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Project A-2125

The Sand and Gravel Market for  
MOUNTAIN HIGH SILICA, INC.

by

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## INTRODUCTION

### Purpose

The purpose of this study is to qualify and quantify the market for sand and gravel that can be serviced by a mining operation, Mountain High Silica, Inc., in Manchester, Tennessee. This plant intends to produce both construction and industrial types of sand and gravel.

### Background

Sand and gravel, by physical volume the most abundantly mined nonfuel mineral in the U. S., reached a four-year production high of 929 million short tons in 1977. This output, representing an 18% increase over the 1975 figure of 789 million short tons, can be expected to further expand to more than 1.2 billion short tons by the end of the century.

Sand and gravel have the lowest average unit value of all minerals mined in the U. S. These nonmetallics are used extensively in construction and industry to manufacture concrete, bituminous mixtures, glass, and fill and for use in processes such as molding, grinding, and filtration. Fortunately, deposits are numerous and U. S. production has been more than adequate to satisfy all domestic needs. Nevertheless, as sand and gravel deposits become depleted, as areas are rezoned for nonmineral utilization, and as lands are covered by urban expansion, it becomes necessary to locate and exploit new sources of mineral raw materials.

Because of a low unit selling price (between one and eight dollars per ton), transportation costs and potential market areas figure prominently in any financial evaluation of particular sand and gravel

sites. Shipping distances of more than 80 - 100 miles frequently prove economically impractical.

With the above considerations in mind, it is the intent of this study to cursorily review the national and state markets for sand and gravel and to determine, by approximating end-use consumption, the potential sand and gravel market available to Mountain High Silica, Inc., of Manchester, Tennessee.

## MARKETS

### National Market

Various segments of the construction industry constitute the largest end-use for sand and gravel. In 1977, building and paving consumed 897.9 million short tons (about 97%) of the total annual domestic production.

Of the 929.2 million tons of sand and gravel sold or used by producers in 1977, 469.1 million short tons were sand and 460.1 million tons were gravel. Because demand for industrial sands accounts for such a small portion of the total sand and gravel market (3.4%), any change in their consumption has had very little impact on the total sand-to-gravel ratio within the industry. As a percentage of the whole, sand production for more than 20 years has been increasing steadily, from 37.3% in 1955, 37.5% in 1960, 38.8% in 1965, to 40.6% in 1970.

According to the U. S. Bureau of Mines, there were 7,222 commercial sand and gravel deposits operating nationally in 1977. Most of these companies (4,804), however, had an output of less than 100,000 tons per year and only produced a combined total of 150 million short tons of sand and gravel. The 315 largest plants, those with production greater than 500,000 tons annually, mined a total of 351 million short tons of sand and gravel.

### Tennessee Production

Sand and gravel production in Tennessee differs only slightly from the national sand and gravel output pattern. Where quality gravel is not economically available in the state, quantities of crushed stone are

substituted for use with sand in construction. In 1977, Tennessee gravel production was 5.39 million short tons, or 42% of the 12.77 million tons of the sand and gravel mined statewide. This gravel percentage compares favorably with the national average of almost 50%.

The Minerals Yearbook, published by the U. S. Department of the Interior, indicates that in 1975 there were 86 companies operating 96 open-pit mines in 37 counties scattered throughout Tennessee. The western part of the state was the principal producing area with Shelby County the leading producer, supplying about 40% of the sand and gravel sold or used during the year. Benton County, where much of the output was mined for glass and molding sands, accounted for the second greatest volume. Interestingly, although western Tennessee produces the major portion of the sand and gravel mined in the state, the counties in the central section consume the bulk of the volumes shipped.

#### The Market for Mountain High Silica, Inc.

The primary market area for sand mined at Mountain High Silica, Inc., will be composed of the Tennessee counties within a 100-mile radius of Manchester, Tennessee. Since Manchester is in Coffee County, between Nashville and Chattanooga, the area would include the 50 central Tennessee counties which are delineated on Map 1.

