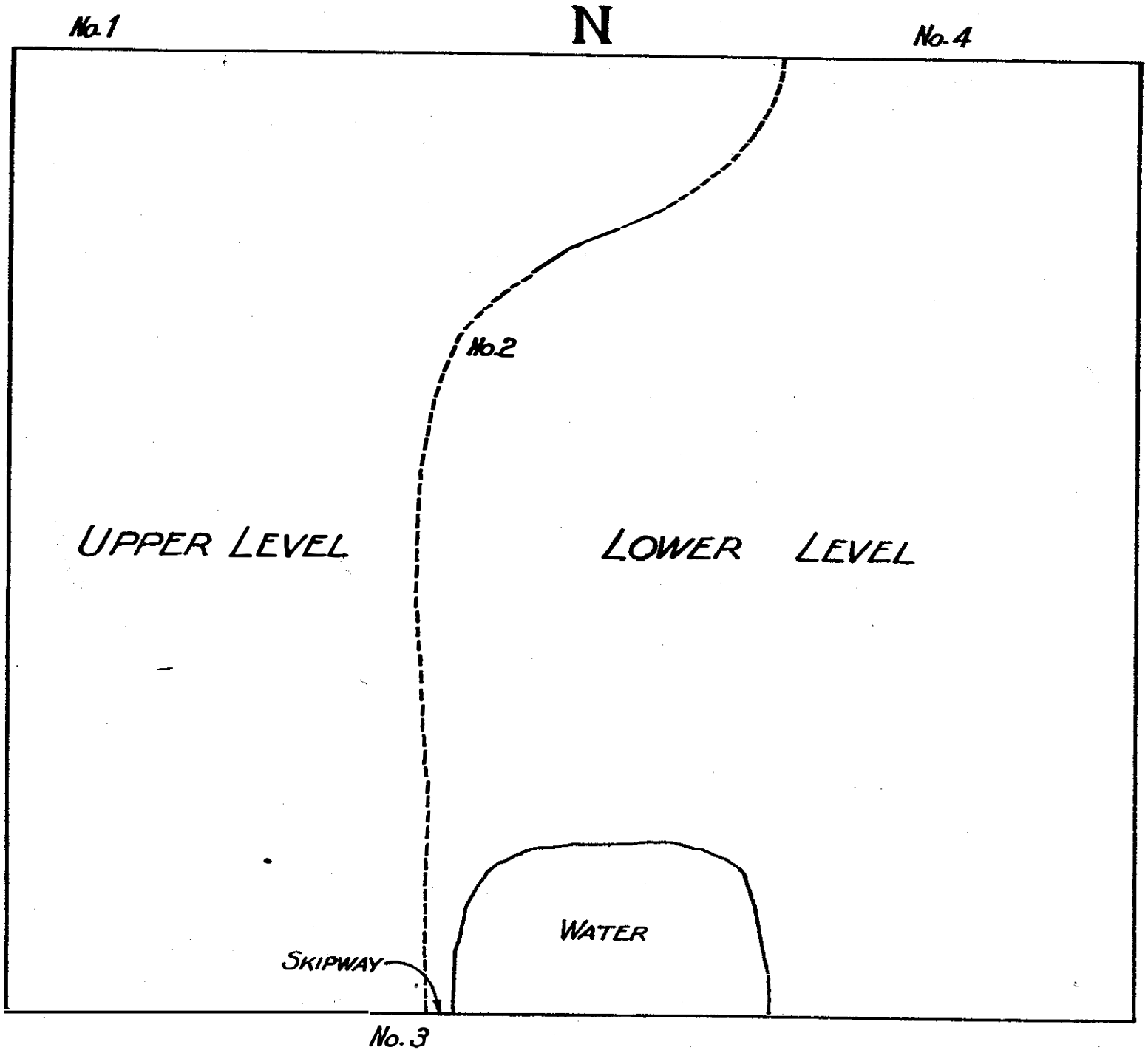
Section No. 3

1' stripping
5' building stone
10' milk stone

Section No. 4

1' stripping
12' building stone
12' milk stone
2½' Vienna stone

Assuming that all beds in the property will maintain the proportions now shown in the quarry, for a depth of 30 feet, the figures in the following table are obtained.



