STATE OF OHIO
John Kasich, Governor
DEPARTMENT OF NATURAL RESOURCES
David Mustine, Director
DIVISION OF GEOLOGICAL SURVEY
Lawrence H. Wickstrom, Chief

Potential Sand and Gravel Resources of the Mansfield 30 x 60 minute quadrangle

Erik R. Venteris, Douglas L. Shrake, Glenn E. Larsen, Richard R. Pavey, and Gregory A. Schumacher
GIS Administration by Donovan M. Powers
GIS Database Administration by Joseph G. Wells
GIS Cartography by Dean R. Martin

DRAFT

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INTRODUCTION AND PURPOSE

The Ohio Department of Natural Resources (ODNR), Division of Geological Survey has completed a reconnaissance map showing areas of mineable sand and gravel resources in the Mansfield, Ohio, 30 x 60 minute (scale 1:100,000) quadrangle. The main purpose of this map was to create a reconnaissance-level map that would show the potential for mining sand and gravel in this quadrangle. We sought to create this map from as many existing ODNR Division of Geological Survey maps and GIS datasets as possible. The map shows areas of surficial materials in increments of 10 feet (ft) and then differentiates sand, sand and gravel, and ice-contact deposits from finer grained materials, such as glacial till, lacustrine clay and silt, and alluvial materials. The sand and sand-and-gravel units includes both surficial and buried outwash and valley train deposits and ice-contact deposits, such as kames, kame terraces, and eskers. To determine if a sand-and-gravel deposit was economically viable, this map shows the total thickness or accumulation of sand and gravel in the Mansfield 30 x 60 minute quadrangle.

The Mansfield map is a derivative map based directly from the ODNR Division of Geological Survey SG-2 series map, *Surficial Geology of the Mansfield 30 x 60 Minute Quadrangle* (Venteris and others, 2008). The SG-2 series features maps based upon polygons that represent a "stack" of mapped unit lithologies and thicknesses. A set of queries were run in ESRI ArcGIS® to illustrate the range of thicknesses of the surficial materials overlaying the topmost bedrock units. The goal is to target areas where the glacial surficial materials are relatively thin, making quarrying the underlying bedrock economically viable. A secondary goal is to use the SG-2 series of surficial geology "stack maps" as the basis for creating a number of easy-to-construct, reconnaissance-scale derivative maps that allow the user to quickly determine the thickness and nature of the drift and the underlying bedrock for a variety of uses, including the potential for mineable bedrock, sand-and-gravel aggregate resources, and solid-waste disposal sites. The "Mapping Conventions" section below describes surficial mapping units and bedrock units and includes a brief discussion of the potential mineable resources of the bedrock units. A more detailed discussion of the data sources and techniques used for creating the original SG-2 map, *Surficial Geology of the Mansfield 30 x 60 Minute Quadrangle*, can be found in Venteris and others (2008).

In addition to the main "stack map"-based derivative map, this publication includes three useful, smaller-scale "inset" maps. The first inset map (fig. 1) shows the location of both bedrock quarries and sand-and-gravel pits located in the Mansfield 30 x 60 minute quadrangle (Wolfe, 2009). The second inset map (fig. 2) shows where the thickness of sand and gravel as opposed to finer-grained materials (essentially waste for the aggregates industry) exceeds a ratio of 4:1. The higher the ratio, the greater the proportion of sand and gravel to fine-grained materials exists in the particular mapped polygon. In some of the deeper, sand-and-gravel filled buried valleys, ratios may exceed 25:1. This also assumes that the sand and gravel at the surface will be covered by no more than 40 ft of finer-grained overburden. The third inset map (fig. 3) depicts the drift thickness of the Marion 30 x 60 minute quadrangle, based upon the *Shaded Drift-Thickness Map of Ohio* (Powers and Swinford, 2004)

MAPPING CONVENTIONS

This map provides a three-dimensional framework of the area's surficial geology and depicts four important aspects of surficial geology:

1. Geologic deposits, indicated by letters that represent the major lithologies.
2. Thicknesses of the individual deposits, indicated by numbers and modifiers.
3. Lateral extent of the deposits, indicated by map-unit area boundaries.
4. Vertical sequence of deposits, shown by the stack of symbols within each map-unit area.

