GEOLOGICAL SURVEY
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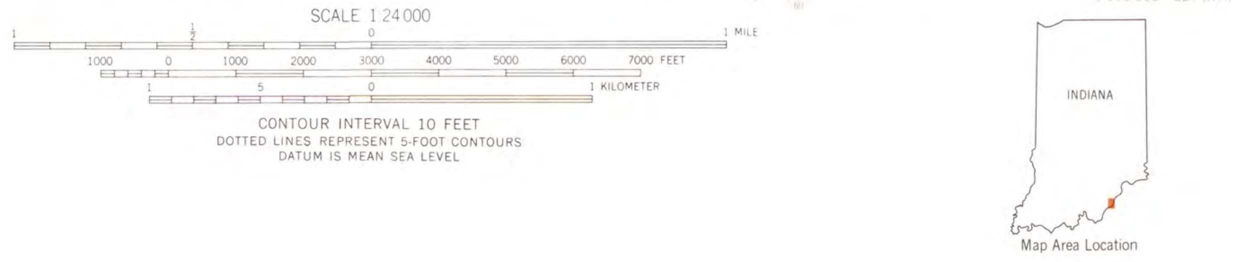
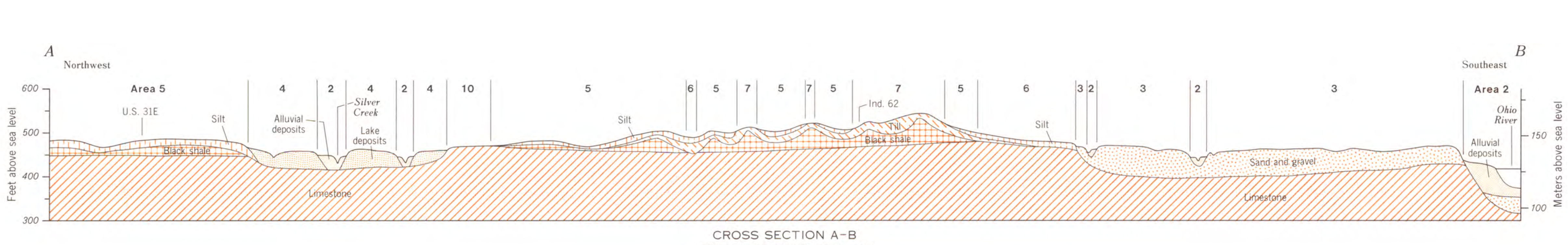
MISCELLANEOUS MAP NO. 20





CROSS SECTION A-B
VERTICAL EXAGGERATION 10 X

INTRODUCTION

This is one of a series of reports on environmental geology of urban areas in Indiana. It is based on field mapping in the spring of 1970 by W. T. Straw, airphoto interpretation and supplementary field mapping in 1971 by Henry H. Gray, and file data from many sources. Emphasis is on interpretation of geologic data toward their practical everyday use, particularly for urban needs.

An area of about 30 square miles is mapped. The 10 subdivisions used in the mapping, called areas, are determined by the various types of geologic materials that are present, including both unconsolidated deposits and bedrock. The first paragraph under each heading is a general description of the area, and the second is an evaluation of the engineering properties of the materials. This is followed by an assessment of the groundwater and mineral resource potential, and the final paragraph is a summary of land use capabilities and problems of the area.

Data that were used in preparing this report may be consulted in the offices of the Indiana Geological Survey, 611 North Walnut Grove, Bloomington, Ind., 47401. A supplementary source for geologic information is Regional Geologic Map 6, "Geologic Map of the 1° X 2° Louisville Quadrangle, Indiana, Showing Bedrock and Unconsolidated Deposits," by Henry H. Gray. This map, which is at the scale 1:250,000 or 1 inch equals 4 miles, shows all of Clark County and adjacent counties. It is available from the Publications Section, Indiana Geological Survey, at the above address. Copies are $1.25 plus 15 cents for packaging and mailing. Additional related information can be found in Supplementary Chart 1, "Properties and Uses of Geologic Materials in Indiana," which is priced at 75 cents plus 10 cents for packaging and mailing.

1

Area 1 includes 1 percent of the mapped area and presents varied limitations in most types of urban land use.

