



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

December 8, 1965

MEMORANDUM

TO: R. O. Beauchamp
Assistant State Highway Engineer

FROM: W. B. Drake

SUBJECT: Borrow Material for
Jefferson County Projects

In your memorandum of September 8th, you requested that the Research Division make a study of borrow material in Jefferson County. I am attaching a copy of the report of this study by Messrs. J. H. Havens, Director of Research, and R. C. Deen, Assistant Director.

This report indicates that most materials in Jefferson County would be suitable for "embankment construction". Of course, borrow for sub-grade usually is most restrictive in that a specific CBR value is required. It may be well to further consider sub-grade requirements and the affect of the higher quality borrow on actual pavement designs.

I will be pleased to further discuss the report and these items with you.


Assistant State Highway Engineer

WBD:nj

attachments

cc: D. H. Bray
cc: A. O. Neiser
cc: M. W. Tinder

*COPY OF REPORT SENT TO
R. C. ALDRICH 12-9-65
R. O. B.*



COMMONWEALTH OF KENTUCKY
DEPARTMENT OF HIGHWAYS
FRANKFORT

HENRY WARD
COMMISSIONER OF HIGHWAYS

December 3, 1965

ADDRESS REPLY TO
DEPARTMENT OF HIGHWAYS
DIVISION OF RESEARCH
132 GRAHAM AVENUE
LEXINGTON, KENTUCKY 40506

MEMORANDUM

M-3-5

TO: W.B. Drake
Assistant State Highway Engineer

FROM: Jas. H. Havens, Director
Division of Research

SUBJECT: Borrow Material; Jefferson County
Projects; Preliminary Study.

REFERENCES: Memo. from R.O. Beauchamp to W.B. Drake,
9-8-65; Memo. from R.C. Aldrich to
R.O. Beauchamp, 9-2-65; Memo. from
W. Bernard to R.C. Aldrich, 8-30-65;
Memo. from Henry Ward to D.H. Bray,
8-9-65; Memo. from M.W. Tinder to Henry
Ward, 8-2-65.

As an outgrowth of the above-referenced communications, the Research Division undertook an assignment to make a comprehensive survey of materials in Jefferson County that would be usable as borrow for embankment construction -- specifically in connection with planned extensions of I 64 and I 264, which has been estimated to encompass 5.3 million cubic yards. The scope of the assignment was somewhat unlimited -- except from the standpoint of the usual practical considerations of time and feasibility. The assessment and appraisal of sites and tracts as well as analyses of economical haul distances have been excluded from the scope of the immediate assignment. The idea of importing fill materials into the city from remote points is rather revolting from the standpoint of transportation costs; on the other hand, importation may become an admissible but expedient recourse when all else fails. This, then, becomes mostly a matter of weighing economics against other desires. We chose, therefore, to utilize information that is already available and to offer a comprehensive treatise on the structure of the area and the occurrence of soil and rock materials. Study and review of available information disclosed several generalities which may have significant bearing on the problem of locating borrow and the utilization of earth materials in that vicinity.

We have concluded that usable materials abound throughout the area; however, there are some materials which would be rather troublesome and which would require tedious engineering -- these are principally shales. The New Providence Shale area, which lies to the southwest of the city, and the Waldron and Osgood shales, which are inter-bedded between limestone (outcropping in the valleys) in the northeast quadrant of the county, are especially difficult to deal with because they weather into rather slippery clays. We do not consider the Devonian Black Shale to be altogether treacherous material -- it is more of a treacherous foundation area, because the soil overlying it cannot drain freely. When disturbed, the Black shale tends to weather into a sandy and silty soil rather than a fat clay. The alluvium terraces along the river, and on which the major portion of the city is built, provide an abundance of suitable material for embankments; some of it is rather sandy and silty, and embankment slopes might tend to erode unless protected by turf or clayey blankets of topsoil. The main problem in this area is that pit-type borrowing is the only recourse. There are, of course, levees and mounds rising 10 to 15 feet above the general terrain of the lower terrace; but these could not possibly fulfill the whole need between Shively and the New Albany Bridge. Ideally, it seems, the material should be taken from borrow areas adjacent to or near the construction corridor. The pit or pits would not, likely, hold water unless they were sealed with a blanket of clay; but they might flood during wet seasons. The gross volume of material needed would be equivalent to a pit about 20 feet deep and covering about 150 acres. Marinas lagoons, and lakes would not seem to be altogether futile considerations.

