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Geology Related to Land Use in the Hennepin Region

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ABSTRACT

The location of a major steel plant near the Village of Hennepin in north-central Illinois is expected to foster industrial growth in the region and expansion of facilities for serving an increased population. Geology and natural resources have implications that bear on land-use planning for the region.

The Hennepin region has abundant water resources, including 270 miles of continuously flowing streams of the Illinois River and its tributaries, from which surface water supplies are available. Large supplies of ground water of good quality can be obtained from the glacial deposits and bedrock formations.

Mineral resources, which have been a major factor in the past and present economy of the area, include coal, clay, shale, limestone, silica sand, and common sand and gravel.

Although the greatest portion of the region is geologically suited for most types of construction or waste disposal, there are such potential problem areas as floodplains of the major waterways with high ground-water levels and periodic floods, thick peat and muck deposits, mined-out coal areas subject to subsidence, and bedrock exposures. High terraces, on which the communities of Hennepin and Henry are situated, are problem areas for waste disposal due to high potential for ground-water pollution.

Sites along the major tributaries—Bureau Creek, Senachwine Creek, Plow Hollow Creek, Allforks Creek, Crow Creek, and the Little Vermilion River—have potential for storage of surface water as well as ground-water re-

charge. Smaller sites, including gravel pits on the Hennepin and Henry terraces and silica sand and limestone quarries in the area of outcrop of the St. Peter Sandstone, also could be utilized for artificial ground-water recharge. The numerous quarries in the area of bedrock outcrop near La-Salle-Peru afford possibilities for development of recreation areas or, in some cases, waste disposal sites.

INTRODUCTION

The Hennepin region of north-central Illinois is expected to undergo accelerated industrial growth as a result of a new major steel plant located there. Accompanying the industrial growth will be an expansion of facilities for serving an increased population. This report describes the geology and natural resources and their relation to development and land use of the region.

The area designated as the Hennepin region includes the portion of Bureau County east of Princeton, the northeastern corner of Marshall County including the city of Henry, all of Putnam County, and western LaSalle County, including the cities of LaSalle and Peru (figs. 1 and 2). This area encompasses approximately 700 square miles.

GEOGRAPHY

The Hennepin region has gently rolling upland plains, ranging from 650 to 750 feet in elevation, crossed by the Illinois River and its tributaries. The principal relief features are the valleys of the Illinois River and its tributaries and a long, broad, glacially built ridge near Princeton.

The mean temperature of the area, based on records at Tiskilwa, La-Salle-Peru, and Ottawa for the period 1931 to 1960, is 51 to 52° F. The coldest months are December, January, and February (mean temperature 27° F), and the hottest months are June, July, and August (mean temperature 74.4° F). Normally, there is a growing season of 157 days with the last frost about May 3 and the first killing frost about October 8.

The average annual precipitation for U. S. Weather Bureau stations at Tiskilwa, LaSalle-Peru, and Walnut

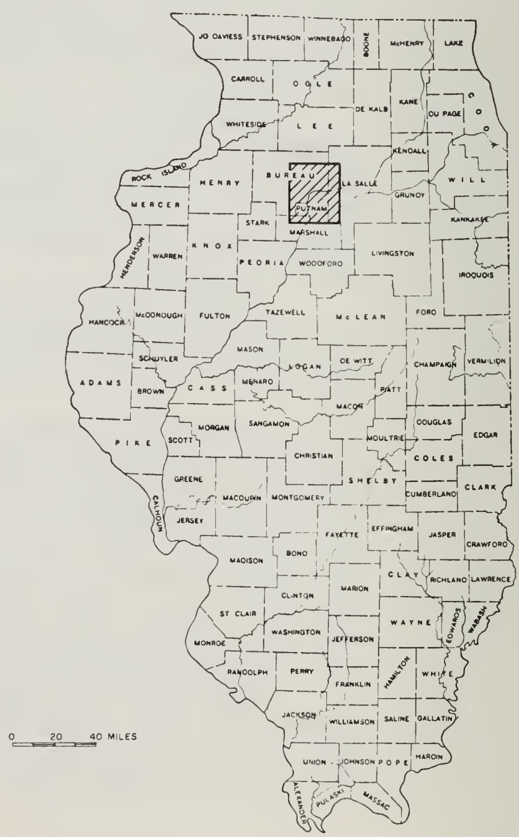


Figure 1 - Location of the Hennepin region.

