COMMONWEALTH OF PENNSYLVANIA.

DEPARTMENT OF INTERNAL AFFAIRS
James F. Woodward, Secretary.

TOPOGRAPHIC AND GEOLOGIC SURVEY

George H. Ashley, State Geologist.

SAND AND GRAVEL IN THE Altoona REGION, PENNSYLVANIA.

By Professor Freeman Ward

Department of Geology, Lafayette College, Easton.

CONTENTS

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>2</td>
</tr>
<tr>
<td>Uses</td>
<td>3</td>
</tr>
<tr>
<td>Specifications</td>
<td>4</td>
</tr>
<tr>
<td>Definitions</td>
<td>5</td>
</tr>
<tr>
<td>Present Sources</td>
<td>7</td>
</tr>
<tr>
<td>Local supplies</td>
<td>7</td>
</tr>
<tr>
<td>Distant sources</td>
<td>8</td>
</tr>
<tr>
<td>Quarry vs Bank sand</td>
<td>8</td>
</tr>
<tr>
<td>Detailed Studies</td>
<td>9</td>
</tr>
<tr>
<td>Barren areas</td>
<td>10</td>
</tr>
<tr>
<td>Favorable areas</td>
<td>11</td>
</tr>
<tr>
<td>Miscellaneous items</td>
<td>14</td>
</tr>
<tr>
<td>Summary</td>
<td>15</td>
</tr>
</tbody>
</table>
In 1927 the Pennsylvania Geological Survey started an investigation of the sand and gravel resources of the State by sending the writer on a reconnaissance trip over the whole State. Nearly all the large cities were visited. The purpose of this trip was to find out (a) where the sand and gravel supplies were coming from, whether they were local or whether they were being shipped in, (b) whether the supplies, from whatever source, were satisfactory as to quality, (c) total quantities needed, (d) costs, freight rates, etc. The problem was approached from the commercial end, which meant interviewing operators of pits and quarries, contractors, dealers, and chambers of commerce. All this was preliminary to detailed geological work which would be taken up in those regions least supplied, by nature, with these resources.

Altoona was one of the regions visited. It was found that the local supplies were not adequate to meet all the needs, necessitating importation of sand from other regions. Since the larger part of the cost of sand and gravel is the item of transportation, it was clear that the Altoona region was one that might be helped if more thorough investigation lead to the discovery of sand deposits nearer to the city.

In August of 1929 the writer made a detailed study of the Altoona region. The immediate vicinity of the city and the territory along the lines of transportation tributary to Altoona for distances ranging from 17 to 30 miles were carefully examined. The accompanying map (Fig. 1) shows the railroad lines leading to Altoona along which most of the work was done.

About two weeks was spent on the problem. All the work was done on foot which allowed close attention to detail. Forrest T. Moyer served as assistant.

The problem involved finding deposits (a) of proper quality; (b) where there was opportunity for washing, because the trade, and especially the large contract, is demanding a uniform, washed product; (c) large enough to warrant putting money into a washing plant and other equipment; (d) near railroad or other trunk line of transportation. Trucking will pay (if roads are good) when the distance is not over 10 miles, is doubtful between 10 and 15 miles, and unprofitable with greater distance. Of course, if the roads are good and one could get $4.00 or more a ton for delivery it would pay to haul by truck 25 or 30 miles. This is a rare case.

The results of this investigation are given in the following pages.
Fig. 1. Railroads in the Altoona Region.

Uses.

Sand and gravel are low-priced commodities. This does not mean that they are an insignificant part of our industrial world. They are necessities and the volume used speaks of their importance. Of all the freight moved by the railroads of the United States in 1928, sand and gravel held fourth place in volume handled, being exceeded only by bituminous coal, anthracite, and iron ore. Every moderately large community uses on the average one ton per capita per year. Altoona, then, with its outlying boroughs, needs, in round numbers, 100,000 tons of sand and gravel each year.