As a matter of interest, I inquired, to the Corp of Engineers at Louisville, about the source of embankment material used to construct the floodwall at Louisville and learned that most of it was taken from the river side of the construction corridor and that the city had certain responsibilities from that standpoint. At the same time, I inquired about the possibility of dredging the river below McAlpine dam. My correspondent felt that material was available there and also suggested that Sand Island, which is privately owned (by Slider) might be for sale. Immediately above the dam, the channel fill would likely be rather shallow. Farther up, of course, a hydraulic-fill operation is quite current. The "Preliminary Soils Report... I 264-1(21)0," prepared by the consultant, says: "It is assumed in this project that the borrow is from river dredgings or from pits in the project area..." The preliminary Plan-Profile shows a high-rise embankment throughout the project; the lowest point in the grade line is at an elevation of 450 feet; and, at this point, the embankment rises 10 feet above existing ground (Sta. 346); the maximum rise is to an elevation of 476 feet. Consideration may have been given already to the alternative of depressing the roadway to about 440 feet and carrying the cross-streets overhead -- at least, this would solve the problem of borrow, but it may further complicate the problems associated with bridges and utilities. Ground water (water table) is 20 to 50 feet below. Never-the-less, aside from other complicating factors one end of the particular project (perhaps the south end

December 3, 1965

might be depressed so as to balance a raised portion to the north.

We have not reviewed any plans other than those pertaining to I 264-1(21)0 and, therefore, cannot be explicit at this time with respect to all current needs for fill materials. In a broader sense, we would prefer that you consider this submission to be in the nature of a pilot study which might subsequently be expanded and made more definitive in regard to aggregates and special-use materials. A copy of a study proposal -- which would extend this type of work to other counties -- is included as an appendix to this pilot submission.

Your appraisal of the value of this type of research relative to the problems at hand will be much appreciated.

Respectfully submitted

A handwritten signature in cursive script, appearing to read "Jas. H. Havens".

Jas. H. Havens
Director of Research

JHH:lhs

Attachment

Research Report

A GENERAL SURVEY OF HIGHWAY CONSTRUCTION MATERIALS
Jefferson County
(A Pilot Study)

by

Jas. H. Havens, Director
R. C. Deen, Asst. Director

Division of Research
DEPARTMENT OF HIGHWAYS
Commonwealth of Kentucky

December 1965

INTRODUCTION

The general geology of Jefferson County is very similar to that of other counties lying along the fringes of the Outer Bluegrass area -- that is to say, bedrocks are more-or-less horizontally stratified and consist principally of limestones and shales. The present topography is largely the result of erosion; the soil mantles are residual products of weathering of the uppermost stratum of bedrock or shale (as the case may be).

The unique features of the area are associated with the Ohio River and outwashes resulting from encroachments of two glaciations. The toe or southern boundary of ice did not cross the River in this area; but the mouth of the Salt River was blocked; and the deeper channel was filled with a mantle of sediment. This sediment might be encountered in the channel of Floyd's Fork and other tributaries and streams in the county. The westward flow of outwash deposited sands and gravels, etc., in the Ohio River valley; and these materials occur as two, fairly distinct terraces or flood plains along the interior arcs of meanders.

Prior to the glaciation, there seems to have been a fall-line in the old river channel where the city of Louisville is now. The valley filling diverted the River northward to its present site. The bedrock of the scarp is still evident at McAlpine Dam (formerly the Falls of the Ohio).

In the early days of road-building, Ohio River gravels and sands were in great demand for road and paving aggregates. These materials were shipped into the central and eastern areas of the State. For instance, in 1927 sand and gravel were shipped by rail to Harlan and Bell counties for use in a concrete pavement between Pineville and Harlan. Quarried and crushed limestone was not in general use prior to that time as an aggregate for portland cement concrete. River sands are still in demand for both concrete and bituminous paving; however, high-quality limestones now provide the greater bulk of coarse aggregates throughout the State. Aggregate-quality limestones occur in Jefferson County, and vast terraces of sand and gravel occur north of the River and westward of Jeffersonville, in Indiana. Gravel and sand are dredged from the River upstream and downstream from Louisville. A few sand pits (fine sand, upper terrace) have been worked commercially above and below Louisville. The major use of this sand, at present, is for blending with coarser, river sand, in the production of Class I, Type A, bituminous paving mixtures. High-quality, angular sands are notably skid-resistant and are preferred over calcareous sands in high-type pavement surfaces.

Fill or embankment materials are available from three types of deposits; they are: 1) soil mantles, which overlie bedrock; 2) valley alluviums and glacial outwash terraces, and 3) quarried bedrock and shales. Quarrying and dredging

operations are usually more expensive than pit-type excavations of loose material such as soil and the terraced sands and gravels. Transporting large volumes of these materials into the city and over roads and streets not built to carry heavy cargo traffic may involve extensive damage and expensive repairs. All factors, such as availability, accessibility, proximity, and comparative costs of borrow come to bear when high-rise highway embankments, floodwalls, or other massive earthworks are contemplated.

