Application of Geology in Developing a Master Plan in Boone County, Indiana

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Abstract

The Boone County Area Plan Commission is currently developing a land-use Master Plan for which geological information provides the basic framework. Four types of land-use are considered; agriculture, urban development, natural resources, and solid waste disposal. These are developed on the basis of geologic surface materials, agricultural soils, topography, and depth to bedrock.

Single land-use categories are depicted on separate transparent overlays showing three classes of land suitability: highly suitable and requiring little or no modification; moderately suitable; and unsuitable, requiring extensive modification. By superimposing the overlays the composite map was compiled outlining regions "ideally" suited to a particular land-use. This map, plus other planning elements such as existing land-use, population projects, and transportation and economic studies, will determine the land-use goals for the Master Plan.

Introduction

Boone County is located in central Indiana northwest of Marion County (see Fig. 1) in the Tipton Till Plain physiographic province. The present population is about 32,000 and is expected to increase by more than 200 percent during the next 20 years (personal communication, Boone County Area Plan Commission). A recent trend of population increase has been promoted by the extensive interstate highway system in the county and an "overflow" of population from Marion County. As a response to the projected growth needs, the Boone County Area Plan Commission (BCAPC) was formed early in 1974. The BCAPC is currently constructing a Master Plan in which geological information provides a basic framework. Geology yields important input for planning in this predominately rural county as the current population is small and localized, and geologic information is particularly useful in determining favorable regions for future urban development, preservation of valuable natural resources, protection of agricultural farmland, and location of solid waste disposal sites.

Geology of Boone County

A detailed geological study of Boone County was conducted by the authors over the past 18 months resulting in the following maps: geologic surface materials (1:24,000), glacial thickness (1:62,500), landforms (1:125,000), sand-gravel resources (1:24,000), and ground water availability (1:125,000), (1,2).

Geologic Surface Materials

The surface deposits in Boone County are composed almost entirely of glacial drift. The mapping units and percentage of surface area are

as follows: glacial till (boulder clay), 64%; outwash deposits (valley trains and kames), 3%; alluvial deposits, 4%; lacustrine deposits, 6%; loess (greater than 5 feet thick) 11%; sloping drift (Miami Soil Series), 11%; bedrock (Borden Group), trace.

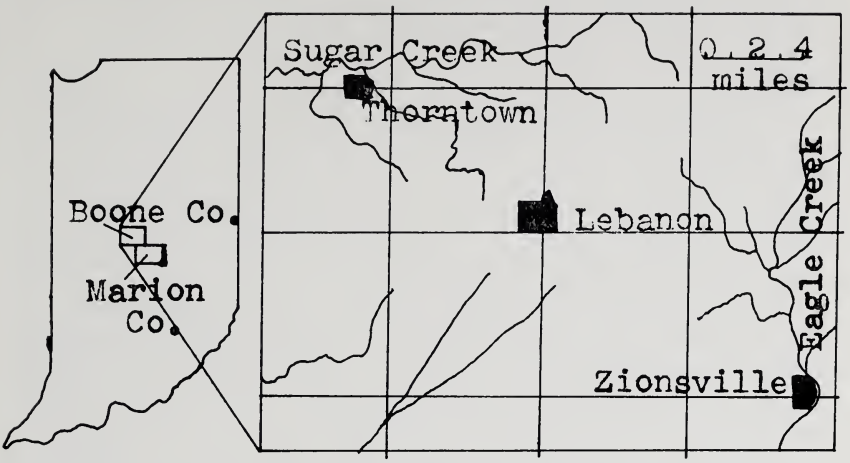

FIGURE 1. *Locations map of Boone County, Indiana.*

Glacial Thicknesses

Most of the northeastern half of the county is underlain by more than 200 feet of glacial drift. The drift in the western part of the county is generally thin and typically less than 100 feet thick. There are an estimated 500-1000 acres in the northwestern part of the county where the bedrock is less than 25 feet below the surface.

Natural Resources

There are three major natural resources in the county. Agricultural soils are the most valuable with about 80 percent of the surface producing high yield crops.

Sand and gravel provide a second resource. The deposits are not widespread and have excessive sand to gravel ratios. The most productive region in the county is along Sugar Creek in valley train deposits. Midstate Aggregate Company, the only crushing and washing operation in the county, is currently mining gravel from this region. There is an estimated 10 to 15 year supply of good quality gravel reserve in another region along Sugar Creek near Thorntown.

Ground water production is the third resource. Wells ranging from 10 gpm to a few hundred gpm are the most common. There is generally enough water to supply the homes in the countryside, however, the larger municipal supplies are investigating new regions to meet current demands. The deposits associated with Sugar Creek are generally the most promising.