Figure 4 illustrates mapping conventions. Letters, numbers, and modifiers are arranged in stacks that depict the vertical sequence of lithologic units for a given map-unit area. A single stack of symbols occurs in each map-unit area and applies only to the volume of sediments within that particular map-unit area.

Letters represent geologic deposits (lithologic units) and are described in detail below. Lithologic units may be a single lithology, such as sand (S) or clay (C), or a combination of related lithologies that are found in specific depositional environments, such as sand and gravel (SG) or ice-contact deposits (IC). The bottom symbol in each stack indicates the bedrock lithologies that underlie the surficial deposits. The detailed lithologic unit descriptions below summarize:

1. Geologic characteristics, such as range of textures, bedding, and age.
2. Engineering properties or concerns attributed to the unit.
3. Depositional environment.
4. Geomorphology or geomorphic location.
5. Geographic location within the map area, if pertinent.

Numbers (without modifiers) that follow the lithology designator represent the average thickness of a lithologic unit in tens of feet (for example, *3* represents 30 ft). If no number is present, the average thickness is implied as 1 (10 ft). These unmodified numbers correspond to a thickness range centered on the specified value but may vary up to 50 percent. For example, *T4* indicates the average thickness of till in a map-unit area is 40 ft, but thickness may vary from 20 to 60 ft.

Modifiers provide additional thickness and distribution information:

1. Parentheses indicate that a unit has a patchy or discontinuous distribution and is missing in portions of that map-unit area. For example, *(T2)* indicates that till with an average thickness of 20 ft is present in only part of that map-unit area.

2. A minus sign following a number indicates the maximum thickness for that unit in areas such as a buried valley or ridge. Thickness decreases from the specified value, commonly near the center of the map-unit area, to the thickness of the same lithologic unit and vertical position specified in an adjacent map-unit area. For example, a *SG9-* map-unit area adjacent to a *SG3* area indicates a sand-and-gravel unit having a maximum thickness of 90 ft that thins to an average of 30 ft at the edge of the map-unit area. If the material is not present in an adjacent area, it decreases to zero at that boundary.

The small scale of this reconnaissance map generalizes the great local variability within surficial deposits. That variability

SURFICIAL UNITS

w **Water.** Lakes generally larger than 20 acres and not appearing on basemap.

m **Made land.** Large areas of cut and fill, such as dams, landfills, and urban areas; may include reclaimed strip mine areas. Underlain by bedrock or other lithologic units.

a **Alluvium (Holocene).** Includes a wide variety of textures from silt and clay to boulders; commonly includes organic material; generally not compact; rarely greater than 20 ft thick. Present in floodplains of modern streams throughout entire map area. Mapped only where areal extent and thickness are significant.

o **Organic deposits (Holocene).** Muck and peat, may contain clay at depth. Generally less than 20 ft thick. Formed in undrained depressions. Organic deposits too small to map at 100K-scale indicated by an asterisk ('*') and underlain by material shown in surrounding map-unit area. Present also on outwash trains, ice-contact areas, and hummocky moraines throughout the map area.

Ac **Alluvium and alluvial terraces (combined).** Shown in areas where insufficient space is available to delineate separate units.

At **Alluvial terraces (Wisconsinan).** Old floodplain remnants along streams that flowed into high, proglacial lakes. Highly variable textures; commonly present tens of feet above modern floodplains.

C **Clay (Wisconsinan).** Massive to laminated; may contain interbedded silt and fine sand; clay content can exceed 80 percent. Laminated clay commonly contains thin silt or sand partings. Carbonate-cemented concretions occur in some areas. Commonly contains fractures 6 to 12 inches apart. Distributed throughout map area as lowland surface deposits, terraces, and as deep-water deposits of proglacial lakes.