Three formations should be excluded from consideration as ordinary borrow material. None of the three occurs in the downtown area, and all three tend to outcrop along scarps or slopes of stream valleys -- that is to say, they would likely be available only by quarrying unless only the soil mantles covering the outcrop slopes were stripped and utilized. These soils would undoubtedly be very clayey and difficult to work. Slope stability would be a problem. The areas where these materials occur might be considered to be vulnerable to slides and slips. The most treacherous area, from the foregoing standpoint is identified the accompanying map (General Highway Map of Jefferson County, Kentucky, base) as New Providence Shale. This area is described in greater detail in a following section of this report. The Osgood and Waldron Shales are the other offending strata, and they outcrop mostly in the area identified on the map as Silurian Limestones and Shales. Detailed descriptions of each area shown on the map also follow.

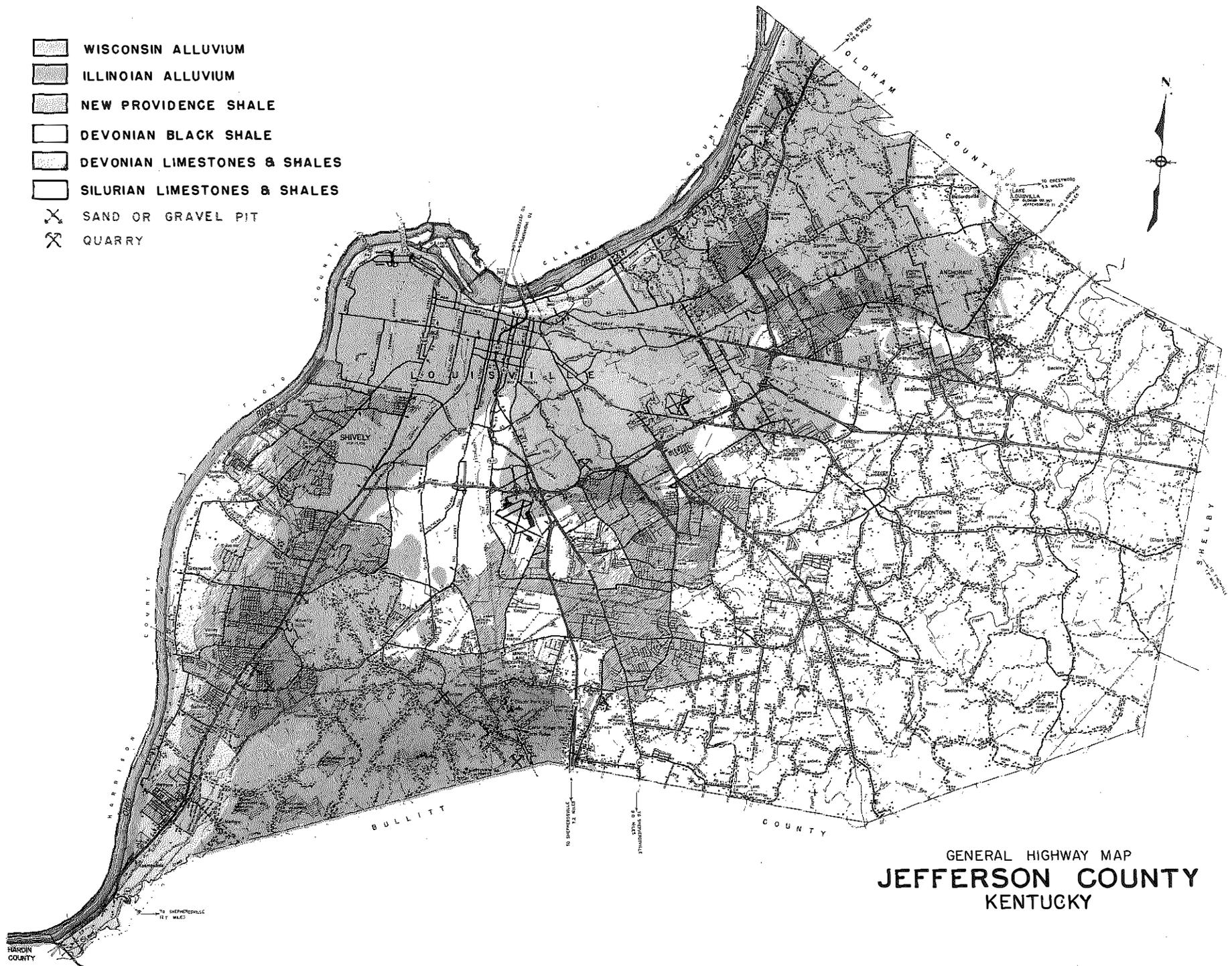
The substrata in the area slope toward the river -- that is, northward and westward; and the underground drainage proceeds in that general direction. Some of these water-bearing strata empty into the sand and gravel deposits under the city of Louisville. Side-hill cuts on the westward and northward side of higher ground may require under-drains and deep ditching as assurance against slides.