Area 1 includes made and modified land, such as areas affected by quarrying operations, gravel pits, and extensive areas of fill. The surface material is varied; in some places it consists of rubble or other spoil or waste, and in others it is bare rock or gravel exposed in quarrying. Material beneath fill in most places is similar to material mapped in areas immediately adjacent.

Engineering properties of Area 1 cannot usually be predicted. Careful study of stability and drainage is required before planning structures or grade modifications.

Groundwater potential of Area 1 is varied and usually is not directly of consequence. Filled areas normally have little effect on groundwater levels beneath the fill, but quarries and gravel pits usually are extended downward until difficulty is encountered in keeping the water out by pumping or other method of drainage. Generally this results in lowering groundwater levels adjacent to the quarry or pit. The extent of the affected area varies, but as a rule, the greater the quantity of water pumped from the pit or quarry, the more widespread and severe the effect. After abandonment, the holes commonly fill with water and the water table in adjacent areas rises. Because water in the pit interchanges with adjacent groundwater, it is essential to avoid using abandoned pits and quarries in any manner that will contaminate the groundwater. Dumping of refuse should be specifically prohibited.

Mineral resource potential of filled areas is negligible. In pit and quarry areas, present or past resource value is obvious; a more important factor is the potential of adjacent areas into which the operation may expand.

Land use potential of Area 1 is mixed. Filled areas are normally useful only for the purpose designed. Most quarries and gravel pits are poorly suited for reclamation because of the great quantities of material removed. Some abandoned quarries and pits can be developed for recreational uses by taking advantage of the pond that usually remains when pumping stops. Some dry quarry floors can be adapted for industrial use, for example, by a related industry such as construction or warehousing. Even where so modified, the quarry or pit forms a large and virtually permanent scar that fits poorly with any surrounding land use. Because of the need for mineral construction materials, however, and because these materials are particularly subject to high relative transportation cost, allowance must be made for their extraction in or near metropolitan areas.

2

Area 2 includes 6 percent of the mapped area and presents very serious limitations in most types of urban land use.

Area 2 is the alluvial area, sometimes known as the first bottom, adjacent to streams. It is underlain by stream-deposited silt, sand, and clay, which generally is 5 to 15 feet thick but which is 30 to 40 feet thick along the Ohio River. Beneath this in most places are deposits similar to those mapped immediately adjacent. Most parts of Area 2 are flooded almost annually, and with each flood is deposited a new layer of silt.

The deposits of Area 2 are varied. Most of the material is soft in consistency and has inadequate bearing capacity for heavy structures, but pilings can usually be driven through the deposits into firmer materials beneath. The deposits are poorly suited for use as fill because of their high moisture and organic content.

Groundwater potential of Area 2 is poor to excellent. Dependable supplies seldom are obtained from the alluvial deposits themselves, but deeper drilling adjacent to Area 3 usually finds large quantities of water in gravel or in cavernous limestone beneath the gravel, and well fields along the Ohio River tap highly productive gravel reservoirs at about 80 feet. Deeper drilling in other parts of Area 2 usually has negligible results.

Mineral resource potential of Area 2 is inconsequential. Sand and gravel deposits underlie parts of Area 2, but frequent flooding makes pit management difficult.

Area 2 is poorly suited to permanent construction for residential, business, or industrial purposes because of frequent flooding and poor bearing characteristics of the materials. Fill may be used to raise parts of the alluvial area above the normal reach of floodwaters, but the low bearing capacity remains a hazard (thick, heavy fill may subside seriously), and care must be taken to see that the passage of floodwaters is not restricted. Area 2 is best suited to grazing, to some types of woodland, and to recreational use.

3

Area 3 includes 31 percent of the mapped area and presents moderate limitations in most types of urban land use.

Area 3 is a terrace or "second bottom" underlain by stream-deposited sand and gravel, which is principally glacial outwash. The terrace surface is 35 to 55 feet above the pool level of the Ohio River. The upper 10 to 15 feet of the deposit is mostly silt; sand and gravel are present at depth. Total thickness of the deposit is 30 to 40 feet in the Jeffersonville-Oak Park area and 70 feet or more near Utica. Gravel extends under adjacent parts of Area 2 and beneath the Ohio River. The underlying bedrock is limestone which, especially in the Jeffersonville-Oak Park area, is jointed and cavernous.

