

Geologic Characteristics of Indiana Streams

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Introduction

Some precipitation while passing through the water cycle reaches streams that flow over the surface of the land. Their importance as sources of water supply for municipalities, industries, and agriculture is well known. The amount of water available from surface supplies varies greatly. These variations are dependent upon two groups of factors. One group of factors is based upon the geologic and topographic conditions of the drainage basin; the other group includes weather and climate. It is the former group with which this paper is concerned.

Surface waters in their courses across Indiana encounter a variety of geological conditions. A steep slope of solid rock will yield promptly nearly 100 per cent of the rainfall. A sandy plain covered with vegetation will slowly yield a small percentage of rainfall directly, in extreme instances approaching zero. The character of the earth materials and geologic processes not only affect the topographic conditions of a region but also are factors affecting natural drainage, runoff, and other hydrologic characteristics. In order to properly interpret and appraise the characteristics of the streams bearing these waters, a knowledge of the terrain and the earth materials present within each drainage area is imperative. Figure 1 shows the major drainage divisions within the State.

The stream flow throughout most of Indiana has considerable regulation by the presence of the great blanket of glacial drift over much of the State. The glacial drift, where porous, acts as a storage basin for ground water. Many of the valleys of the rivers draining away from the glaciated area are deeply filled with sand and gravel. These valleys also retain large volumes of water. The ground water released from these areas is the base flow of these streams and is the total flow during dry seasons. The area north of the Wabash River still largely retains the original forms following continental glaciation. The presence of many lakes, marshes, and shallow basins tends to regulate the flow of streams in that area. The middle portion of Indiana is largely a great till plain of low relief. The type of glacial material found here is not as useful in retaining water as that found in the morainic areas and along the discharge routes of melt waters. The greatest diversity of both relief and rock types are found in the unglaciated portion of southern Indiana. These variations have a marked effect upon the characteristics of the smaller streams.

Major Drainage Areas

WABASH. The Wabash drainage basin, excluding the White and Patoka rivers, lies almost entirely in glaciated areas. The regional direction of the main tributaries of the Wabash River has been determined to a large extent by the presence of the crescent-shaped terminal moraines