To make these materials better appreciated a brief list is given of the various uses to which they are put. These uses may be grouped in several ways, one of which is as follows:
1. Concrete - for highways, streets, sidewalks, buildings, blocks, fence posts, etc.
2. Mortar - for laying brick, stone, etc.
3. Plaster and finishing coats.
4. Asphalt paving.
5. Roofing.
6. Cushion sand - for laying paving brick, etc.
7. Road dressing - gravel alone; with binder for sand-clay roads; for oiled roads.
8. Railroad ballast.

Abrasives.

10. Sand blast.
12. Sawing stone.
13. Scouring scaps.
14. Tumbling sand.

Manufacture (the main constituent).

15. Glass.
17. Silica brick.

Manufacture (as an accessory).

18. Foundry sand.
20. Pottery glaze.
22. Filler for fertilizer.
23. Sweeping compound.
24. Dusting tar paper.
25. Carborundum.

Miscellaneous.

27. Filters.
28. Engine sand.
29. Fire sand.
30. Standard sand.
31. Playground sand.
32. For golf courses.
33. On paint.
34. Bedding stock cars.
35. Sand flotation.
36. Horticultural purposes.
37. Agricultural testing.
38. Bird sand.

In a large community all of these uses will find a place, though naturally, as far as quantity is concerned, some are insignificant while others run into very large figures.

Specifications.

Quite logically, one kind of sand will not do for all purposes. A sand that is too fine for concrete may be just the thing for asphalt pavement; a sand that would never do for glass making may be entirely suitable for foundry purposes. The specifications or qualities required for each of the uses listed have been rather exactly determined, though authorities differ as to details. The extensive literature on the subject should be consulted by those who expect to be producers of these commodities. No attempt will be made here to discuss these specifications, but a partial list of the
necessary qualities may make clearer the scope of the requirements.

In general, sand and gravel should be clean, that is, free from loam and organic matter. The individual particles should be durable. Texture plays an important part; this refers to the sizes of the individual particles and the proportions of the various sizes present. Their features are determined by standardized methods of screening. The shape of the particles is to be considered; too many flat pieces is objectionable. Chemical composition is important only for a few of the uses, especially the high silica sands. Strength tests are made for comparison with standard sands. Other properties that may enter into the qualities of good material are color, fusibility, permeability, sharpness of particles.

Those who wish to improve or standardize their product would do well to study the precise requirements that the best trade demands. Many articles are published by the National Sand and Gravel Association, Munsey Building, Washington, D. C., by the American Society for Testing Materials, Philadelphia, Pa., U. S. Bureau of Mines, Washington, D. C., and by similar organizations. For instance, those who are interested in the specifications for highway work should consult Form 408, Pennsylvania Department of Highways, Harrisburg; or if planning to produce molding sands consult Molding Sands of Pennsylvania issued as Bulletin M 11 by the State Geological Survey, Harrisburg. Similarly each of the uses listed has its own literature.

Definitions.

This report makes the use of certain terms whose meaning will be better understood by referring to the following definitions.

Bank Sand or Gravel. This term applies to ordinary sand and gravel such as is seen along a river bank. It has been carried there, sorted and deposited by water. It is loosely packed and hence easy to shovel or dig into. Coarse and fine materials are arranged in alternating layers. Individual pieces commonly show the wear and tear they have suffered during transportation, that is, they have lost their angularity; some may even be well rounded. Often called river sands.

Quarry sand. This is made artificially by crushing rock. The bedrock is quarried in the usual manner by the help of more or less blasting. The blocks of rock are further reduced by crushers or rolls, and then sorted into sizes by screens. The ordinary crushed rock is equivalent to the various gravel sizes; the finer sizes are the sand.

Texture. This term refers to the sizes of individual particles and also the proportion of the various sizes present.

Sand — grains less than % inch: may be coarse, medium, fine.
Fine gravel — % to 3/4 inch.
Gravel — 3/4 to 1 1/2 inch.
Coarse gravel — 1 1/2 to 6 inches.
Cobbles - 6 to 12 inches.
Bowlders - greater than 12 inches.