CG **Complexly interbedded deposits of clay, silt, sand, gravel, and till in deeper parts of buried valleys (unspecified).** Unit identified from well logs; data insufficient for more detailed differentiation or age assignment. Present in deeper buried valleys throughout the area.

IC **Ice-contact deposits (Wisconsinan).** Highly variable deposits of poorly sorted gravel and sand; silt, clay, and till lenses common; may be partially covered or surrounded by till. Deposited directly from stagnant ice as kame or esker landforms. Commonly associated with deep buried valleys.

L **Silt (Wisconsinan).** Massive or laminated, commonly contains thin sand partings. Carbonate-cemented concretions occur in some areas. May contain localized clay, sand, or gravel layers. Clay content commonly increases with depth. Present throughout the map area as lowland surface deposits; terraces; and thick, deltaic deposits of proglacial lakes.

LB **Backwater lake deposits (Wisconsinan).** Mostly lacustrine silt and clay in tributary valleys south of the glacial border. Commonly interfingered with alluvium, alluvial fans, and debris flows from surrounding steep-walled tributary and main valleys.

LC **Silt and clay (Wisconsinan).** Laminated to interbedded,, may contain thin, fine sand or gravel layers. Occurs as thick, lacustrine valley fill deposits of high, proglacial predecessors of lakes. Also may occur as thick, proglacial, deltaic deposits or as thick, deltaic, outwash deposits in upland depressions. Present as terraces along streams in the eastern half of the map area.

S **Sand (Wisconsinan).** Contains minor amounts of disseminated gravel or thin lenses of silt or gravel; grains well to moderately sorted, moderately to well rounded; finely stratified to massive, may be cross bedded; locally may contain organics. In deep buried valleys, may be older than Wisconsinan age. Present in terraces and buried valleys throughout the map area, and in association with deltaic deposits or outwash.

SG **Sand and gravel (generally Wisconsinan).** Intermixed and interbedded sand and gravel commonly containing thin, discontinuous layers of silt, clay, and till. Grains well to moderately sorted, moderately to well rounded; finely stratified to massive, may be cross bedded; locally may contain organics. In deep buried valleys, may be older than Wisconsinan age. Present as terraces along valley walls and in buried valleys throughout the map area.

SGi **Sand and gravel (Illinoian).** Properties similar to unit (SG) above, except upper part of unit is deeply weathered and leached where near surface. Present in high-level terraces and in deep buried valleys in the south-central-southern map area.

GA **Basal gravel.** Highly variable, poorly sorted gravel and sand, with significant amounts of silt and clay. Present in the northwest part of the map area; deposited at or near the front of the ice sheet directly on bedrock. Presumably of Wisconsinan age, but may be older.

T **Unsorted mix of silt, clay, sand, gravel, and boulders, fractures/joints common (Wisconsinan age when at surface).** May contain silt, sand, and gravel lenses. Deposited directly from several separate ice advances. Undifferentiated and nonspecified age in buried valleys or where separated by intervening non-till units from an overlying designated till. Most common surficial material in the map area.

Ti **Loam till (Illinoian).** May be overlain by up to 3 ft of loess. Till contains silt, sand, and gravel lenses; unit deeply weathered and leached to 6 ft; fractures/joints common. Deposited by direct lodgement or meltout from glacial ice. Widespread in the eastern map area as a surface and buried unit.

BEDROCK UNITS*

*Bedrock unit symbols in bold appear in the legend for the second inset map (fig. 2) showing the bedrock geology of the Mansfield 30 x 60 minute quadrangle.