Whereas, considerable latitude may be exercised in selecting borrow materials for ordinary embankments, subgrade materials (the top layer of an embankment carrying a roadway) should be selected on the basis of CBR or soil classification; slope covers or blankets, to sustain turf or sod and to prevent erosion, should consist of moderately plastic soils; core-walls for levees or dams normally consist of impervious, clayey soils.

Aggregates are customarily imported into the urban area of Louisville. However, these are premium materials; and known and proven sources and markets have been established -- making production a highly competitive business. In contrasting aggregate demands with demands for borrow (and ordinary excavation for roadways) the following volumes of materials utilized during 1964 in all state highway construction may be of interest.

Roadway Excavation	-----	38 million cu.yds.
Borrow	-----	4 million cu.yds.
Aggregates	-----	9 million cu.yds.

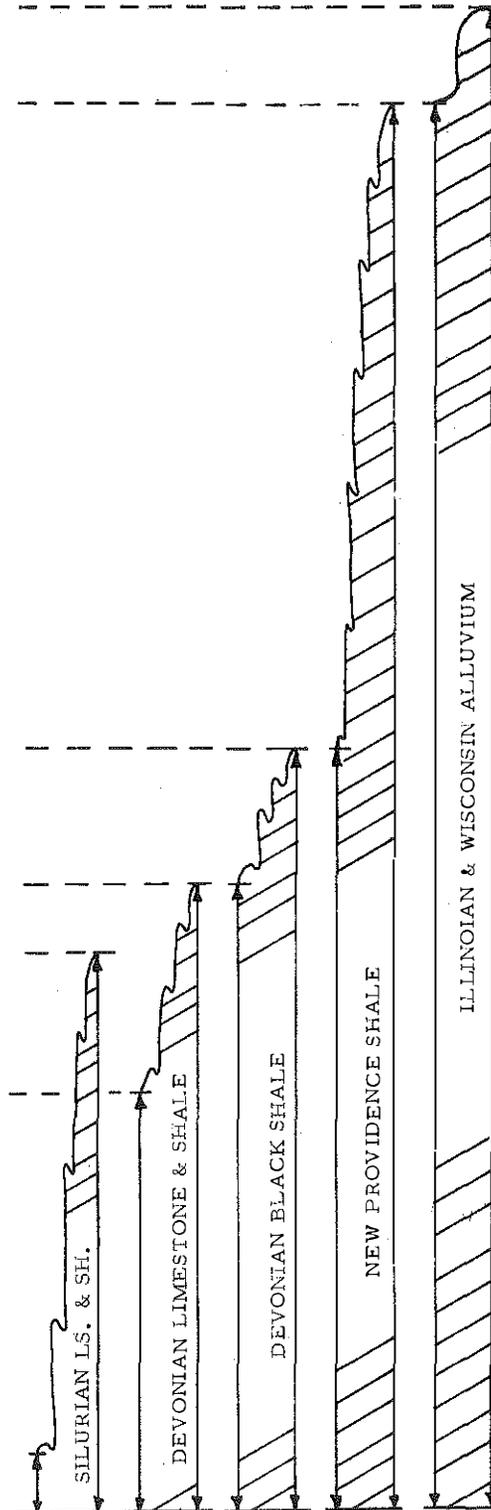
-  WISCONSIN ALLUVIUM
-  ILLINOIAN ALLUVIUM
-  NEW PROVIDENCE SHALE
-  DEVONIAN BLACK SHALE
-  DEVONIAN LIMESTONES & SHALES
-  SILURIAN LIMESTONES & SHALES
-  SAND OR GRAVEL PIT
-  QUARRY