Except in the case of sand, the natural deposits seldom contain one size only, as above defined. Rather there is a mixture of several sizes. For field purposes the writer has somewhat arbitrarily used four classes.


Ordinary = Less than 20 per cent but more than 5 per cent over 3 inches. Moderate coarse gravel. Cobbles seldom present. Sand and fine gravel the dominant sizes.

Fine = Less than 5 per cent over 3 inches. Abundant sand.

This classification may be used in describing a single large bed, or, more often, for the average of the whole deposit.

Quantity. Since quantity is one of the requirements of the sand and gravel problem, the descriptive terms used must be given some exactness. They are based on the requirements for commercial plants. It will seldom be possible to get proper returns on capital invested in a washing plant and other equipment unless the operation is continued for at least 10 years. On this basis the following terminology is used.

<table>
<thead>
<tr>
<th>Output per day</th>
<th>Reserves required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very large</td>
<td>1,000 tons</td>
</tr>
<tr>
<td>Large</td>
<td>500 &quot;</td>
</tr>
<tr>
<td>Medium</td>
<td>200 &quot;</td>
</tr>
<tr>
<td>Small</td>
<td>100 &quot;</td>
</tr>
<tr>
<td></td>
<td>2,000,000 tons</td>
</tr>
<tr>
<td></td>
<td>1,000,000 &quot;</td>
</tr>
<tr>
<td></td>
<td>400,000 &quot;</td>
</tr>
<tr>
<td></td>
<td>200,000 &quot;</td>
</tr>
</tbody>
</table>

Experience shows that it is hardly practicable to set up a washing plant unless the output averages 100 tons per day.

Value. Waste material or unsalable product of a quarry or pit needs as much consideration as the quantity in the deposit. In a region where hard rock quarries and crushed rock are common there will be little use for a bank deposit in which gravel and coarse gravel dominate. Whatever its quality, coarse gravel will be hard to sell and constitutes an element of waste. The opposite is true; in a region where hard rock quarries are scarce and the bank deposit is largely sand, a great deal of the sand will have to be
sold at a low price in order to get rid of it at all. In such a region a bank deposit with gravel and coarse gravel as well as sand would be the most profitable. Again, much of the deposit may be fine sand, too fine for concrete. If the customers are only concrete makers, the excess fine sand is a waste product, in the way and unprofitable.

It amounts to this, the value of a bank deposit even when both quantity and quality are excellent, depends on the market demand within the range of profitable transportation.

Producers who are willing to study the many varieties of sand, know the many possible uses and specifications of each, may turn their waste product into a saleable article and so increase the value of their deposit as a whole. For instance, (a) an excess of coarse gravel may, when crushed and washed, be more acceptable in specification work than ordinary crushed rock; (b) the overburden may be just right for foundry sand; (c) excessive fine sand, while not saleable for concrete work, may be used in finishing work, asphalt paving, striking sand, etc.; (d) the fine powder washed from high silica quarry sand might have a use in scouring compounds, etc.

Present Sources.

Local Supplies. No bank sands are worked in this region. The local supplies are all quarry products. Except for one limestone quarry all the rock used is sandstone. Weathering weakened this sandstone for a depth of 10 to 25 feet so that much of it may be quarried with pick and shovel. Deeper down the fresher rock is tougher and often rather quartzitic in quality, requiring the usual blasting.

The sand is prepared by crushing and screening the rock. The screening produces sand of three sizes, - concrete, mason, finishing. Sand is washed at one plant only and not continuously there. In some localities the rock is fine-grained. Where such a rock is well weathered the grains are separated and small. As a result, there is no possibility of producing a concrete sand. The fresh rock will, of course, hold together sufficiently to yield any size by screening. The rock of intermediate soundness is apt to yield a sand with too much fines. Chemically the sands are of the high silica type some of which might be used for glass sand. No attested analyses were seen, but one quarry reports sand running 97 per cent silica.