Development of the Master Plan

The authors were involved in a consulting and advisory capacity with the BCAPC to incorporate existing geological information into the future land-use goals for the county as specified in the Master Plan. To help bridge the gap in terminology between geology and planning, the planning director worked in close association for the duration of the project.

Method

A transparent overlay technique was used to develop and illustrate the geologic input. Four types of land-use were considered; agriculture, urban development, sand-gravel resources, and solid waste disposal. Optimum land-use was determined using four physical (or geologic) criteria: geologic surface materials, agricultural soils, topography, and depth to bedrock. Each land-use category was depicted on a separate transparent overlay and rated according to the three classes of land suitability as follows: /A/ highly suitable land-use requiring little or no modification, /B/ moderately suitable land-use, and /C/ unsuitable land-use requiring extensive modification. The approach is non-restrictive as it does not rule out a particular land-use for an area but instead indicates the degree of modification required to implement such use.

A numerical rating scheme with values ranging from one to nine was developed to predict the significance of environmental interactions as a consequence of geologic conditions and proposed land-use (see Tables 1-4). Each of the mapping units (glacial till, outwash deposits, alluvial deposits, lacustrine deposits, loess, sloping drift and bedrock) were analyzed in turn considering the four geologic criteria (surface materials, agricultural soils, topography and depth to bedrock) and the four possible land-use categories. Each significant aspect or property of a geologic condition was considered singly to isolate the environmental interactions. For example in Table 1, permeability of the surface material (soil) is a significant consideration relative to agricultural use.

Each property-mapping unit combination was assigned a value from one to nine; an average of these values for a single mapping unit yielded the overall measure for that unit. To illustrate, in Table 1, values for the nine listed properties (permeability through crop maintenance) were determined by considering their effect on loess and subsequently averaged to provide the overall rating for loess in agricultural use. In turn the other mapping units (lacustrine, till, etc.) were similarly analyzed. These averaged values were compared for all mapping units and on this basis subdivided into the three suitability classes (A, B and C).

The suitability classes were subsequently color-coded (A(green), B(yellow) and C(red)) for each of the four land-form-map transparencies. Three of the four land-use maps were superimposed and a final composite map constructed (the solid waste disposal map was not included in the overlays but used strictly for information on solid waste disposal).

The composite map (Fig. 2) depicts regions "ideally" suited for one particular land-use based on geology data. This was accomplished by

delineating regions where only one of the three land-use types showed a highly suitable rating. There is only one small region where there was an overlap of two land-use classes which were both "ideally" suitable. This is in a region along Sugar Creek where the area is suitable to both sand-gravel resources and urban development.

TABLE 1. *Land-use properties and rating factors for agriculture.*

Properties		
geologic units		
permeability		
composition		
flood hazard		
erosion hazard		
drainage maintenance		
topography		
erosion		
absorption rate		
growth density		
crop maintenance		
Rating (see text for explanation)		
(A)	(B)	(C)
loess	sloping drift	none
lacustrine deposits	alluvium	
glacial till	outwash deposits	
	5%-10% slope	

TABLE 2. *Land-use properties and rating factors for urban development.*

Properties		
geologic units		
foundation support		
erosion		
grading capability		
drainage maintenance		
water potential		
flooding hazard		
sewerage conditions		
topography		
slumping hazard		
downcutting stream erosion		
sheet erosion		
waste disposal		
foundation support		
depth to bedrock		
ground water potential		
foundation excavation		
public utility installation		
sewage disposal		
Rating (see text for explanation)		
(A)	(B)	(C)
outwash deposits	glacial till	loess
sloping drift	lacustrine deposits	alluvium
		bedrock
		10% slope
		30 feet to bedrock

TABLE 3. *Land-use properties and rating factors for sand-gravel resources*

Properties and Rating (see text for explanation)	
(A)	(B)
sand-gravel ratio: 60/40	less than (A) rating specifications
composition: 5% deleterious substances	
extensiveness of deposit: >20,000 cu. yds.	
depth of overburden: <15 feet	
lack of excessive ground water infiltration	

TABLE 4. *Land-use properties and rating factors for solid waste disposal.*

Properties		
geologic units		
permeability		
workability		
ponding		
topography		
subject to ponding		
depth to bedrock		
depth to shallowest ground water aquifer		
proximity to surface water		
Rating (see text for explanation)		
(A)	(B)	(C)
lacustrine deposits	none	sloping drift
glacial till		outwash deposits
loess		alluvium
>50 feet to bedrock		<50 feet to bedrock
>30 feet below base of landfill to shallowest ground water aquifer		<30 feet below base of landfill to shallowest ground water aquifer
not subject to ponding		subject to ponding
not within Miami Soil Series region of stream valley		within Miami Soil Series region of stream valley

Results

Summarized below are the results of this study organized according to the four land-use classes considered. Mapping units for the county are related to the three suitability classes.