GENERAL HIGHWAY MAP
JEFFERSON COUNTY
 KENTUCKY

GENERAL STRATIGRAPHIC SECTION
FOR JEFFERSON COUNTY

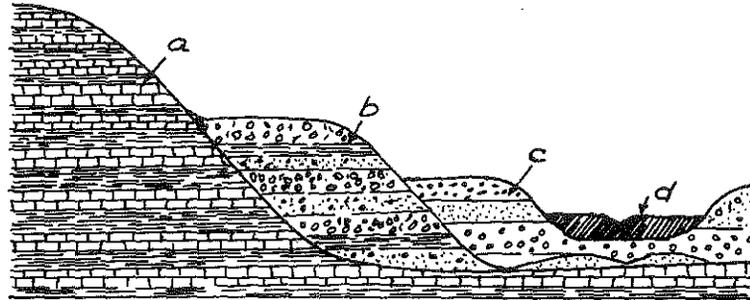
		Thickness in Feet	
RECENT	Aluvium		
PALEOZOIC	Glacial sand and clay		50-100
	Warsaw limestone		65-82
MISSISSIPPIAN	Holtzclaw sandstone		15-25
	Rosewood blue-gray shale		190
	Kenwood sandstone		40
	New Providence green shale		150-160
	Devonian		
	New Albany black shale		90-100
DEVONIAN	Sellersburg limestone		12-24
	Jeffersonville limestone		20-25
	Louisville limestone		42-100
SILURIAN	Waldron shale		8-12
	Laurel dolomite		80-40
	Osgood formation		22-30
	Brassfield limestone		8-7
	Saluda limestone		80-40
	Liberty formation		38-50
ORDOVICIAN	Waynesville formation		40-50
	Arnhem limestone and shale		76-100



WISCONSIN AND ILLINOIAN ALLUVIUM

Some of the uniqueness of this area has already been described in introductory discourses. The area is shown in yellow and orange on the accompanying map of Jefferson County. The term, alluvium, signifies material deposited by water and implies that the material may be sorted and sized according to swiftness of the water currents -- usually sands and gravels predominate. Although the area is nearly flat, two terraces are recognizable. The lower one (yellow) is at an elevation of approximately 430 feet, and the upper one (orange) rises 15 or 20 feet higher (445-450 ft). The top 10 or 15 feet of both consist of fine sand and silty soil. The terraces are underlain with beds of sand and gravel and occasional lenses of clay and former marshes; coarser material and boulders may be encountered in the lower depths. The terrain is somewhat eroded; and some natural levees may be encountered. The natural, ambient elevation of the water table is near 390 feet elevation -- this is approximately 50 feet below the surface. Perched water tables may be encountered over clay lenses and former marshes -- if punctured, they would probably drain.

In general, the cross-section of the Ohio River valley and its alluvial terraces is illustrated by diagram on the following page. In pre-glacial times, the channel was cut deep into bedrock; during the melting of glacial ice, outwash carried sand and gravel, etc. into the valley and westward. The channel may have been filled as much as 100 to 200 feet and re-eroded to its present bed elevation.



The diagram above illustrates: a) pre-glacial bluffs along the Ohio River and the deep erosion of the bedrock in the channel at various locations, b) interbedded sand, silts, and gravel valley-fill attributed to Illinoian glacial outwashes, c) valley-fill attributable to Wisconsin glacial outwash gravels and sands, and d) recent channel-fill. Two distinct terraces are recognizable. The upper terrace is approximately 15 to 20 feet higher than the lower one in the vicinity of Louisville. The major part of the city is built on the upper terrace. The upper 15 to 25 feet of the upper terrace is usually fine sand. It is interesting to note that the valley fill is some 40 feet deeper under the heart of the city than the present river bed at the falls. This indicates that formerly the course of the river went through the present site of the city. The deeper valley has been filled, and the present channel is perched on the Sellersburg Limestone farther north and west than the earlier fall or scarp. The older, deep channel is down into the Louisville Limestone. Where the bedrock rises toward the hills, the fill is bedded on New Albany (Devonian) Black Shale.

The filling occurred in two glacial epochs, the Illinoian and Wisconsin -- hence, the two terraces. The glacial recessions seem to have had quite similar effects from the standpoint of filling the valley. Coarser gravels were deposited upstream from Louisville; whereas only pea gravel was deposited westward of Owensboro. Wide terracing occurred along the interior arcs of meanders -- in the slower currents.

At Louisville, a pre-glacial fall-line or scarp is thought to exist in the old channel of the river -- dropping 40 feet or more through Sellersburg and Jeffersonville limestones and cutting into the Louisville Limestone. The older channel passes under the downtown area of Louisville. At its deepest point, it is thought to be at an elevation of about 340 feet -- meaning of course, that sand and gravels may be 100-110 feet in depth. Islands or ridges may have been cut or left in the bedrock, and it may be assumed that the bedrock rises toward the pre-glacial banks and bluffs.