SCALE 1" = 40'.

ALLWOOD QUARRY.

	Tons of rock	Tons of lime
Vienna	310,000	170,000
Milk	620,000	340,000
Building	2,170,000	1,190,000

At the office is a well 116 feet in depth. Mr. Goss, Superintendent, is of the opinion that all of this depth is suitable for building lime. In the future the quarry may be operated at a greater depth, but this will involve higher quarrying costs.

Vienna Stone. This is a dense blue-gray crystalline dolomite. The bed in section 1 extends 150' east and 150' south of the northwest corner of the quarry. In the northeast corner the 2½' bed probably continues to the W and S to join the Vienna shown in section 2. It is probable in the northeastern part of the quarry an even larger amount of the face could be used as Vienna. Miss Squires states that to date 10% of the quarry product is Vienna stone. My estimate checks this very closely. I believe the Vienna beds are due to replacement and that they will be found to thicken or thin. Assuming that the present proportion is maintained over the property for a depth of 30', there will be about 310,000 tons available or an amount sufficient to produce 170,000 tons of lime.

Milk Stone. This is called milk stone in the quarry since the lime from this stone is used to make milk of magnesia. This is a white crystalline dolomite, somewhat softer than the Vienna. 5 feet of this stone are exposed at section #1, at section #3 there is 10', and at #4 12'. On the basis of this I estimated that the quarry

would run 30% of the milk stone. Miss Squires' figure is 20%. I have used the latter figure in order to be conservative. I was unable to determine whether the Allwood Company has, by virtue of their trade name, a practical monopoly of this product. If so, a study of their sales in the past, profits on this product, etc, should be a large factor in determining the value of the property.

Building Stone. This term is applied to the stone used in making commercial lime. This includes all the slightly weathered rock as well as all rock that does not meet the requirements for Vienna or milk rock. It must be understood that these types are not absolutely distinct, as there are all gradations between the types. It is quite likely that a careful study of the beds would develop a much larger number of type rocks. They are now producing a "baby lime" from a 2½" - 4" bed of dense fine grained lithographic limestone.

Operation of Quarry. At present the maximum amount of stripping seems to be under two feet and from the surface indications it is believed that the stripping will be light all over the property. The rock seems quite free from wide joints and pockets so stripping is easy.

This quarry is operated more like an open pit iron mine than like a quarry. Drilling and blasting must be so planned that the various types of rock may be loaded separately. This will affect costs since there seems to be no way to load except by hand. A more intelligent superintendent and more observant laborers are required in this than in a quarry devoted solely to the production of

building lime. At present a good deal of work is done by contract. There is no union, a good many of the men are married and live in company houses, so that labor conditions seem above the average.

A disadvantage of this quarry is that it lies in level country so that the rock must be elevated from the quarry to the kilns and the drainage of the quarry must be cared for by pumping.

Value of Quarry

In fixing a value for this quarry we shall consider the land entirely apart from the equipment. I consider this land to be worth $750.00 - $1,000.00 per acre. This figure is based upon the following considerations:

1. The question as to whether or not the Vienna and milk stone are confined to this particular quarry.
2. The technical question as to whether this quarry has any special advantage in material or process for the production of hydrated lime.
3. Value of quarry land in neighboring counties.

1. Are the Vienna and milk types of stone confined to this quarry? In order to answer this question analyses were made of composite samples of these formations.

	Insoluble & Silica	Iron & Alumina	Lime Carbonate	Magnesium Carbonate
Vienna	.64	.61	54.75	44.61
Milk Stone	.51	.76	53.75	45.32

In order to compare these analyses with others from the same formation, Tables 1 and 2 were prepared. Table 1 was compiled from various publications. Plate II

indicates the location of the quarries from which the samples for these analyses came. Table 2 was compiled from unpublished analyses. The numbers are analysis numbers. These tables show that the composition of the Niagara is relatively constant over a wide area.