P **Vertically and horizontally variable sequences of sandstone, shale, siltstone, claystone, limestone, and coal bedrock, including associated colluvium of the Middle and Lower Pennsylvanian age (Allegheny and Pottsville Groups undivided).** Sandstone nonbedded to massive; may be conglomeratic in basal portion and interbeds of shale, sandstone, siltstone, clay, coal, and limestone common in upper portion of unit. The basal portion of the Pottsville Group is predominantly a light-gray, medium to coarse grained, nonbedded to massive sandstone with abundant, rounded quartz pebbles and quartz pebble conglomerate unit known as the Sharon Sandstone, and conglomerate thatwhich forms resistant hills and cliffs.

SSh **Vertically and horizontally variable sequences of Mississippian- and Devonian-age sandstone, shale, and siltstone, including colluvium of Mississippian age (Logan and Cuyahoga Formations).** The dDominant basal stack unit over the eastern three-quarters of the map area. The Includes following stratigraphic units may be mapped as (**SSh**): Mississippian Logan and Cuyahoga Formations undivided and , Sunbury Shale, and Devonian Bedford Shale and Berea Sandstone undivided. **Logan and Cuyahoga Formations (Upper and Lower Mississippian undivided).**, sandstone, conglomerate, shale, and siltstone. Logan Formation:, sandstone and siltstone; shades of gray, yellow, and brown. Cuyahoga Formation: mainly shades of gray, olive, brown, and yellow sandstone, siltstone, and shale;. Ssandstone, silty to conglomeratic, occurs in thin to massive beds. **SSh** may also be used in map areas comprised of the colluvium derived from sandstone and shale bedrock associated with the Mississippian- age Logan and Cuyahoga Formations. **Sunbury and Bedford Shales undivided. Sunbury Shale (Upper Devonian to Lower Mississippian):.** Sunbury Shale present in a north- to -south band in the western quarter of the map area;, is brownish black to greenish black; carbonaceous; pyritic. Bedford Shale, shades of gray to olive green; silty to clayey; soft with some siltstone. Berea Sandstone, a resistant unit that forms a north- to -south escarpment of hills and cliffs in the western quarter of map area; is light gray to shades of brown; medium to fine grained to silty;, and thin to massive bedded.

Sh **Shale.** Designation **Sh** used in western quarter of map area primarily to denote areas underlain by black shale. Key stratigraphic units are broken out in descending stratigraphic order. Sunbury Shale: (Lower Mississippian), age; present as brownish black; carbonaceous; pyritic, in a north -to -south belt from Plymouth to Mount Gilead. Ohio Shale, including associated colluvium: (Devonian age,), present as black to brown;, silty, organic-rich, carbonaceous, fissile parted shale;, which contains beds of gray to greenish-gray, soft, clay shale; , Ddominant basal stack unit within a north- to- south belt along the western edge of map area. Olentangy Shale: (Upper and Middle Devonian age,), present as upper portion greenish gray, lower portion gray; clayey; disseminated pyrite; locally contains lenses and nodules of limestone;. Ccontains thin, brownish-black shale beds in upper portion;. Unit mapped only in very northwestern corner of map area;, may also be included with the Ohio Shale.

Ls **Limestone (Devonian).** Devonian-age Delaware and Columbus Limestones, present as a basal bedrock designation only in the extreme northwest corner of map area. Delaware Limestone: is medium brown;, fine to medium crystalline;, fossiliferous;, cherty limestone containing shale laminae. Columbus Limestone: is light to medium gray to brown;, fine to coarse crystalline;, fossiliferous;, and cherty in the upper portion.

SLs **Shale and limestone (Devonian).** Devonian-age Olentangy Shale and Delaware Limestone, present as an undifferentiated basal stack unit in the northwestern corner of map.