The rock strata to the east and south of the river slope slightly northward and westward; underground drainage is believed to empty into the sands and gravels filling the old channel. The water table is only 7 or 8 feet higher than the pool elevation of the River (383 ft.) downstream from McAlpine Dam.

A geologic section of the River and terraces on the Kentucky side at mile 615, near the Riverside Gardens subdivision, is shown in a following diagram. Unfortunately, the borings did not penetrate to bedrock, but the depth of gravels indicate that rock is deeper here than it is nearer Louisville proper.*

Undoubtedly the alluviums thin out toward the east as bedrocks of the pre-glacial banks rise to the surface. To the south and east of Shively, the emergent formation is the Devonian (New Albany) Black Shale; and to the east of U.S. 31-W, the higher ground emerging is New Providence Green Shale. These also, undoubtedly wedge under the alluvium and toward the River. Both of these formations merit special attention, and each is described further in succeeding sections of this report. It hardly suffices to say that shallow overlapping of alluvium over these formations along this margin, may obscure treacherous foundation problems for structures and embankments.

* As a matter of interest concerning possibilities of dredging at this location, see excerpt from Better Roads, Sept., 1965, in Appendix.

DEVONIAN (NEW ALBANY) BLACK SHALE

The Devonian Black Shale area is shown in blue on the accompanying, base map of Jefferson County. This area consists of a relatively flat plain having an elevation of approximately 460 feet. The soil mantle is 10 or 15 feet in depth. It is underlain by Black Shale which may be as much as 100 feet in thickness. The Black Shale is somewhat bituminous and sulfurous; when exposed to air, it tends to undergo autogenic calcination (spontaneous combustion). It is not unusable as embankment material; several fills on the Kentucky Turnpike were built of it -- at least in part. It is a very sandy and silty shale and weathers into a low-clay soil. If used for embankments, it should be protected with soil blankets. The soil mantle is also usable.

The unique feature of this area is the imperviousness of the shale bed to infiltrating surface water. Although there is a shallow slope toward the River, the gradient is not sufficient to drain the area; consequently, the water table rises to the surface during rainy seasons; and crayfish holes pervade the area. Runoff is poor, and the main engineering problems in the area are concerned with surface and sub-surface drainage. Paved, parking areas, roads, and airport runways at or near ground elevation have exhibited histories of failures because of this condition.

NEW PROVIDENCE (GREEN) SHALE

This area is shown in purplish red on the accompanying map of Jefferson County and comprises the higher ground south of Shively; it is a massive formation approximately 150 feet in thickness and rises to an elevation of 710-720 feet. Some of the knobs are capped with Kenwood Sandstone, which may be as much as 40 feet thick. Higher caps of Rosewood Shale are also evident; both the Kenwood and Rosewood are shaley and are believed to be merely more sandy layers of the New Providence Formation. The New Providence is the basal layer of the Mississippian group; it overlies the Devonian (New Albany) Black Shale.

The unique feature of the New Providence (at least in this general area) is its high clay content; it yields mostly plastic clay when weathered; it slakes to clay in a matter of a few hours after it has been wetted; but, when fresh, it appears hard and rock-like. It weathers to a depth of about 30 feet, and these resulting clays appear as the soil mantle overlying the slopes of the knobs in Jefferson County.

Ordinarily, these soils and shales would not be considered to be usable for embankment construction.

This shale is presently being quarried, crushed, and burnt for the production of light-weight aggregate -- near Shepherdsville. Upon burning, to near fusion, the shale

bloats naturally and remains fused after cooling. It is marketed under the trade name, "Kenlite".

An island outcropping of this formation occurs north of the intersection of I 264 and U.S. 60 (Shelbyville Road).

DEVONIAN LIMESTONES AND SHALES

In the north central part of the county, limestones and shales of the Middle Devonian Series are exposed. In stream beds, erosion has been more severe and limited outcrops of the underlying Silurian limestones and shales are found. There are some limited exposures of the troublesome Waldron Shale (see Waldron Shale in Section on Silurian Limestone and Shale Area). The soil mantle in this area is approximately 10 to 15 feet thick and would be generally suitable for embankment and subgrade construction.

SELLERSBURG LIMESTONE - The top six to eight feet of this formation is known as the Beechwood Limestone and consist of gray, thick-bedded, coarse-grained limestone. Below this is a thick-bedded, dark gray, fine-grained siliceous and aluminous limestone (cement rock). The magnesium carbonate content ranges from 15 to 35 percent. This layer is known as the Silver Creek Limestone and is eight to ten feet thick in Jefferson County.