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DRAINAGE BASINS

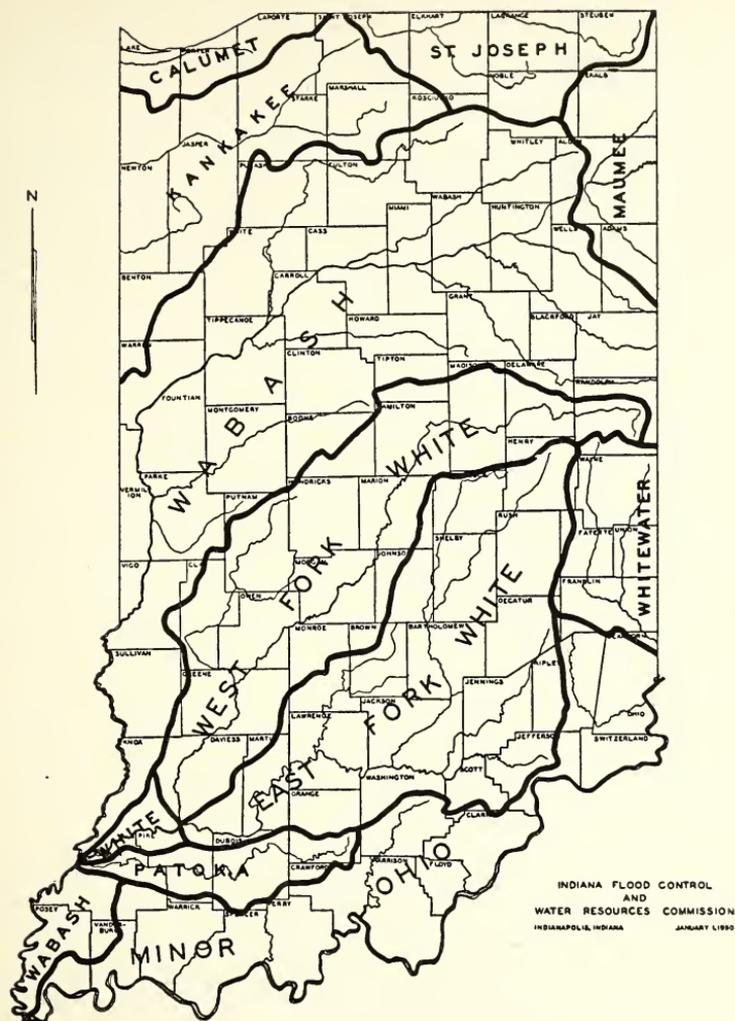


Figure 1

in the headwater portions. The valleys of the Wabash, Salamonie, Mississinewa, Eel, and Tippecanoe rivers and the valleys of many of the other streams were carved out chiefly in glacial times and have suffered little alteration since that time. Farther south the glacial plain is older. Considerable dissection of the glacial plain has taken place along the Wabash River and in the area between Lafayette and Terre Haute. Tributaries such as Big Pine, Little Vermilion, Sugar, and Raccoon creeks flow through rocky gorges.

The Wabash drainage basin, as defined above, encompasses 11,965

square miles in Indiana. Because of its size several types of geology and topography are expressed. That part of the basin lying north of a line from Columbia City to Monticello stores much water in the outwash plains and gravel-filled valleys. Elsewhere surficial deposits are largely a clay till which will absorb relatively little precipitation, even though the relief is not great.

EAST FORK OF WHITE. A great diversity of geologic and topographic conditions exists in the drainage basin of the East Fork of White River. The headwaters of this 5,680 square mile area rise in the glacial till plain area of Henry County at elevations of greater than 1,100 feet. The main streams and tributaries flow in a west and southwest direction. In the southeastern part of the East Fork of White drainage basin the topographic condition reflects the structural attitude of the underlying resistant rocks. Although the whole area has been subjected to glaciation, the surface slope corresponds very closely to the slope of the rock strata. The streams rising in the southeastern part of the basin are relatively swift and flow at or near bedrock surfaces except locally.

Between west-central Jackson County and the western edge of Martin County, East Fork of White River crosses unglaciated Indiana. Here the greatest local relief in the basin occurs. This large stream system enters the unglaciated area through a notch in the Knobstone escarpment in western Jackson County. The Knobs area is characterized by high, rugged hills, deeply dissected valleys, great local relief, and impervious rock formations. Runoff is necessarily rapid. Salt Creek, the largest tributary to enter East Fork of White in the unglaciated region, lies almost entirely in this rugged area.

On westward in Lawrence and Orange counties the basin occupies a portion of a limestone region which is characterized by subterranean drainage features. Drainage is largely through sinkholes. Surface tributaries in the limestone area are rare, but where present are usually short. The headwaters' portion of Lost River is situated here.

East Fork of White River follows a deeply entrenched, meandering valley south and west across Martin County. High and low hills, V-shaped and flat-bottomed valleys, bluffs, and sandstone-capped ridges, and almost flat table lands produce a variety of features throughout this part of the drainage basin. From the Martin-Daviess county line to the confluence with the west fork, East Fork of White River flows through a region which can best be described as hilly to rolling. The topography is nowhere as rugged as the Martin County area and immediate local relief rarely exceeds 100 feet. The relief becomes more subdued toward the confluence of the two forks of White River, and earth materials more capable of retarding surface runoff.

WEST FORK OF WHITE. Like its counterpart to the east, West Fork of White River drainage basin contains diversified geology and topography. The headwaters of this stream lie within a few miles of the headwaters of East Fork of White and Whitewater rivers. The watershed boundary between these drainage systems contains the highest elevations in the State.

The entire length of West Fork of White River and most of its drain-

age basin, some 5,430 square miles, lies within the glaciated portion of Indiana. Vast quantities of water are stored in the sands and gravels that fill the valley from above Indianapolis to its junction with the east fork and thus serve to help regulate the stream during periods of low flow.