GLACIAL GEOLOGY AND SAND-AND-GRAVEL MINING POTENTIAL

The uppermost surfical deposits found in the Mansfield quadrangle are predominantly Wisconsinan in age (Venteris and others, 2008; Pavey and others, 1999). Illinoian-age deposits comprise the uppermost surficial units in portions of the southeastern corner of the quadrangle. The southeastern corner of the quadrangle also contains some unglaciated areas in the uplands which appear as dark gray on the map. In 2008 sand-and-gravel production from pits located in the Mansfield quadrangle was more than 1.7 million tons, which is approximately 5 percent of the state's total annual sand-and-gravel production (Wolfe, 2009).

The Mansfield map is intended as a general guide to exploration for potential sand-and-gravel resources. The map also may be useful for land-use planning and zoning. Because the Mansfield map is based on reconnaissance-level surficial geology and bedrock-topography maps, it should not be used for resource leasing purposes. A more detailed geologic and engineering investigation utilizing soils maps, additional water-well data, drilling, and laboratory testing of chemical and physical properties would be needed to delineate and evaluate the economic viability of the carbonate resources.

ACKNOWLEDGMENTS

Data were collected from numerous sources (see References). The concentration of data was greatest near the surface and decreased with depth. County soil survey maps, which described the top 5 ft of surficial materials, provided an initial guide to map-unit areas. These areas were modified through interpretation of local geomorphic settings and other data that indicated change of deposits at depth, such as Ohio Department of Natural Resources (ODNR) water-well logs; Ohio Department of Transportation and Ohio EPA test-boring logs; theses; and published or unpublished geologic reports, maps, and field notes. These data also provided the basis for lithologic unit descriptions, which summarize, as accurately as possible, recognized associations of genetically related materials. The total thickness of surficial deposits was calculated from ODNR Division of Geological Survey open-file bedrock-topography maps, which are available for each 7.5-minute quadrangle in the map area. The bedrock units were summarized from ODNR Division of Geological Survey bedrock-geology maps, also available for each 7.5-minute quadrangle. Land-surface topography shown on the basemap was prepared largely from data derived from the U.S. Geological Survey's National Elevation Dataset (30 meter grid spacing).