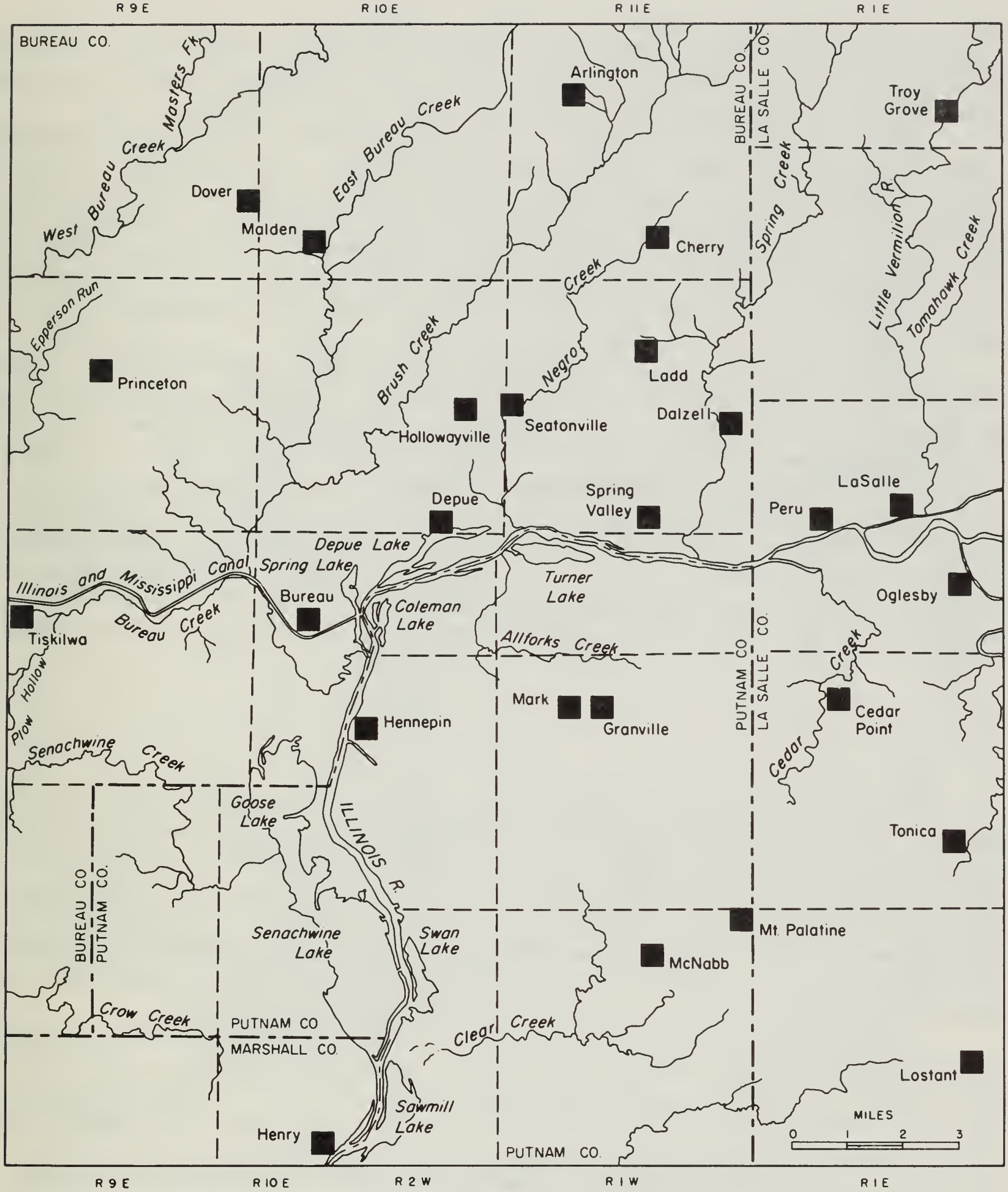


Figure 2 - Principal geographic features of the Hennepin region.

(north of Princeton) ranges from 32.7 inches at LaSalle to 34.1 inches at Walnut. Maximum average monthly precipitation occurs during the months of May and June, with about 4 inches of rainfall. The dry months are November to March, with less than 2 inches average monthly precipitation (U. S. Weather Bureau, 1962).

The principal drainage feature is the Illinois River, which flows through the center of the region. There are approximately 270 miles of continuously flowing streams, including the main stem of the Illinois River and Bureau, Spring, Negro, Senachwine, Crow, and Allforks Creeks, and Little and Big Vermilion Rivers, which drain into the Illinois River. Generally, the maximum flows occur during June and July and the minimum flows (which may include several days of no flow on the smaller streams) occur in September, October, and November (U. S. Geological Survey, 1964).