The deposits of Area 3 are noncohesive but have good bearing capacity. Fairly heavy structures may be founded on this material, and generally it is adequate for use as fill. Silt in the upper 10 to 15 feet is not free draining, and as a consequence frost damage potential is high.

Groundwater potential of Area 3 is good. Dependable supplies ranging from 10 to 30 gallons per minute are typically reported by drillers. Some wells near the northwest margin of Area 3 penetrate blue clay (similar to that of Area 4) from which no water may be obtained. Best production is from gravel beds or from jointed and cavernous limestone immediately beneath the sand and gravel.

Mineral resource potential of Area 3 is good to excellent. Large gravel deposits underlie the Utica area; the gravel size is finer and the gravel content is lower to the southwest. Thus the best gravel supplies are presently being worked. Beneath Oak Park and Jeffersonville, limestone lies at a depth of 30 to 40 feet. Though the gravel here is of lower quality than at Utica its extraction might someday be practical, but this area is rapidly becoming urbanized.

Much of Area 3 was covered by the 1937 flood. Although levees and floodwalls now protect part of this area from floods of this magnitude, flooding is still a hazard in most of the terrace area. Despite this, Area 3 is attractive for further urban expansion: drainage is reasonably good, bearing capacities are adequate, and excavation is easy. The flood hazard is considerably less for higher ground than for lower, and development of unprotected areas below about 460 feet altitude probably should be discouraged or controlled. In areas of high population density that are not served by sanitary sewers, there is serious danger of contamination of groundwater, which is mostly shallow, by septic tank effluent. Development of sanitary sewers in these parts of Area 3 is recommended.

4

Area 4 includes 11 percent of the mapped area and presents serious limitations in most types of urban land use.

Low, poorly drained areas of backwater terrace or "second bottom" constitute Area 4. These were formerly lake bottoms and are underlain by lake-deposited silt and clay, which is generally 5 to 20 feet thick but which in places is 40 feet thick. The material is calcareous below a depth of 10 to 15 feet, and it becomes increasingly sandy toward Area 3. The boundary between Area 4 and Area 3 is gradational and is somewhat arbitrarily placed. Limestone is the bedrock in most parts of Area 4.

Deposits of Area 4 are mostly of soft consistency. Bearing capacity is adequate for residential construction but is inadequate for most heavier loads. The material is poor for use as fill because its capillary water content is high and proper compaction is difficult. Internal drainage is slow. Cuts must have low slopes and are subject to sliding, slumping, and mudflowage if sufficient time is not allowed for drainage and stabilization.

Groundwater potential of Area 4 is poor. There is little producible water in the lake deposits themselves. Limited supplies may be obtained from the underlying limestone, which in places is jointed and cavernous, and sand lenses along the boundary with Area 3 yield some water.

Mineral resource potential of Area 4 is poor. The silt and clay is calcareous and is unsuitable for ceramic use. Along the east margin of Area 4 where the lake deposits are thin, quarrying has been carried on in the underlying limestone. Drainage of these quarries was difficult, however, and they are now abandoned.

Land use in Area 4 is severely limited by poor surface drainage and poor soil drainage. A part of the area was inundated in the 1937 flood; this is not protected by floodwall or levee, and uses requiring permanent construction should be discouraged or regulated in those parts of Area 4 that lie below about 460 feet altitude. Because of the very poor drainage, however, local flooding anywhere in the area may follow periods of heavy rainfall. These minor floods do not usually cause extensive damage, but they are apt to disrupt services. Poor soil drainage also makes the use of septic tanks absolutely impracticable, even where lot sizes are large. The water table is high and tile field drainage almost invariably breaks out to the ground surface. Residential development should be restricted to those parts of Area 4 where sanitary sewers are available.

5 6

Areas 5 and 6 include 24 percent of the mapped area and present moderate limitations in most types of urban land use.