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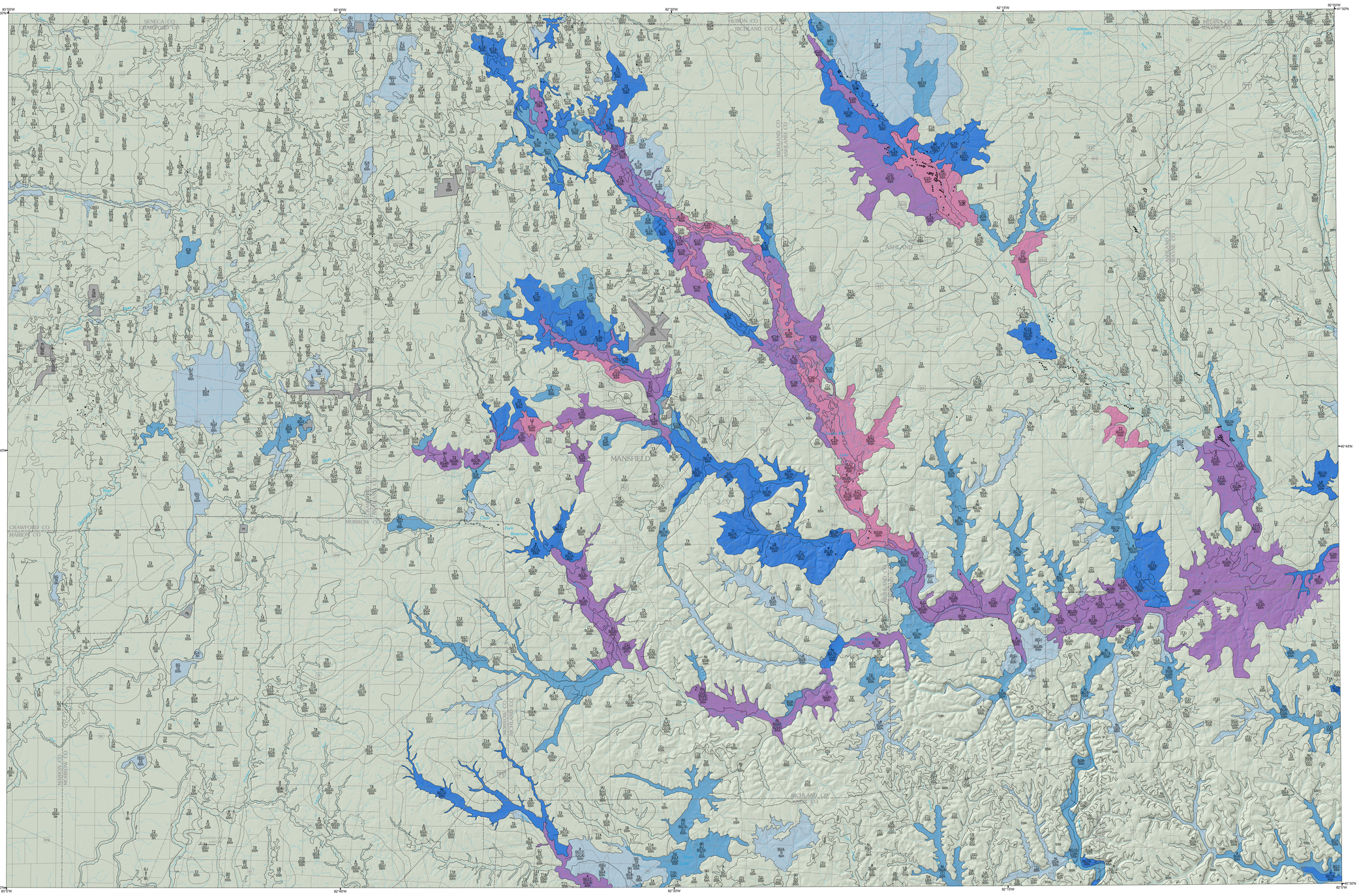
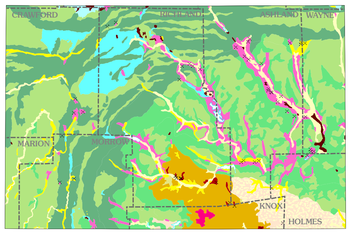


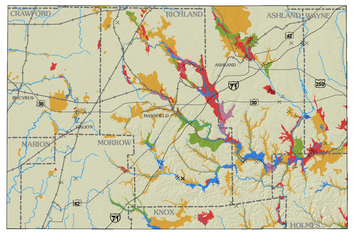
Thickness of Sand and Gravel Resources

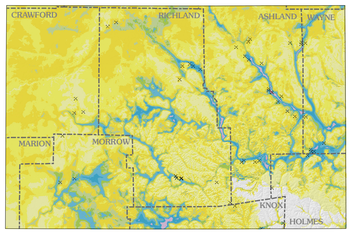
10 – 50 ft
51 – 100 ft
101 – 150 ft
151 – 200 ft
201 – 400 ft
No sand or gravel resources
made land, quarries, mines or large pits

MAP SYMBOLS

- Small area of organic deposits
- Quarry, mine, or strip mine; floored in bedrock; may contain reclaimed areas.
- Sand and gravel pit. Pit bottom generally underlain by unconsolidated lithologic units of surrounding polygon(s). May contain reclaimed areas.
- Boundary between map-unit areas having different uppermost continuous lithologies or significant bedrock lithology change; underlying lithologies may or may not differ.
- Boundary between map-unit areas having the same uppermost, continuous lithology but different thickness or different underlying lithologies.







Location of the Mansfield 30 X 60 minute quadrangle.

Base map derived from Ohio Department of Transportation data sets. Projection of data is Ohio coordinate system, south zone, North American Datum, 1983.