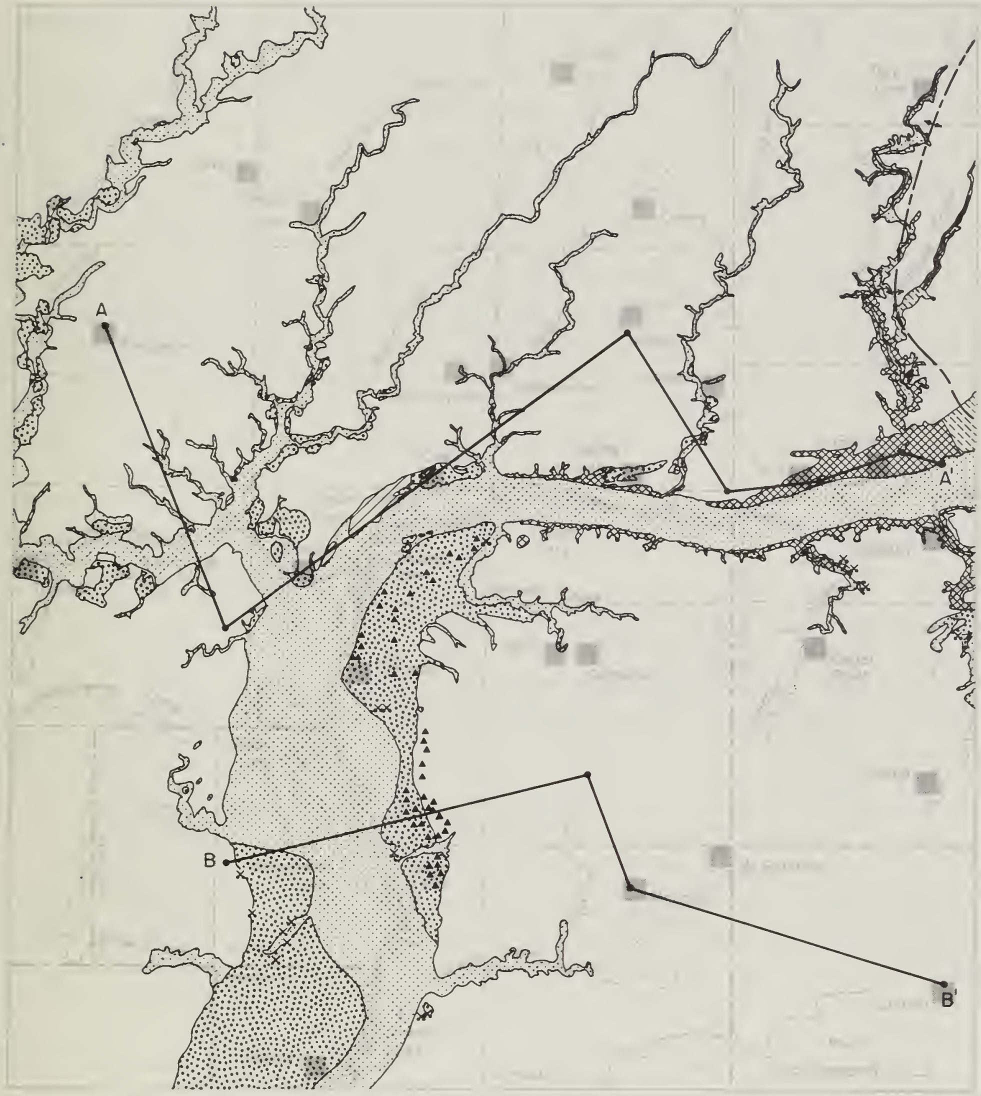
Significant floods on the Illinois River occur about once in 8 years. Floods on the tributary streams generally occur more often. Minor seasonal floods on both the main stem and the tributaries usually develop between February and July, with the greatest number occurring in July (U. S. Geological Survey, 1964). Seasonal floods result in relatively minor damages, except to crops on the low-lying farms along the tributaries. The maximum flood on record on Bureau Creek produced a rise of 13 feet above a datum of 449.2 feet above mean sea level at the recording station at Bureau (Mitchell, 1954). The most severe flood of the Illinois River on record occurred in May 1943, when the river rose to 28.8 feet at Peoria, downstream from LaSalle, and remained above flood stage for 34 days (Peterson, 1967, p. 262).

GEOLOGY

The landscape of the Hennepin area has been shaped and modified principally by running water and glacial ice. Running water cuts into the land, removes rock and soil particles, and deposits them in stream and river bottoms. The features produced by glacial ice were developed when continental glaciers covered much of the northern United States. Ice sheets advanced from centers of snow accumulation in Canada, carrying abundant rock debris that was deposited as drift when the ice melted. Irregular and unconsolidated deposits of unsorted clay, silt, and pebbles left by the ice are called till and cover most of the area.