In Tennessee, as elsewhere, the construction industry constitutes the principal market for sand and gravel. In 1977, more than 5,012,000 short tons, or 41.7% of the state output, were used for structures and 6,719,000 short tons, or 55.9%, were used for highways.



PRIMARY MARKET AREA FOR  
MOUNTAIN HIGH SILICA, INC.



Building Construction. On a county basis, there are no data quantifying the consumption of sand and gravel. However, by interrelating production and shipments to end-use, valid consumption estimates by county can be calculated.

Since sand and gravel are used extensively for structural purposes, it is not surprising to find an extremely high coefficient of correlation (0.93) between shipments of sand and gravel and residential and nonresidential construction. (See Appendix 1.) By introducing this high correlation as an area market indicator, based on building construction volumes, county consumption of sand and gravel for this purpose can be approximated.

There are 15 counties in central Tennessee that have their building activity reported by F. W. Dodge Reports. All 15 are located within 100 miles of Manchester, Tennessee. In 1977, new residential and nonresidential construction in these counties was valued at \$942.5 million. By prorating the activity in the state's nonreported counties, the remaining 35 counties in the study area are estimated to have had \$290.4 million worth of new building construction in 1977. This would indicate a combined study area total of almost \$1,233 million for the year. (See Table 1.)

By using the high correlation between building construction and the utilization of sand and gravel as an equating basis, sectional product demand can be quantified. Since building construction in the 50-county study area is approximately 60.6% of total building construction in Tennessee (Table 1), it can be assumed that in the study area, consumption of sand and gravel is approximately 60.6% of the volume used in the state for residential and nonresidential construction. Based on this assumption, the market for building sand and gravel in the 50-county area can be established at more than 3,037,000 short tons for 1977.

Table 1

BUILDING CONSTRUCTION IN TENNESSEE STUDY  
AREA BY SMSAs AND OTHER COUNTIES, 1977

<u>County</u>	<u>Building Construction</u> <u>(\$000)</u>
Anderson	27,217
Blount	40,012
Cheatham	5,520
Davidson	306,463
Dickson	11,211
Hamilton	111,283
Knox	175,267
Marion	10,951
Montgomery	61,393
Robertson	19,716
Rutherford	57,711
Sequatchie	5,199
Sumner	60,155
Williamson	23,036
Wilson	27,391
Sub Totals	942,525
Other 35 Counties	290,406
Study Area Total	<u>1,232,931</u> = 60.6%
State Total	2,034,450

Source: Derived from F. W. Dodge reports data.

In all probability, sand and gravel consumption in Tennessee was even greater in 1978. Preliminary data for 1978 indicate an increase of over 20% in building activity for the state over the previous year.

Highway Construction and Maintenance. Of the 6,719,000 short tons of sand and gravel sold or consumed in Tennessee during 1977 for road and street paving, the largest volumes were used within the study area. Although the Tennessee Department of Transportation does not keep individual county statistics on sand and gravel used, the Bureau of Business Management, Office of Finance, does keep expenditures by county for road construction and maintenance. By apportioning these expenditures according to monies appropriated for the roadwork for the year, relative county consumption can be estimated. On the basis of state expenditures for road construction and maintenance by county, the 50-county study area used 3,756,000 short tons or 55.9% of the paving sand and gravel consumed in the state.

Industrial Consumption. In addition, approximately 750,000 short tons of industrial sand were sold or used in Tennessee in 1977, practically all of which was mined in the western part of the state (Benton and Shelby Counties). Of this volume about 42% went to the manufacture of glass, 12% for molding sands, and the remaining 46% for other purposes which included grinding and polishing furnace sands, and filters.

By using employment within an industry by county as a common denominator, it is estimated that glass companies in the study area used 51% of the industrial sand devoted to the manufacture of glass in the state; foundries in the study area used 83% of the molding sands consumed

in the state; and other uses in the study area accounted for a conservative 50% of industrial sand that was used for miscellaneous purposes in the state. On this basis, industrial sand consumption in the 50-county area would be almost 408,000 short tons, or 54.4% of the state total.