Areas 5 and 6 are low rolling uplands mantled by a layer of windblown clayey silt (loess). The silt is very deeply weathered, as indicated by the fact that it is noncalcareous and that it contains much iron oxide as nodules and small pellets. In some areas a few feet of reddish-brown cherty clay till similar to that of Areas 7 and 8 lies between the silt and bedrock. In most places the thickness of the silt is 5 to 20 feet, but it is somewhat thicker on lower hillslopes. It thins to a wedge edge adjacent to Areas 7, 8, 9, and 10, so that this boundary cannot be accurately mapped. Area 5 has a black shale substratum; Area 6 has limestone as bedrock, but in a few places small thin patches of black shale are present.

The silt of Areas 5 and 6 is mostly of medium to stiff consistency. Bearing capacity is adequate for moderate loads. In most parts of these areas the silt is not thick and heavy structures may be founded on bedrock. The silt is adequate for use as fill, but it is not free draining and frost damage potential is high. Shrink-swell potential is low to moderate.

Groundwater potential of Area 5 is poor to fair. The silt is too thin to serve as an aquifer, and the underlying shale yields only a little water, usually sulphurous, from joints. Deeper drilling reaches limestone, from which drillers report yields of 1 to 10 gallons per minute.

Groundwater potential of Area 6 is fair to good. Here too the silt is too thin to be an aquifer, but the underlying limestone, the upper part of which is jointed and cavernous in most places, commonly yields 10 to 30 gallons of water per minute. Some wells are dry, however, and most wells deeper than 80 to 100 feet produce only salt water.

Mineral resource potential of Areas 5 and 6 is good. Good quality limestone lies at shallow depths and pit drainage would present only a minor problem. One large quarry has been operating adjacent to Area 5 for many years.

In most parts of Areas 5 and 6, natural slopes provide adequate surface drainage, the water table is not high, and excavation is relatively easy. Internal soil drainage is poor, however, and the use of septic tanks is impracticable except on lots of large size. Development of sanitary sewers is desirable if urbanization is to continue in these areas.

7 8

Areas 7 and 8 include 12 percent of the mapped area and present moderate limitations in most types of urban land use.

Areas 7 and 8 are low rolling uplands blanketed by a layer of reddish-brown stony, silty clay till, the deposit of a glacier. The upper foot or so in many places is clayey silt similar to that of Areas 5 and 6. The till is generally 5 to 20 feet thick; it is somewhat thicker on lower hillslopes and thins to a wedge edge adjacent to Areas 9 and 10. Thus this boundary cannot be accurately mapped. In Area 7 the bedrock is black shale; in Area 8 it is limestone.

Deposits of Areas 7 and 8 are mostly of stiff consistency. Bearing capacity is adequate for moderate loads. In most parts of the area the till is not thick and heavy structures may be founded on bedrock. The till compacts well and may be used as fill, but some parts of it are not free draining and frost damage potential is high. The shrink-swell potential is moderate.

Groundwater potential in Area 7 is poor to fair. The till cover is too thin and impermeable to be an aquifer, and the underlying shale yields only a little water, usually sulphurous, from joints. Beneath this is limestone from which drillers report yields of 1 to 10 gallons of water per minute. Salt water is found at depths greater than 80 or 100 feet.

Groundwater potential of Area 8 is fair. The till cover is too thin and impermeable to be an aquifer, but the underlying limestone, the upper part of which is jointed and cavernous in most places, is reported to yield 1 to 30 gallons per minute. A few wells are dry, and salt water is found at depths greater than 60 to 100 feet.

Mineral resource potential of Areas 7 and 8 is good. Good quality limestone lies at shallow depths, especially in Area 8, and pit drainage would be only a minor problem. Overburden would be excessive in the parts of Area 7 where knobby topography indicates greater than average thickness of black shale. A large quarry operates adjacent to Area 8 north of Utica.

In most parts of Areas 7 and 8, natural slopes provide adequate surface drainage, the water table is not high, and excavation is easy. Urbanization of these areas is therefore limited principally by very slow soil permeability, which makes the use of septic tanks inadvisable. With continued expansion of rural water systems, water use will increase and heavier loads will be placed on existing sewage disposal systems. Development of sanitary sewers in urbanized and urbanizing parts of Areas 7 and 8 is strongly recommended.

9

Area 9 includes 1 percent of the mapped area and presents serious limitations in most types of urban land use.