The list of local quarry sand producers is as follows:
None of the above are directly on a railroad. The distances from the railroad range from \(\frac{1}{4}\) to 1\(\frac{1}{2}\) miles. Other quarries have been worked intermittently.

The daily output varies with the size of the plant and the demand. The plant capacities range from 30 to 150 tons per day. The sand sells for $1.00 to $1.25 per ton at the plant. Delivery charges range from $0.75 to $1.25 per ton. Thus the cost, delivered, is $1.75 to $2.50 per ton. More sand is sold nearer the higher figure than the lower. All of it is hauled by truck.

Distant sources. Both quarry sands and bank sands are obtained from sources beyond the immediate vicinity.

The quarry sands are in part like the local ones. They are hauled by railroad and because of the increased cost are not so much in demand. They come from Warriors Mark, Dungarvin (25 mi.), or Marklesburg (45 mi.). One sand comes from Everett (75 mi.). It is a whiter sand of special quality and is used for certain jobs albeit the price is $7.50 per ton delivered. A limestone product comes from Blairfour, selling for $2.50 to $3.60 delivered.

Slag sand is obtained from Johnstown, selling for about $2.50 per ton delivered. It is used only for cushion sand.

By far the larger part of the sand used in the Altoona region is bank sand obtained either from Pittsburgh or Williamsport. More of it seems to come from Pittsburgh than from Williamsport. Sands from these places sell, delivered, for from $4.00 to $5.25 per ton of which $1.60 to $1.70 is freight. Some city contracts have gotten sand delivered from Pittsburgh for $3.50 per ton.

In one rare instance, when the highway department was hard pressed, Jersey sand was secured. This, as is to be expected, costs more than the Pittsburgh product.

Quarry vs. Bank sand. In spite of the fact that Pittsburgh or Williamsport sand costs $2.00 a ton more than the quarry sand, a great deal of it is used. Estimates place the total bank sand used as perhaps one-half of all the sand used by the city. The question naturally arises why do people pay more to import sand when they have sand at home? Considering all the uses of sand in the region, $40,000 - $50,000 per year could be saved if only the local sand were used.
Of one thing we can be sure, there is no shortage of rock from which the local quarry sand is made. There are enormous reserves of this material, enough to furnish several times the total needed for many years to come.

In the first place one must realize that no one sand can serve all purposes. The list of 38 uses on a previous page should convince one that several varieties and types of sand are required.

But if we confine our attention to the commoner uses, such as construction, there are some other reasons for the choice between the two types. The two bank sands by long usage have become a standard product accepted as having the proper quality. The quarry sand, on the other hand, does not yet have a completely accepted position in the sand market. The burden of proof, thus, is with the quarry sand. The writer in talking with many dealers, contractors, masons, and some engineers, finds staunch supporters of each type of sand. No doubt there is some prejudice in the matter, and no doubt part of it is a matter of opinion, like buying any other article of trade. It is true, that the quarry sand has been used successfully in many large structures in the region, as bridges, roads, factories, etc.

Despite this, two facts remain against the quarry sand as a whole. One is that the quarry sand is not uniform; the other is that there is apt to be too much "fines" in this sand. The rock is not all alike through the hills; its character may differ in one quarry. Sometimes too little care is taken in removing the overburden.

The problem of the quarry sand industry, then, is greater care in the selection of the rock and in handling the overburden, installation of additional screens to get rid of the fines, in some cases installation of washing systems, running of many tests and analyses to get exact information on what is being produced, and finally a good selling and advertising plan to place the improved, uniform product on a par with the standard imported sand.

No doubt there will always be a demand for Pittsburgh and Williamsport sand for certain uses.

In comparison with the Reading district, where similar studies have been made (Bulletin 99), the sand rock around Altoona is generally finer textured. For this reason, the quarry sand operators in the Altoona region have more of a problem to solve.

Detailed Studies.