Glass	-	750,000 s.t.	x	42%	x	51%	=	160,700 short tons
Castings	-	750,000 s.t.	x	12%	x	83%	=	74,700 short tons
Others	-	750,000 s.t.	x	46%	x	50%	=	<u>172,500</u> short tons
								407,900 short tons

Total Consumption. From these data, it would appear that total consumption (construction and industrial) of sand and gravel within a 100-mile radius of Manchester, Tennessee, in 1977 was 7.2 million short tons, or 56.3% of the state total. In actuality, however, the market area for sand and gravel from Mountain High Silica, Inc., would extend well beyond the confines of the Tennessee border. There are eight northeastern Alabama counties and eight northwestern Georgia counties that are well within the area that can be economically serviced from the proposed sand and gravel pit. Since Alabama cities such as Decatur, Gadsden, and Huntsville and Georgia cities such as Dalton and Rome are located in the area, the total sand and gravel market within 100 miles of Manchester, Tennessee, conceivably could exceed 9 million short tons annually.

#### Future Demand

In March 1978, James R. Evans of the U. S. Bureau of Mines, delivered a paper at the annual AIME meeting titled "Forecasting Sand and Gravel, Crushed Stone, and Aggregate Demand in the U. S."

In developing his projections for this paper, Evans cited several important relationships that were incorporated into the final trend line for sand and gravel:

The 1950-60 trend is comparatively steep, showing an average annual growth rate of 8.2 percent. From 1960 to 1970 the trend is less steep with an average annual growth rate of 3.2 percent. From 1970-76 the trend line is negative, showing a minus 0.1 percent average annual growth rate. It is clear that the 1950-60 and the 1960-70 trends were not suitable for forecasting to 1976, and in my opinion they are not suitable for forecasting to 1985 or 2000. The 1970-76 trend is also unsuitable for prediction.

According to Evans, however, a 15-20 year trend line (1960-1976) shows a moderate slope that would be reasonable for forecasting.

From these data, Evans calculated the linear regression value for sand and gravel demand in the year 2000. Based on a 15-year trend line, the forecast was 1.01 billion short tons, while a 20-year trend produced a higher forecast of 1.28 billion short tons.

Evans also stated in his paper that reliable forecasts may be made for local or regional market areas, irrespective of geographic or political boundaries, provided a proper data base is available. This belief adds validity to the linear regression trend in Appendix 2, which used 17 years (1961-1977) to forecast the 1987 market for sand and gravel in Tennessee at 15.3 million short tons. At that time, should the 50-county study area continue to consume 56.3% of the state total, the Tennessee market open to Mountain High Silica, Inc., will approximate 8.6 million short tons.

In many areas of the U.S., a factor which could affect supply/demand relationships of sand and gravel is the increasing growth or new development of a market of substitute materials. As sand and gravel deposits become depleted, various substances such as crushed stone, iron slags, fly ash, bottom ash, or boiler slag may take part of the market, particularly for road-building materials. Recycled old road materials,

processed solid wastes, and crushed glass may also be used, especially where transportation and other costs of sand and gravel rise to the point where there is no longer a competitive edge. The potential use of substitute materials to satisfy supply/demand can play havoc with the need for and the production of sand and gravel.

This, however, should not be the case in central Tennessee. The sand and gravel deposit at the Mountain High Silica, Inc., site is judged to be more than adequate for many decades, of good quality, and readily accessible. If need be, Mountain High Silica, Inc., could supply, by volume, all of the sand and gravel consumed in the area well into the next century.

## CONCLUSION

All available data indicate that the market for sand and gravel in Tennessee is large and expanding. For the next 10 years the state's output, currently at 12.77 million short tons, is expected to increase at an average annual rate of 4.6% to more than 15.3 million short tons in 1987. A major portion (49%) of these minerals are mined in two western counties, Shelby and Benton, while the 50 counties in central Tennessee that consume the bulk of the sand and gravel shipped in the state (7.2 million short tons) are known to produce no more than 18% of the total Tennessee output.