From the headwaters to northeastern Morgan County, West Fork of White River flows across the glacial plain. Bedrock is exposed occasionally along the valley but glacial materials predominate. In southern Morgan County the stream crosses the northern extremity of the exposed Knobs area. Steep, rocky slopes are present along the valley but the uplands are capped with glacial drift and are generally flat. Bean Blossom Creek, which joins West Fork of White River in the extreme northwestern corner of Monroe County, has most of its drainage area in the "Knobstone" region. The low flow of this creek during summer months and its high rate of discharge during periods of precipitation reflect the inability of the rocks to retain or store water.

Only a small part of West Fork's drainage area lies in the sinkhole area of southern Indiana. The limestone plain which it crosses has been modified in part by glacial deposits and subterranean drainage is relatively insignificant. That portion in Owen and northern Greene counties is as diversified and rugged as any within the drainage basin. Massive sandstones cap hills and ridges, and form rugged bluffs and steep slopes. However, from Worthington in Greene County to the confluence with the east fork the topography is more subdued, becoming rolling to almost flat.

PATOKA. The geologic and topographic conditions present in the 860 square miles making up the Patoka drainage basin fall under two general types. That area between the headwaters in Crawford and Orange counties and Jasper in Dubois County is typical of the Crawford upland physiographic region of Indiana. Rugged hills, ridges, and bluffs, deeply dissected valleys, and considerable local relief are present throughout this area of Chester and Pottsville outcrop. Most of the tributaries are short and steep, and runoff is rapid. From Jasper westward to Wabash River the topography is gently rolling to almost flat. Here, too, the tributary streams are short but their gradients are not nearly so steep. The local relief decreases progressively to the west as Pennsylvanian shales predominate. Many of the frequent floods along this stream are the direct result of the physiographic conditions found within the drainage basin.

MINOR OHIO. The greatest diversity of relief and rock types in Indiana is found in the Minor Ohio River drainage area, an area of some 4,040 square miles. The region bordering the Ohio River, though the portion upstream from Jeffersonville was subjected to glaciation, represents the severest relief in the entire State. The severity, however, is greatly reduced downstream from Grandview in Spencer County.

Most of the streams are short and relatively steep, and flow through rock-walled valleys. Blue River, which drains portions of Washington, Harrison, and Crawford counties, has the largest drainage area of any streams in the Minor Ohio drainage basin. It lies almost wholly within the cavernous limestone belt of southern Indiana and its tributary drainage is largely underground. The subterranean drainage peculiarities of this stream directly affect the characteristics of its runoff pattern.

WHITEWATER. The Whitewater River drainage basin lies entirely in the glaciated area. Whitewater River rises by two main branches in southern Randolph and Wayne counties. The two branches join at Brookville from which it flows southeast to the junction with the Miami River at Valley Junction, Ohio. The drainage basin, including adjacent minor Miami River drainage, encompasses 1,355 square miles. Is it in an upland area which reaches elevations of over 1,000 feet. The main streams have trenched this upland from 200 to 300 feet below the general upland surface, though much of the upland surface is still preserved. Areas of upland near the headwaters of the streams are notably flat and often quite extensive. Most of the tributary streams are short and the fall from the upland headwaters is relatively great. Along the main streams the slopes are most frequently quite steep, though bluffs are rare.

The bedrock formations are largely the interbedded limestones and shales of Cincinnati age. The lower courses of the two main valleys contain thick deposits of sand and gravel as terrace deposits and valley fill. The inability of the rock formations to store water precludes the development of surface water supplies on the smaller streams except through impounding.