JEFFERSONVILLE LIMESTONE - This formation overlays the Silurian limestones and shales and is approximately 20 to 25 feet thick. The Jeffersonville is a gray, coarsely crystalline, thick-bedded dolomitic limestone with some cherty seams. This limestone is known as the main coral bed of the "Falls of the Ohio". It is also a probable source of limestone aggregate.

SILURIAN LIMESTONES AND SHALES

In the western portion of Jefferson County, geologic materials of the Silurian age account for the predominate outcroppings. In the far western part of the county, smaller areas of older, Ordovician materials outcrop in stream valleys where erosion has been the greatest. The soils of this area are generally satisfactory for embankment and subgrade materials. Exceptions to this are the soils derived from the Waldron Shale and the shale layers in the Osgood Formation.

LOUISVILLE LIMESTONE - This limestone is the predominate material outcropping in the western portion of the county. This formation is the uppermost material of Silurian age and consists of 40 to 100 feet of massive, gray, fine-grained limestone. Two layers near the top are well known to quarrymen as the "Blue Ledges " and are extremely high magnesium limestones. This formation is the principal source of limestone aggregate in the county, as indicated by the quarry sites on the attached map.

WALDRON SHALE - This formation outcrops in very limited areas. It is a highly calcareous and magnesian, greenish gray, coarse-textured shale eight to twelve feet thick. On weathering it disintegrates rapidly into a greenish clay which has undesirable engineering characteristics for general highway purposes. If this shale is used in embankments, it must be well protected from weathering elements.

LAUREL DOLOMITE - The Laurel is 30 to 40 feet of bluish, medium fine-grained, dolomitic limestone. The top foot or two is evenly bedded and suitable for building stone.

The formation is a good source of aggregate.

OSGOOD FORMATION - This formation is 20 to 30 feet thick, consisting of thin-bedded, fine-grained magnesian limestone and calcareous and magnesian shales. Upon weathering the shales break down into clays of undesirable characteristics.

BRASSFIELD LIMESTONE - This formation is the lowermost formation of the Silurian age outcropping in the county. It is very limited in extent, being only three to seven feet thick. The formation consists of a medium to coarsely crystalline, grey to pink, dolomitic limestone.

SALUDA LIMESTONE - This is a thick-bedded, fine-grained, dolomitic limestone 30 to 40 feet thick. This is the youngest formation of the Ordovician age exposed in the county.

LIBERTY FORMATION - This formation is 35 to 50 thick in Jefferson County and consists of alternating, thin-bedded, calcareous shales and crystalline limestones.

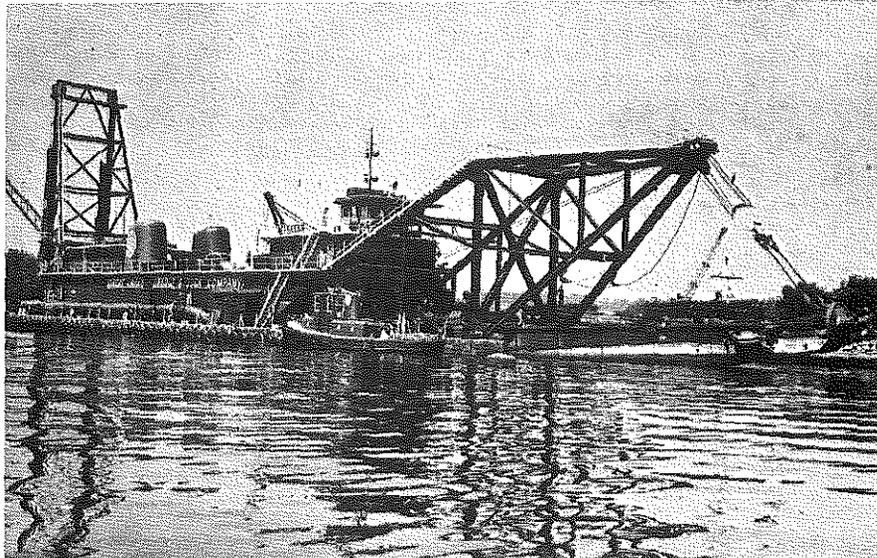
WAYNESVILLE LIMESTONE - This formation consists of a succession of shales and fine-grained, earthy limestones totaling about 40 feet in thickness.

ARNHEIM FORMATION - The alternating, coarse, calcareous shales and blue, crystalline limestones of the Arnheim formation are the oldest materials outcropping in the county. The formation is 75 to 100 feet thick and is approximately 300 feet above the Eden Shales, which are common materials exposed in the Outer Bluegrass.