Area 9 includes broad hilltops underlain by black shale with only a thin cover of residual soil and windblown silt (loess). Small patches of cherty clay till are present in places. The shale is as much as 20 feet thick and thins to a wedge edge adjacent to Area 10. This boundary is fairly accurately mapped because the black shale forms a nearly horizontal layer whose presence can readily be predicted.

Shallow excavations in Area 9 reach relatively unweathered black shale which normally is firm enough to support high foundation loads. Weathering is rapid, however, and produces thin, slick clay films which may cause problems with some types of foundations.

Well records are not available in Area 9, and its groundwater potential can only be estimated, on the basis of geologic evidence, as probably poor. Wells drilled through the black shale into the underlying limestone may yield small supplies of sulphurous water. The sulphur is derived mainly from weathered pyrite (iron sulphide) in the black shale.

Mineral resource potential of Area 9 is good. Beneath the thin shale cover is limestone of good quality. Pit drainage would present few problems.

Land use in Area 9 is limited mainly by poor subsoil drainage. If this area is to become urbanized, the use of septic tanks is inadvisable and development of sanitary sewers is strongly recommended.

10

Area 10 includes 14 percent of the mapped area and presents serious limitations in most types of urban land use.

Area 10 is rolling to rugged land underlain by limestone with a thin cover of residual clayey, cherty soil and windblown silt (loess). Small patches of cherty clay till are present and in places are probably as much as 20 feet thick. A few beds of the limestone are silty and shaly and much of the limestone contains abundant chert. The limestone occurs in nearly horizontal layers and is altogether more than 200 feet thick.

Shallow excavations in Area 10 reach limestone that is jointed and cavernous in the upper few feet. Sound rock is usually encountered at a depth of about 10 feet, except in the western part of Area 10, where the depth to sound rock is difficult to predict because abundant sinkholes indicate extensive cavernous conditions.

Groundwater potential of Area 10 is poor. The few wells that have been drilled in this area are dry or yield only 1 to 3 gallons per minute. In the western part of Area 10, drilling to depths of 60 feet or more yields salty and sulphurous water. In the eastern part, deep wells are dry.

Mineral resource potential of Area 10 is excellent. The best quality stone is obtained from the upper layers of the limestone. Old quarries northwest of Watson were for cement rock; quarries north of Utica, including a large active one, are for aggregate.

The eastern part of Area 10 is hilly and erosion is a severe problem wherever the land has been cleared; much of this area has been stripped nearly to bare rock. Only the hilltops are now under cultivation. The slopes are best suited to woodland. Hills in the western part of Area 10 are less steep and erosion is less severe, but sinkholes are prominent and because of the drainage and foundation problems that these create, this part of the area is best suited to agricultural use.

⚒ Limestone quarry, active

⚒ Limestone quarry, abandoned

⚔ Gravel pit, active

SUMMARY AND PROGNOSIS

The Jeffersonville area is underlain by many kinds of rocks and soils. Each of the 10 areas mapped has specific capabilities and resources, along with specific hazards and problems. Discussed here are some of the resources and problems that are general to the area.

Engineering properties of the rocks and soils for the most part are not disadvantageous except in Areas 2 and 4, where the soils are soft and special studies are required for construction involving more than light foundation loads. In the western part of Area 10, sinkholes that indicate possibly hazardous cavernous conditions in the bedrock are abundant, and in the eastern part of Area 10, rugged topography probably rules out most conventional types of construction. Elsewhere, flat to rolling topography and generally good foundation conditions prevail, although in Areas 5-6 and 7-8 heavy structures probably will need to be founded on bedrock, which is mostly at shallow depth.

Groundwater for rural water supply presents a diminishing and generally noncritical problem in the Jeffersonville area, mainly because of the rapid growth of municipal and rural water systems. Most of the groundwater in the Jeffersonville area is produced from high capacity wells in gravel close to the Ohio River and is in fact not true groundwater, but simply river water effectively filtered through natural materials. The most urgent problem connected with groundwater is contamination, as from too extensive use of septic tanks in Area 3, or from poorly sited landfills and dumps. All groundwater in the Jeffersonville area eventually emerges to the surface and becomes part of the flow in Silver Creek or the Ohio River. Protection of groundwater quality is therefore essential even where the groundwater itself is not used directly.