Table 1

Analysis of Limestone

Name of Company and Location	Insoluble	Silica $Si O_2$	Iron Fe_2O_3	Alumina Al_2O_3	Lime Carbonate $Ca Co_3$	Magnesium Carbonate $Mg Co_3$
1.NW¼ of NE¼ sec 27 T 12 R 16E		3.57	.77	3.49	50.52	40.97
2.NE¼ of sec 11, T 10 R 18E		4.52	1.02	2.67	50.54	40.37
3.Cliffton lower 20'	1.23		.30	.10	53.95	44.28
4.Taycheedah	.26		.31		55.03	44.34
5. Upper layer Audley's quarry sec 20 T 7 16E	1.35		.43	.46	54.91	42.77
6.Lower layer Audley's quarry	1.73		.57	.18	55.18	41.70
7.Butler's quarry sec 10 T 14 17E	.67		.26	.10	54.25	44.48
8.Pelton's quarry Pewaukee	3.44		.32		52.86	42.98
9.Horlick's quarry Racine	.28		.82		52.16	45.50
10.Beswick's quarry, Racine	.40		.92		55.23	43.52
11.Druecker's quarry, Port Washington		.50	.61		55.41	43.48
12.Sheboygan Lime Works,Sheboygan		.55	.40	.24	55.09	43.91
13.Union Lime Co. High Cliff		1.12	.40	.06	54.82	43.79
14.Marblehead Lime & Stone Co. Marblehead		2.12	.59		53.51	43.54
15. Sturgeon Bay		1.09	.33		54.42	44.17
16.Bauers Quarry,Knowles		.02	.005		54.74	45.07
17.Ormsby Lime Co. Brillion		.59		.36	55.09	43.96
18. Byron	.67		.26	.10	54.25	44.48
19. Wauwatosa		1.49	.31	.21	54.56	43.41
20.Nast Bros,Knowles	.28		.24		54.3	45.32
21.Milwaukee Falls Lime Co. Grafton	.62	.37	.92		52.57	45.34

Analyses 1 - 6, Geology of Wisconsin, Volume II, p 338
Analysis 7, " " " " , p 345
Analyses 8 - 11, " " " " p 381
Analyses 12 & 13, Technical Paper No. 16, Bureau of Standards p 9
Analyses 14, 15, 16, Bulletin IV, Wisconsin Geological Survey p 420
Analysis 17, U.S. Geological Survey 20th Annual Report, Part 6 p 462
Analysis 18, Geology of Wisconsin, Volume I p 303
Analysis 19, " " " II p 390

Table 2

Analysis Number	County	Insoluble	Iron Fe_2O_3	Alumina Al_2O_3	Lime Carbonate Ca Co_3	Magnesium Carbonate Mg Co_3
174	Calumet	.90	.30	.00	54.20	44.60
176	"	.73	.20	.00	53.90	44.20
177	"	1.40	.00	.00	53.25	44.40
165	Door	1.68	.40	.00	55.75	42.10
165	Calumet	1.12	.00	.13	53.80	44.90
178	Manitowoc	.96	.14	.13	54.95	43.50
179	"	.81	.13	.17	54.30	43.80
143	Dodge	1.22	.27	.10	54.30	44.00
138	"	.41	.13	.25	54.60	44.75
139	"	.37	.36	.00	54.70	44.70
142	"	.70	.24	.00	54.50	43.90
144	"	.63	.28	.00	54.90	44.00
148	Fond du Lac	1.06	.00	.45	54.45	44.00
149	"	.94	.20	.00	54.50	44.25
150	"	.81	.08	.49	54.25	44.25
151	"	1.13	.40	.00	54.90	43.70
152	"	.66	.24	.00	54.90	44.25
180	Ozaukee	1.14	.16	.12	54.50	43.60
170	Sheboygan	.30	.06	.42	55.00	42.60
171	"	.66	.28	.00	54.50	44.75

Table 3

Limestone Similar to Vienna

	Insoluble	Silica	Iron Alumina	Lime Carbonate	Magnesium Carbonate
Vienna	.	.64	.61	54.75	44.61
#4 Table 1	.26		.31	55.03	44.34
#16, Table 1		.02	.005	54.74	45.07
Analysis 138, Table 2	.41		.13 .25	54.60	44.75
" 139 " 2	.37		.36 .00	54.70	44.70
" 152 " 2	.66		.24 .00	54.90	44.25
" 171 " 2	.66		.28 .00	54.50	44.75