APPENDIX

- I. Excerpt, Better Roads, Sept., 1965
- II. Research Proposal

Big Dredge Begins 2-Year Job



The dredge "Alaska," one of the largest in the construction industry, is removing borrow from the Hudson River at Albany, N. Y., in the photograph above. The material will provide fill for Interstate Route 787, which will run along the Albany river front. The work is being performed under a \$10,694,059 contract for grading and drainage work held by Great Lakes Dredge & Dock Co., Chicago, Ill.

Operated by a 35-man crew, the Alaska is removing fill from the river bottom and pumping it ashore through a 27-in. pipe. Later it will work along the west shore, cutting back the river bank in some areas to widen it and provide further borrow for the 10-ft.-high embankments. The dredge is expected to be in continuous operation along the river front, weather permitting, throughout the next 2 years. Com-

pletion date for the contract, which also includes land operations, is Dec. 1, 1967. Land work began in April of this year.

The grading contract calls for preparing an area for the highway 108 to 144 ft. wide, from a planned interchange of the Albany Northside Route (Interstate Route 90) and the river front expressway on Lower Patroon Island, northerly along the west side of the river through Albany and Menands to the vicinity of Seventh St. in Watervliet. Included in the project is grading of 0.35 mile for the Northside Route where it will connect to the west end of the Patroon Island Bridge now being built between Albany and Renselaer.

The project is under the direction of Frank J. Fuller, Albany district engineer of the New York State Department of Public Works. ■

ENGINEERING PROPERTIES
OF
GEOLOGICAL MATERIALS

I. RESEARCH

A. SPECIFIC AIMS

The objective of this study is to determine the engineering characteristics of geological materials of Kentucky.

B. PROCEDURE

As a result of increased activity in subsurface exploration associated with the design and construction of modern highway facilities, there is a large number of samples of geological materials available for evaluation. It is proposed that these samples and associated logs be obtained by the Research Division and be used for the purpose of evaluating the engineering characteristics of these materials. Such characteristics as specific gravity, porosity and bulk density, permeability, unconfined compressive tests, moduli determination of clays and insolubles in certain materials, absorption, expansion, hardness, and others will be determined. Once this information is available it will be necessary to develop a systematic method of subdividing the geologic formations of the State into lithologic units and to summarize the engineering characteristics and predicted behavior for these various units. A means will be developed to briefly and conveniently present this information to the practicing engineer and to provide a means of indicating special geologic features or problems that might be associated with the various materials.

C. SIGNIFICANCE OF RESEARCH

Much effort in recent years has been devoted to the development of engineering data for pedologically mapped soils in many areas of this country. This type of information has been and will be a great benefit to engineers and planners in the preliminary planning and site-selection stages of engineering projects. By having this type of information available, time and money usually required for preliminary surveys can be used for a more rapid development of the project.

Generally the bedrock in the State of Kentucky is relatively near the surface or actually outcrops and therefore often plays a significant factor in the selection of sites and the resultant designs for many highway and other engineering projects. If engineering information were available for the geologic materials in the State, this would be of great value to the planner and engineer and would enhance greatly the use of the soil surveys and geologic maps which are presently being prepared.

D. FACILITIES AVAILABLE

The soils section of the Division is equipped with all necessary laboratory and field equipment to perform the various routine engineering tests.

II. SUPPORTING DATA

A. PREVIOUS WORK DONE BY THE DEPARTMENT OF HIGHWAYS

The Department has had considerable experience in providing engineering data for pedologically mapped soils in the State. Research Study KYHPR-64-13, Engineering Properties of Soils, is directed toward this specific purpose. Using this as a background,

it is hoped that the Department will expand and extend its efforts toward the goal of obtaining or providing engineering characteristics for geological materials as well.

B. LITERATURE REVIEW

Much work has been done by several agencies toward determining engineering properties for soil profiles. Many agencies have also been concerned with the location and study of sites from which construction materials can be obtained for specific purposes. Both of these endeavors are well established as shown by the large number of such studies that are currently in progress as indicated in the recent issue of Highway Research In Progress published by the Highway Research Board. The HRB publication, however, indicates that there is less effort directed toward engineering evaluation of geologic materials. It is noted, however, that the U.S. Bureau of Reclamation is devoting some effort in this area through its Research Study SP-39. The Texas Highway Department also has become involved in such a study in its Research Study Number 1-8-63-63. The Oklahoma Highway Department is also concerned with this area of development as manifested by its recent report entitled "Engineering Classification of Geologic Materials", prepared as part of its Research Study 61-01-1.

C. ESTIMATED COST

1. Personnel	\$5,000
2. Non-Expendable Equipment	0
3. Consumable Supplies	1,000
4. Travel and Subsistence	3,000
5. Other Expenses	1,000
6. Total Funds for Fiscal Year	10,000