Since a prime factor in any sand production profit and loss picture is transportation, it would appear that Mountain High Silica, Inc., located in the center of a vital and expanding market area could, with an economically and qualitatively competitive product, readily penetrate by 15% to 20% the existing central Tennessee sand and gravel market.



## APPENDICES

# Appendix 1

## CORRELATION BETWEEN CONSUMPTION OF SAND AND GRAVEL IN TENNESSEE AND BUILDING CONSTRUCTION IN TENNESSEE

<u>Year</u>	<u>X</u>	<u>Y</u>	<u>x</u> (X-A)	<u>y</u> (Y-A)	<u>xy</u>	<u>x<sup>2</sup></u>	<u>y<sup>2</sup></u>
1960	629	449	-237	-550	130350	56169	302500
1961	623	439	-243	-560	136080	59049	313600
1962	668	481	-198	-518	102564	39204	268324
1963	761	559	-105	-440	46200	11025	193600
1964	797	636	- 69	-363	25047	4761	131769
1965	819	732	- 47	-267	12549	2209	71289
1966	803	748	- 63	-251	15813	3969	63001
1967	798	825	-131	-174	22794	17161	30276
1968	814	999	- 42	0	0	2704	0
1969	747	941	-119	- 58	6902	14161	3364
1970	842	1166	- 24	167	-4008	576	27889
1971	862	1241	- 4	242	- 968	16	58564
1972	1084	1591	218	592	129056	47524	350464
1973	1201	1887	335	888	297480	112225	788544
1974	1071	1522	205	523	107215	42025	273529
1975	1091	1239	225	240	54000	50625	57600
1976	<u>1110</u>	<u>1536</u>	244	537	<u>131028</u>	<u>59536</u>	<u>288369</u>
Sum	14720	16991			1212102	522939	3222682

Average (A) 866 999

Number (N) = 17

$$\sigma_x = \sqrt{\frac{\sum x^2}{N}} = \sqrt{\frac{522939}{17}} = \sqrt{30761} = 175.4$$

$$\sigma_y = \sqrt{\frac{\sum y^2}{N}} = \sqrt{\frac{3222682}{17}} = \sqrt{189570} = 435.4$$

$$\text{Coefficient: } r = \frac{\sum xy}{N \sigma_x \sigma_y} = \frac{1212102}{17(175.4)(435.4)} = \frac{1212102}{1298276} = 0.93$$

NOTE: x - Sand and gravel in Tennessee  
y = Building construction in Tennessee

## Appendix 2

### LINEAR REGRESSION TREND FOR SAND AND GRAVEL SOLD OR USED IN TENNESSEE

<u>Year</u>	<u>y</u>	<u>x</u>	<u>xy</u>	<u>x<sup>2</sup></u>
1961	6230	-8	-49840	64
1962	6680	-7	-46760	49
1963	7610	-6	-45660	36
1964	7970	-5	-39850	25
1965	8190	-4	-32760	16
1966	8030	-3	-24090	9
1967	7980	-2	-15960	4
1968	8140	-1	-8140	1
1969	7470	0	0	0
1970	8420	1	8420	1
1971	8620	2	17240	4
1972	10840	3	32520	9
1973	12010	4	48040	16
1974	10710	5	53550	25
1975	10910	6	65460	36
1976	11100	7	77700	49
1977	<u>12770</u>	8	<u>102184</u>	<u>64</u>
	153680		142030	408

$$a = \frac{\sum y}{n} = \frac{153680}{17} = 9040$$

$$b = \frac{\sum xy}{\sum x^2} = \frac{142030}{408} = 348$$

$$Y = 9040 + 348 (-8) = 6256$$

$$Y = 9040 + 348 (+8) = 11824$$

$$Y = 9040 + 348 (18) = 15304$$