Agriculture

(A) includes most of the surface area of the county
(B) deposits and slope conditions associated with stream valleys and kame moraines
(C) none

Urban Development

(A) outwash deposits and sloping drift (Miami Soil Series)
(B) includes most of till plain
(C) floodplains, loess deposits, and shallow bedrock regions in western part of county

Sand-Gravel Resources

(A) small region along Sugar Creek near Thorntown
(B) remaining outwash deposits associated with streams and kames
(C) none

Solid Waste Disposal

(A) includes most of the surface area of the county
(B) none
(C) all stream valleys inclusive of the Miami soils region, and shallow bedrock region in western part of county

Composite Map (Fig. 2)

Most of the county is "ideally" suited for agriculture. Regions "ideally" suited for urban development are in the broad outwash plains of Sugar and Eagle Creeks near the town of Thorntown and

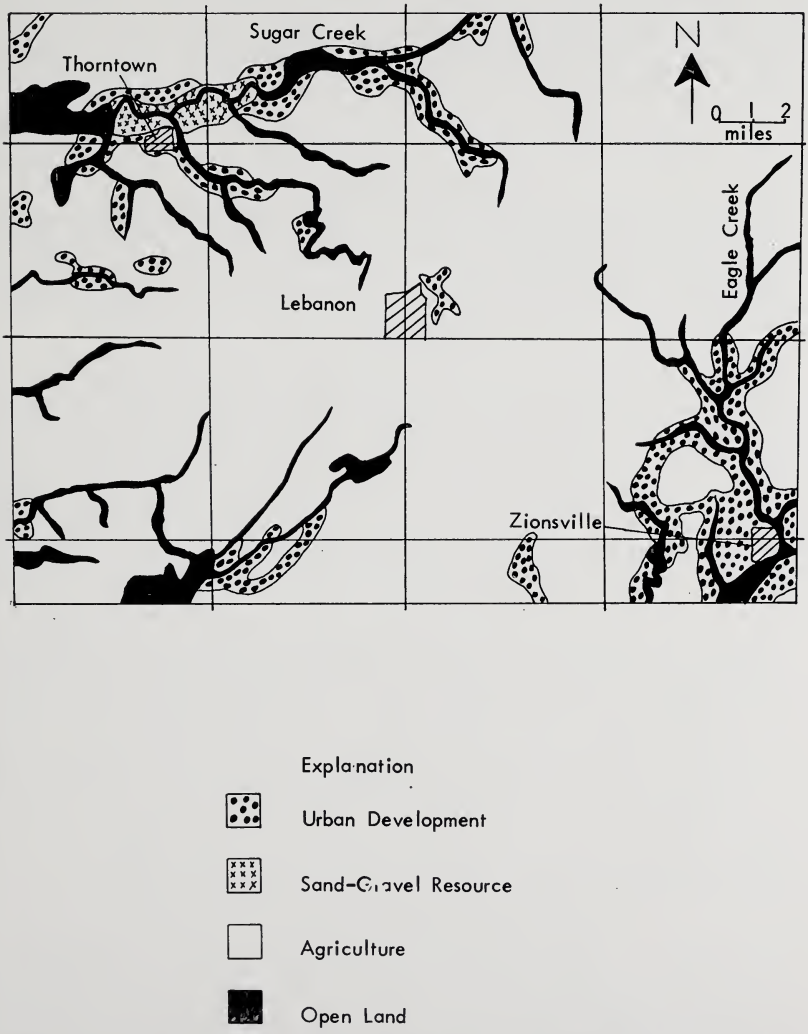

FIGURE 2. *Composite map of Boone County for land-use suitability based on geologic information.*

Zionsville. Sand-gravel resources are restricted to a small region along Sugar Creek. A fourth category is termed open land which is not suited to any of the land-use types. This unit includes most of the floodplains, slopes in excess of ten percent, and regions of shallow bedrock.

Conclusions

The composite map is being used as a basic framework for developing the Master Plan. However, additional elements of planning including an existing land-use map, population projections, and transportation and economic studies, are being incorporated to produce the final Master Plan. After the land-use goals are set, zoning restrictions will follow and determine land-use regulations for the county. A desired end result is to create an environment for a better quality of life.

Literature Cited

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