Until the quarry sand is standardized, as suggested in the preceeding paragraphs, the demand for a good bank sand equal to the standard Pittsburgh and Williamsport sand will remain large; and afterwards there will always continue to be some need for the bank sand. There is the further possibility that the quarry sand producers will be satisfied with conditions as they are.
Hence the greater part of the field work in this region was devoted to the search for bank sand. A large deposit of good bank sand within 25 miles of the city would save the long haul and high freight costs of the imported product. Because of the importance of transportation in the sand problem, the search for bank sand was confined to areas along and near the railroad lines. The need for a sand of proper quality and in quantity sufficient to justify exploitation was always kept in mind.

Barren areas. There is always an advantage in knowing one's limitations. Uncertainty is disturbing. To prove the lack or absence of a certain material is one of the factors in any industry. To state the worst first, then, certain areas in the region, we are sure, contain no commercial bank sand and gravel.

Bank sand being a water-laid material, it is natural to look for it in present or former water courses.

It is believed by geologists that streams once flowed at a higher level than the present streams. In the immediate vicinity of Altoona the crests of the hills between Brush Mountain and the Allegheny Mountains mark this level. Probably there were at least two of these levels, one marked by the hills rising to an elevation of 1200 to 1400 feet and another still higher with an elevation of 1600 to 1800 feet above sea level. There are similar heights in the adjoining territory. One must imagine that the crests now at the highest level mark a land that was an undulating plain with moderate relief with rivers flowing across it, and with little elevation above sea level. An uplift of the land enabled these rivers and their tributaries to cut deeply below this surface, finally establishing a new undulating plain at a new level and with somewhat lesser width (now marked by the lower set of hill crests). Repetitions of this process have resulted in the present topography.

The present hill crests, then, are remnants of former plains along which rivers flowed. It is logical, thus, to expect that typical, stratified bank sands and gravels carried and deposited by these former rivers might in part still be present on these hill crests. Accordingly a number of these were examined with that end in view. Not a single bed of sand or gravel was found. Indeed, not more than a dozen rock fragments showing the wear of river transportation were discovered. It is apparently true that the crest remnants are too narrow to retain any quantity of the original sand and gravel deposits, or the crests are below the old plain and so all sand and gravel has been removed, or they represent interstream areas where there never was any sand and gravel on the old plain.

Furthermore, the bedrock (shale, sandstone, limestone) was very near the surface. Gullies, road cuts, and occasional collar hole or other artificial opening commonly showed bedrock within a few feet of the surface. In many places the soil was thin enough to show abundant angular fragments of bedrock. In other words, there is not room on top of the bedrock for a loose deposit of bank sand of any thickness; only residual soil is there, not transported sand and gravel.
Favorable areas. From the above discussion it seems clear that the only places where one might expect to find commercial bank sands and gravel are along the valleys of the present streams.

The flat floors of these valleys are convincing evidence of waterlaid deposits. Each flat floor is typical valley "fill." This means that the valley was once deeper but has since been filled up to the level of the present valley flats. The filling has been brought in by the river and its tributaries. Along its whole length small streams and rain wash have gullied the hillsides, sweeping in debris eroded from the slopes. The main stream has moved this farther along and, using the fragments as tools, has in turn deepened and widened its valley. The load has accumulated during the years and constitutes the fill. During this process of transportation and deposition the currents have worked over the material, grinding and sorting it. This produced a layering or stratification, an alternation of silt, sand, and gravel, as the currents varied in strength.

It is clear, then, that wherever there is such a fill there is a chance of commercial sand and gravel. The character, quality, and quantity of the fill must be determined before development is begun, because a fill may not be saleable material.

In many valleys in other regions there are terraces of sand and gravel on the sides above the flat bottoms. Such terraces are remnants of a once deeper fill which has in large part been removed by subsequent erosion. These terraces 20 to 80 feet above the flats along many of the valleys of this region. They all proved to be either wholly rock terraces or rock terraces with a veneer of material too thin to be of any commercial use.