MAUMEE. The Maumee drainage basin, covering 1,285 square miles, lies entirely within the glaciated portion of Indiana. However, a variety of conditions are present. The St. Joe River rises in the rolling lake and moraine district north of Fort Wayne. The St. Mary's River rises in the nearly flat glacial till plain region of Ohio and flows northwest to Fort Wayne where it joins the St. Joe to form the Maumee. Lobate moraines separate the St. Joe and St. Mary's rivers from the Maumee and from the headwaters of the upper Wabash system. In Allen County the Maumee River flows across a flat, featureless, lake plain which covers about 120 square miles. The plain has an elevation of about 750 feet above sea level; the channel through which the Maumee flows has been cut 25 to 40 feet below the lake plain. In spite of their glacial origin and low relief the earth materials are of low permeability.

KANKAKEE. The greater part of the Kankakee drainage basin is characterized by a broad plain covered with a thin deposit of somewhat ridged sand. The most prominent ridges are 35 to 40 feet in height, but the majority are less than 20 feet, and many are only 5 or 10 feet. Dunes also are common but nowhere approach the size of those along Lake Michigan. A morainic ridge, which passes through the middle of Newton and Jasper counties, separates the sandy plain along the Kankakee River from the sandy plain along the Iroquois River. This moraine is narrow and has a rolling or hummocky topography. The extremely flat terrain and the presence of sand and muck soils permits great storage of water and slow runoff. However, the presence of many artificial drains, both open ditch and tile, allows surface runoff to reach the streams in a shorter time than it would otherwise.

CALUMET. The 615 square mile area described here includes both the watershed of the Calumet River system and minor Lake Michigan drainage. Two distinct geologic conditions are present here. The area

just south of the tip of Lake Michigan was once covered by lake waters and is now represented as a lake plain. It is marked by a number of low sand ridges which extend parallel to Lake Michigan. The outer margin of the plain is somewhat trenched by Deep River and its tributaries in the vicinity of Hobart. East and northeast of Gary and adjacent to the lake occurs a belt of dunes. Mt. Tom, the highest of these massive dunes, rises over 190 feet above the surface of Lake Michigan. The altitude of the lake plain is below 640 feet. Lake Michigan normally has an altitude of about 580 feet.

Beyond the lake plain is the Valparaiso moraine, a massive moraine curving about the head of Lake Michigan. It is composed of ridges, knolls, sags, and basins. The moraine rises abruptly above the lake plain, and within two miles has risen 150 feet. Its highest knolls are approximately 300 feet above Lake Michigan and approximately 10 miles distant. Its basins contain a number of small lakes. The Valparaiso moraine is the divide between the St. Lawrence and the Mississippi drainage basins in the northern part of Indiana.

ST. JOSEPH. The St. Joseph drainage basin, an area of 1,645 square miles, is situated in a region of variable topography. The surface of this area is composed of the younger drift of the last glacial epoch to reach Indiana and contains some of the thickest deposits of glacial drift known in the State. Porous sand and gravel deposits are abundant and are important factors in affecting the runoff characteristics of the surface waters. An outwash gravel plain, one of several gravel plains in the drainage basin, stretches southeast in St. Joseph County from the outer margin of the Valparaiso moraine.

Elkhart, Little Elkhart, and Pigeon rivers, important tributary streams, have their headwaters in the lake and moraine region of northeastern Indiana. Massive, rugged moraines and hundreds of lakes and marshes characterize this latter area and control runoff conditions. The highest knolls and ridges are in Steuben County where elevations of 1,200 feet are present.

Conclusions

The geology and physiography of a drainage basin, that is, the character of the earth materials, the steepness and nature of the land forms, and gradients, have striking effects upon the streams of Indiana. These factors vary from one area to another. However, they are most pronounced in the watersheds of the smaller streams. In the larger rivers the effects of several types of geology and topography tone down small area characteristics, or successively change characteristics as they pass from one section to another.

The physiographic classifications provide a key to the general topography and character of the land surface and the hydrologic conditions in the area. The glacial deposits are relatively more important than sandstones, limestones, and shales in a hydrologic sense, for the character of the surficial material determines in a large part the rainfall-runoff relation in Indiana. As the character of glacial drift may range from impermeable till to highly permeable gravel in a short distance, the glacial geology as well as bedrock geology requires intensive study.