Table 4

Limestone Similar to Milk Stone

	Insoluble	Silica	Iron Alumina	Lime Carbonate	Magnesium Carbonate
Milk Stone		.51	.76	53.75	45.32
#20, Table 1	.28		.24	54.30	45.32
Analysis 165, Table 2	1.12		.00 .13	53.80	44.90
Analysis 174, Table 2	.90		.30 .00	54.20	44.60

Table 3 is a group of analyses quite similar to the Vienna. These were selected on the basis of lime and magnesium content. From this it appears that limestone of composition similar to the Vienna stone is of rather widespread occurrence, though the iron-alumina content is higher in the Vienna than in the others. It is possible that for your purpose the texture, not the com-

position of the Vienna lime is the important factor, but I do not think this likely.

Table 4 is a grouping of analyses similar to that of the milk stone. It seems a little more difficult to duplicate the milk stone analysis. Here again the iron-alumina content of the Allwood stone is higher than in the others.

The analyses indicate that the quality of this stone is excellent, but both Vienna and milk stone can probably be duplicated elsewhere. In case you decide not to purchase this property, it would pay you to experiment with lime from the beds most nearly the duplicate of the Vienna, listed in Table 3.

The Rockwell Lime Company quarry which joins the Allwood on the west has a three foot bed of dense blue limestone quite similar to the Vienna. There is also a limestone quite similar in character to the milk stone.

It seems therefore that the land is of no extra value because of the composition of the stone.

2. Has the Allwood quarry any special advantage in material or process for the production of hydrated lime from dolomite? I have no way of answering the latter part of the above question. If the process is valuable, this value should be included in the purchase price of the plant. It does not add to the value of the stone. If, on the other hand, the limestone is especially adapted to the manufacture of hydrated lime, then the land has a greatly enhanced value. There seemed to be an impression around the office that this company had been more successful in the production of hydrated lime from dolomite than have other companies. This does not

seem to be verified by technical reports.

Technical Paper, No. 16, Bureau of Standards, entitled Manufacture of Lime is a very complete scientific report. Following are quotations:

p. 79 "In general magnesian limes hydrate far less quickly than high calcium limes and there is less danger of 'burning'. Consequently, the water does not need to be mixed so quickly or so thoroughly, and practice has demonstrated that magnesian limes can be hydrated with good success in a Clyde hydrator."

p. 10 "Experience has shown that it generally requires less heat and lower temperatures to burn magnesian than a high calcium stone."

p. 14 "The manufacturers of hydrated lime judge from the gain in weight of their product that magnesium oxide when burned at the temperature of an ordinary limekiln hydrates very slowly if at all. Nine samples of dolomitic hydrates analyzed by this bureau showed an average content of 30.92 per cent magnesium oxide and 2.29 per cent magnesium hydroxide. This peculiarity has been made the subject of scientific research the conclusions from which are that magnesium oxide will combine with water with reasonable rapidity only when it has been burned at some temperature below 1200C. (This is somewhat lower than the temperature of an ordinary limekiln.)" In this report nineteen lime plants in thirteen states are described. Of these eleven are producing hydrated lime. Four of

the eleven are using dolomites.

Table 5

Analysis of limestone

Name of Company	Location	Iron Fe_2O_3	Silica $Si\ O_2$	Alumina $Al_2\ O_3$	Lime Carbonate $Ca\ Co_3$	Magnesium Carbonate $Mg\ Co_3$
Chas. Warner Co.	Cedar Hollow Pa	.40	1.23	.32	56.38	41.97
Union Lime Co.	High Cliff Wis.	.40	1.12	.06	54.82	43.79
Woodville White Lime Co.	Woodville Ohio	.15	.34	.02	56.79	42.92
White Marble Lime Co	Marblehead Mich	.20	.56	.05	55.00	44.31
Allwood Vienna			.64	.61	54.75	44.61
Allwood Milk			.51	.76	53.75	45.32

In the Manistique plant of the White Marble Lime Company the hydrate mill is supplied exclusively with dolomitic lime from Marblehead in spite of the fact that they are producing a high calcium lime from the Manistique quarry.