Since commercial sands and gravels were being sought, the matter of quantity had to be kept in mind. It should be evident that narrow fills, while really consisting of bank sands or gravels, must needs be eliminated. On this basis many valleys and parts of valleys have been eliminated from consideration. The only possible productive areas are as follows:

Little Juniata River. From East Altoona to Charlestonville there are three areas to be considered, one near Pinecroft, one near Bellwood, and the third near Tipton.

Each of these localities has a valley flat of good dimensions. At first sight the one at Bellwood seems very wide but the upper flat from the central part of town north for three-quarters of a mile is a rock terrace with only a moderate amount of gravel on top of it.

In each place the evidence as to the character of the fill is not complete. Very few holes or cuts are at hand. There are a number of wells but for many of them there is no reliable log. Such wells as give anything at all definite are as follows:

Pinecroft district. Three wells, maximum depth 20 feet, none of which struck rock. One well close to the bordering hill
slope struck rock at 10 feet. All the wells show that gravel and sands are present.

Bellwood district. Eight wells. Three were 14 to 18 feet deep, another 20 feet, another 33 feet deep without striking rock. One well struck rock at 22 feet, another at 30 feet; one struck rock at 10 feet but was near the bordering hill slope.

Tipton district. Seven wells. Five of these were 18 to 20 feet deep and another 13 feet deep without striking rock. One struck rock at a depth of 50 feet.

The average section indicated by these wells and the few shallow holes, shows coarse (see p. 6) material in the upper portion with ordinary textured material below. Of course there may also be fine material below, but the records are too meagre to prove anything.

Considered on the basis of size alone and with the average depths at Pinecroft 7 yards, Bellwood 8 yards, Tipton 9 yards, there are very large reserves in each district. But trolley lines, highways, dwellings and other properties interfere to some extent. However, a large deposit should be present at each of the districts.

It should be emphasized that no test holes were put down. Of course thorough testing should be carried out before any production is attempted.

Ground water is 10 to 15 feet deep below the surface. There is no possibility of drainage except by pumping. Naturally, development should consider the use of suction dredges or drag lines.

One other factor is important though its full effect is not known. The sewage from Altoona is dumped in the Little Juniata. This has already, by seepage, contaminated a few of the wells. Aside from the offensive odor and the spoiling of a beautiful stream there is another possible effect. Of course it is well known that organic matter is detrimental to sands and gravels for structural purposes. It is also true that water is purified by seeping through sufficient sand. It remains to be determined whether the small amount of organic matter from the sewage that penetrates the sand and gravel really spoils it for use in concrete, mortar, etc. There is also the question as to how far this effect reaches.

Bare to Petersburg. This favorable area is many miles farther down the Little Juniata. The wide valley flats indicate another fill and hence, possible commercial bank sands and gravels. Here there are about a dozen wells; most of them are shallow (10 to 15 feet deep) and none give wholly satisfactory evidence. Three deeper ones show that bedrock is 20 to 35 feet below the surface. The evidence indicates that bank material of coarse texture makes the portion near the surface and that the texture becomes finer with depth. On the basis of size alone and assuming an average depth of 6 yards the reserves are very large. Even granting the loss of
space by the railroad, highways, etc., there are two places where large reserves probably occur. No holes or test pits were put down to prove the district.

Frankstown Branch of the Juniata River. Here again are prominent valley flats indicating considerable fill and hence possible commercial production. But as in the first districts discussed, information as to the character of the fill is not conclusive. In this stretch of some 8 miles there are only about a dozen wells, and a few shallow holes. The best information was gained from three test holes put down where the Pennsylvania Central considered building a plant just east of Frankstown and adjoining Mr. Brua's property. These holes penetrated to a depth of 30 feet without striking rock. The upper 7 feet consisted of sand; below that all was coarse gravel with a streak, or so of sand. Since these holes were towards the side rather than the center of the flat it may be expected that the fill may be 50 or more feet thick. And if the rule holds here as in the other cases cited, sand will be found below the gravel. In another place a well 60 feet deep struck rock, but there was no record to tell whether the hole just reached the rock or whether it penetrated some feet of it. The other wells and holes are 7 to 18 feet deep with indefinite records except that sand and gravel is present. The water table was encountered 8 to 12 feet from the surface.