During the advance and retreat of the glaciers, sediment-laden meltwaters flowed down the valleys that led away from the glaciers and partially filled them with outwash—deposits of silt, sand, and gravel. Between periods of flooding, the outwash deposits were subjected to wind erosion, and large quantities of silt and sand were picked up and deposited on the uplands adjacent to the valleys. The wind-laid silt formed deposits called loess, which covers most of the area with thicknesses up to 15 feet. Sand dunes were formed east of the Illinois River south of the big bend, on the gravel terrace, on the bluffs, and on the adjacent uplands (fig. 3).

Bedrock, which is near or at the surface east of the big bend of the Illinois River and now deeply buried by the drift in the remainder of the area, consists of layers of shale, sandstone, limestone, dolomite, and chert (figs. 4 and 5). The bedrock strata, which originally were horizontal, have been folded east of LaSalle into an assymmetrical archlike structure 1 mile wide, called the LaSalle Anticline. The anticline trends north-south and the crest is about 3 miles east of LaSalle (figs. 3 and 4). Rocks on the west limb of the anticline dip west about 2000 feet



QUATERNARY SYSTEM

- Floodplain deposits - clay, silt, sand, and gravel
- Marsh deposits - peat and muck
- Terrace deposits - sand and gravel
- Sand dunes
- Glacial till deposits - pebbly clays and silt

PENNSYLVANIAN SYSTEM

- Shale, sandstone, and limestone

ORDOVICIAN SYSTEM

- Sandstone and dolomite

- Axis of LaSalle Anticlinal Belt
- A A' Line of cross section
- Sand and gravel pit

Figure 3 - Areal geology of the Hennepin region (after Cady, 1919).