The following quotations are suggestive:

"The Kelley Island Lime and Transport Company is the largest single producer of lime within the state. They own about seventy-four kilns in the state, and six or eight more at Duluth, Minn . The latter are supplied by stone shipped by water from Kelley's Island and Marblehead. It is probably safe to state, however, that their annual output does not exceed sixty per cent of the total capacity represented by these kilns. Their properties located at Kelley's Island, Marblehead and Sandusky are very favorably situated with reference to large and good markets, being in

easy reach by water transportation of such centers of population as Detroit, Toledo, Cleveland and Buffalo. This firm maintains a number of large warehouses in Cleveland, from which they distribute a general line of builders' supplies as well as lime and cement. They own and operate a number of large boats for the handling of their output, as well as a railroad on Marblehead which connects with the Lake Shore road. It is a significant fact that this firm, which up to this time has produced nothing but high-calcium lime, has within the last year purchased the sixteen kiln plant and property of the Toledo White Lime Company, at Clay Center, which is a producer of dolomite lime. It is probable that this firm realized that if they wished to maintain their former supremacy in the lime market, they must have at least one plant producing good dolomite lime. There is no doubt but that this newly acquired property will be put in the best of condition, and operated mainly for the production of a hydrated lime. Lime has been hydrated at Marblehead for some time, but the product has not been as well received as the hydrated dolomite lime, which gave a whiter mortar."

The Limestones and Lime Industry of Ohio.
Bulletin 4, Geological Survey of Ohio, pp 228-229

"High Calcium limes slake much more quickly than do high magnesian limes and it is generally conceded more difficult to make hydrated lime from high calcium lime than from high magnesian lime."

R. K. Meade, Concrete Age, August 1915, p 13.

The following conclusions regarding magnesian lime

are taken from Mineral Resources of the United States, Part II, 1913, under the discussion of Uses of Lime.

p. 1582 Mortar

"In conclusion, therefore, we find that if all other conditions are equal, pure, well-burned, high-calcium lime should be the best for making mortar, because it produces the greatest volume of mortar from a given weight of lime. The deciding factor in choosing lime for mortar is the experience of the labor in the particular locality, for this will determine the yield of mortar obtained from any given lime."

p. 1582 Concrete

"The use of hydrated lime for this purpose brought about a demand for information toward which a number of investigators have been working. Their conclusions may be summarized as follows: (1) The magnesia in a magnesian hydrate does not act the same as magnesia in the cement itself, but a mixture of cement and magnesian hydrate is stronger at the end of a year than a similar mixture containing high-calcium hydrate."

p. 1583 Finishing Lime

"In general, it may be stated that magnesian limes work better under the trowel and most of them have a better color than high-calcium limes. The former are therefore to be preferred even though the latter give the greater volume of putty."

p. 1591 Paper

"For the maker of sulphite pulp magnesia is a

desirable constituent of the lime or limestone. Magnesium sulphite is more soluble than calcium sulphite (100 parts of water dissolving 1.25 parts of the former or 0.0043 parts of the latter), and consequently permits of making a stronger liquor. Moreover, the presence of magnesia in the liquor gives the pulp a better color and makes it softer to the touch, so that it will felt together better when made into paper. Therefore, magnesian lime is much preferable to the high-calcium lime. The impurities are not harmful."

3. Value of similar quarry land in neighboring counties. In order to determine what prices are paid for quarry land, I wrote to the county highway commissioners in counties underlain by Niagara limestone, asking them the following questions:

A. Assume good agricultural land underlain by limestone of good quality, 20 - 30' face, 20 - 40 acres available, stripping 1 - 3', weathered rock 2 - 5' on railroad but far enough from city so that land value is not affected by city prices, truck haul possible, what would such land be worth per acre in your county?

B. What would same land be worth per acre if it were not underlain by limestone?

Replies were received from seven counties. The average for question A is $680.00, for question B is $300.00.

Conclusion

The value of the Allwood land is determined more by location than by quality of stone. (1) It is on a good

railway system. (2) It is nearer to sources of cord wood than are quarries farther south. (3) Its location makes it relatively free from labor trouble. I do not believe $750.00 - $1,000.00 per acre to be an excessive price.

Respectfully submitted

E F Bean