The flat for the first mile east of Hollidaysburg is largely occupied by railroad yards and so is unavailable.

From this point on to Frankstown the flat is of sufficient size to contain a large reserve, assuming an average depth of seven yards.

Just east of Frankstown is the locality where the deepest test holes were put down. The area is smaller but the average depth is apt to be 10 yards. Hence, a medium sized reserve is possible.

Beyond the Frankstown locality.- Basing the estimates on size alone, as before, there are two possible places that may be of commercial importance. One near White Bridge with medium reserves; another between White Bridge and Reese can be rated as large, assuming an average depth of 8 yards.

Between Reese and Flowing Spring the flat is narrower, but has rather long stretches. Here may be expected one large and one medium deposit, 8 yards being assumed as the average depth.

No holes or test pits were put down to prove the deposits.

Alfarata to Petersburgh is another district with good-sized valley flats. Here again the evidence of depth and quality is altogether too slight for positive prediction though there is no doubt that sands and gravels are present. Eight wells were found, and records for three of them. Two of these struck rock, one at 25 feet, the other at 30 feet. The third one was 45 feet deep and described as encountering "mostly sand."
The tract from Alfarata to and including Alexandria can be eliminated at once, since it is so well occupied by town, suburb, amusement park, etc.

Between Alexandria and Aqueduct School are several medium or medium to large reserves, based as usual on size alone and assuming an average depth of 6 yards.

Between Aqueduct School and the junction with the Juniata is a possible large deposit.

As in the other districts, the water table is 10 to 15 feet below the surface.

Two other localities should be mentioned, neither of which will yield more than small deposits. The flat about 1 1/2 miles south of Altoona is of good size. Well records are lacking. A few shallow holes showed coarse gravel. It is the site of a rapidly developing suburb, much more territory being occupied by homes than the topographic map shows. In other words, only smaller parts of this large flat might be used for sand production.

The flat south of Kladder is another locality where the records are too indefinite for specific estimate, except to say that it is a possible source.

Miscellaneous items. The following statements are applicable to all the deposits examined.

No well holes or test pits were put down anywhere. Any of the favorable areas that may be considered for commercial development should be thoroughly tested as to depth and quality of deposit before production is attempted.

The deposits are soaked with ground water, the water table (as revealed by wells) being 8 to 15 feet below the surface. This will require special preparations in putting down test pits. Also, since there is no possibility of drainage except by pumping, development will need to make use of suction dredges, drag lines, or related processes.

Considerable coarse material will be encountered, especially in the upper portions of the deposits. The records rather uniformly show finer material below. It so happens that in this region there are relatively few hard rock quarries. This means that there will be a good demand for coarse aggregate, especially the broken and washed material.

The higher slopes bordering the valley fills contain considerable shale. Some contamination by flat, weak shale fragments may be expected in the sand and gravel deposits. This is believed not to be a serious menace, partly because the shale itself is rather sandy, and partly because in the few cases where the deposits were seen the contamination was insignificant.
The local sands now in use are all quarry sands not as yet standardized fully enough to satisfy all the trade demands.

Bank sand to supplement the quarry sands is shipped in from Pittsburgh and Williamsport in large quantities.

The field work was confined largely to a search for bank sand.

The only possibilities for bank sand in the region are along the river valleys.

The most favorable localities are along the Little Juniata between Altoona and Charlottesville, and between Baree and Petersburg, also along the Frankstown Branch of the Juniata between Hollidaysburg and Flowing Spring, and between Alexandria and the junction with the Juniata.

The size and character of these deposits is yet to be determined by test holes.