Description of Quaternary Units

- Water
- Alluvium and alluvial terraces, deposited in present and former floodplains; ranges from silty clay in areas of fine-grained deposits to coarse sand, gravel, or cobbles in areas of shallow bedrock.
- Peat, 1 ft or more thick, with minor amounts of sand, silt, or clay; also contains organic muck or marl in some areas.
- Lacustrine silt, deposited in low-velocity water of glacial and glaciovalley lakes; may contain fine sand or clay; well laminated in distal portions of deltas, poorly laminated elsewhere.
- Lacustrine clay, deposited in calm water of glacial lakes; mostly laminated; covered in places with thin organic deposits.
- Outwash, undifferentiated, deposited by meltwater in front of glacial ice; occurs as valley terraces or low plains; sand and gravel, well sorted and stratified.
- High-level outwash terraces (Kennard, Mount Vernon, Vanatta levels); formed from 22 to 18 ka; sand and gravel with 4 in to 3.5 ft of silt or loess cover.
- Kames and kame terraces, deposited by meltwaters in contact with glacial ice; forms groups of hummocks or high valley-side terraces; sand and gravel, poorly sorted and bedded, contains some boulders and till masses.
- Ground moraine, flat to gently undulating.
- End moraine, occurs as hummocky ridges higher than adjacent terrain.
- Hummocky moraine, occurs as nonlinear hummocky patches higher than surrounding terrain.
- Kames, in hummocks and hollows; ice contact sand and gravel, covered with 4 in to 10 ft loess.
- Outwash, in small benches and high terrace areas; uniform beds of sand and gravel, some coarse silts, 1.6 to 6.6 ft loess cover.
- Dissected ground moraine, occurs on ridgetops and mixed with weathered bedrock as colluvium on slopes.
- Hummocky moraine, in noncontinuous patches, plugs, or benches, mostly in valleys; mixed with bedrock colluvium on slopes.
- Colluvium derived from local bedrock in unglaciated areas; includes scattered areas of residuum, weathered material, landslides, and bedrock outcrop.
- Sand-and-gravel pit
- Bedrock quarry

FIGURE 1.—Quaternary geology of the Mansfield, Ohio, 30 X 60 minute quadrangle.

Ratio of sand-and-gravel resources to drift thickness

4:1 – 10:1
10:1 – 15:1
15:1 – 20:1
20:1 – 25:1
over 25:1
Sand-and-gravel pit
Bedrock quarry

FIGURE 2.—Bedrock geology of the Mansfield, Ohio, 30 X 60 minute quadrangle.

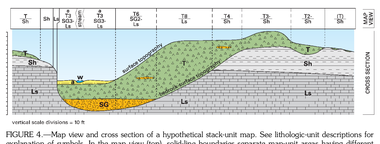


FIGURE 4.—Map view and cross section of a hypothetical stack-unit map. See lithologic-unit descriptions for explanation of symbols. In the map view (top), solid-line boundaries separate map-unit areas having different lithologic units at the surface; underlying lithologic units may or may not differ. Dashed-line boundaries separate map-unit areas having the same surface lithologic unit but different thickness or different underlying lithologic units. The cross section illustrates thickness and mapping conventions. Thickness values are in tens of feet. Values are gross averages that can vary up to 50 percent, except (1) those followed by a minus sign (-), which represent the maximum thickness of a thinning trough- or wedge-shaped sediment body, or (2) units in parentheses ( ), which indicate a discontinuous distribution of that unit. Precise surface topography can be determined from topographic maps that are available from the ODNR Division of Geological Survey at several scales: bedrock-surface topography and bedrock geology are available from the ODNR Division of Geological Survey as 1:24,000 scale quadrangle maps.

Thickness in Feet

0 – 30
31 – 60
61 – 100
No Data
10 – 130
131 – 160
161 – 225
226 – 300
301 – 360
361 – 460
461 – 723
Sand-and-gravel pit
Bedrock quarry

FIGURE 3.—Drift thickness of the Mansfield, Ohio, 30 X 60 minute quadrangle.

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