Mineral resources of the Jeffersonville area include limestone (primarily for crushed stone) and sand and gravel. Of these, limestone is available in almost limitless supply. Areas 5-6, 7-8, 9, and 10 offer good potential, and it should be possible to optimize the location of future quarries with respect to transportation and surrounding land use. Existing quarries are fairly satisfactorily located and probably have resources for many years of future production. Sand and gravel, however, may become critical in the years to come if provision is not made for the future of this industry. Area 3, particularly that part of the area near Utica, is the only source of sand and gravel in the Jeffersonville area; but Area 3 is under heavy urban pressure, and residential and industrial construction is rapidly sealing off possible future sites of sand and gravel production.

The Jeffersonville area is no stranger to land use problems. The floods of 1913, which reached a gauged elevation of 447 feet, and of 1937, which reached an all-time high of 459 feet and flooded 90 percent of Jeffersonville, are still fresh in the memories of those who experienced them. Floods of this general magnitude have occurred several times in the past 150 years. Less spectacular are local floods, particularly in Area 4, that follow heavy rainfall because of the poor surface drainage and slow soil infiltration rates. These sometimes disrupt services but cause relatively little property damage. Soil infiltration rates in Areas 5-6 and 7-8 also are slow, and care must be taken in all developing areas not to disadvantageously modify the natural surface drainage that now exists. Flood damage will result if development, such as along Highway 62 near Watson, is allowed to shed excessive increased runoff into adjacent areas that are not prepared to handle it.

Septic tanks were developed for rural use and should never be used on small lots in subdivision-type developments. Furthermore, none of the soils of the Jeffersonville area are well suited to septic tank use. Most of the soils are far too slowly permeable, some are too thin, and some have a clay pan that seriously impedes downward percolation of the effluent. Where septic tanks must be used, lot sizes should be sufficient to allow construction of drain fields of very generous size, and also to leave room to construct an alternate field for use when the first field fails. (After a recovery period of several months, the first field usually may be used again.) In Area 4, septic tanks are entirely unsuitable; the soil is very slowly permeable, the water table is high most or all of the year, and tile fields cannot drain properly. In Area 3, tile field drainage is likely to be too rapid, with the result that unrejuvenated effluent will enter and contaminate the underlying groundwater. Ready availability of water through rural water systems is greatly aggravating the septic tank problem in the Jeffersonville area. Septic systems that were barely adequate for users who were dependent on limited water supplies from wells or cisterns are rapidly failing as a result of more lavish use of water and the addition of water-consuming appliances, such as garbage disposals and automatic dishwashers.

Sanitary landfills are best sited in Areas 5 and 7, where a fairly thick and slowly permeable soil cover overlies black shale that is also slowly permeable. Sites should be obtained where the soil is more than 20 feet thick, and the area-fill method of disposal, with cover trucked in, is to be preferred over methods requiring excavation. Sites in Area 4 may be satisfactory if the high water table and hazard of flooding can be properly controlled, but in no case should sites in Area 3 be considered because of the certainty of groundwater pollution by rapidly seeping leachate.

Earthquakes are a nearly forgotten hazard in the Midwest, yet it should be noted that the New Madrid (Missouri) earthquakes of 160 years ago were the most severe in all history. A repetition of these today would cause disruption of services, structural damage, and possibly loss of life in the Jeffersonville area. Damage in Areas 3 and 4, where unconsolidated deposits are rather thick, would be most severe. There is no way to predict whether or when an earthquake of such magnitude will take place in the foreseeable future; it can only be said that the likelihood of such an event at some time within the next several hundred years is quite high.

This map can be purchased from the Publications Section, Geological Survey, Indiana University, 611 N. Walnut Grove Ave., Bloomington, Ind. 47401.

Base from U.S. Geological Survey topographic map, 1965; photorevised 1971.

Geologic mapping in 1970-71. Groundwater information from Division of Water, Department of Natural Resources. Drafted by James R. Tolen.

ENVIRONMENTAL GEOLOGY OF THE JEFFERSONVILLE AREA, INDIANA

By W. T. Straw and Henry H. Gray

1974