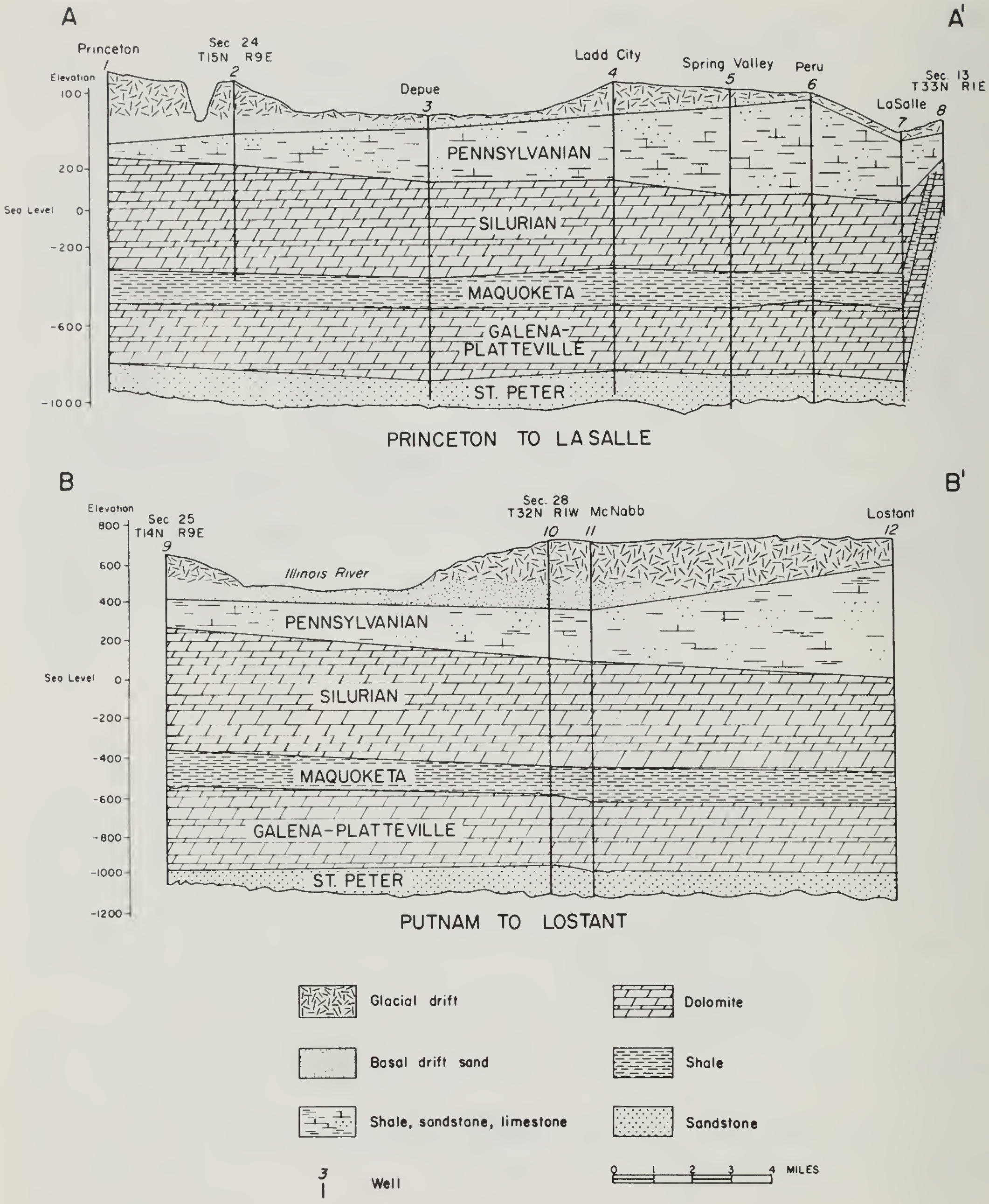


Figure 4 - Cross sections of glacial drift and upper bedrock formations.

per mile; on the flatter east limb, rocks dip east less than 50 feet per mile (Willman and Payne, 1942). The St. Peter Sandstone lies at or near land surface along the crest of the anticline but is 1500 feet deep at LaSalle, less than 1 mile from the outcrops.

NATURAL RESOURCES

Surface Water

The mean discharge of the Illinois River near Hennepin is estimated to be approximately 12,000 cubic feet per second; the tributary system adds about 1000 cubic feet per second to the total (U. S. Geological Survey, 1964). The low flow of the Illinois River, which is equalled or exceeded 95 percent of the time, has been estimated at 4200 cubic feet per second (Peterson, 1967, p. 105).

In the Illinois River lowland, there are three large natural lakes—Spring Lake, Depue Lake, and Goose Lake—encompassing a total of 1248 acres; their storage capacity is not known (Dawes and Terstriep, 1967). At present, there are no man-made reservoirs for water supply in the Hennepin region.

Water from the Illinois River near Peru usually has a low content of dissolved solids, ranging from 334 ppm (parts per million) to 454 ppm, and is moderately hard, ranging from 208 ppm to 320 ppm total hardness (Illinois State Sanitary Water Board, 1966). The water of the Vermilion River at Oglesby, southeast of LaSalle, is similar in chemical character to the Illinois River. Data on the inorganic chemical content of the remainder of the tributaries in the region are lacking.

Ground Water

Water-yielding beds (aquifers) occur in the glacial drift and in the bedrock formations. Within the drift, the aquifers are deposits of sand and gravel that may occur at the surface, interbedded within, or at the base of the drift. The principal aquifers in the bedrock are layers of sandstone, limestone, and dolomite. Locally, water may be obtained from fractured shale, coal, and chert.

Sand and Gravel Aquifers

In the Hennepin region, there are three areas of differing potential for ground-water development in the drift (fig. 6): (1) areas of near-surface deposits of sand and gravel in the lowlands of the Illinois River and its tributaries (mapped in figure 6 as containing less than 100 feet of drift overburden); (2) areas where thick sand and gravel deposits occur at the base of the drift (mapped as containing from 100 to more than 180 feet of drift overburden); and (3) areas where sand and gravel deposits are thin, discontinuous, or absent, and, where present, occur at variable depths.

Lowlands of the Illinois River and its tributaries consist of floodplains and terraces (fig. 3). Deposits in the Illinois River floodplain consist of fairly thick layers of clay and silt with some thin, discontinuous beds of sand and gravel. Most frequently the finer deposits directly underlie the floodplain surface. The coarsest deposits in the Illinois River floodplain are encountered near the mouths

SYSTEM or SERIES	HYDROGEOLOGIC UNITS	GRAPHIC LOG	ROCK TYPE	WATER-YIELDING CHARACTERISTICS
PLEIS-TOCENE	Drift (0-300')		Unconsolidated glacial deposits, loess and alluvium (drift).	Water yields variable, largest from thick basal sand and gravel deposits (Sankoty Sand) in bedrock valleys.
PENNSYLVANIAN	(280-475')		Mainly shale with thin sandstone, limestone, and coal beds.	Generally unfavorable as an aquifer. Locally, domestic and farm supplies obtained from thin limestone and sandstone beds. Casing usually required.
SILURIAN	Niagaran-Alexandrian (410-505')		Dolomite; argillaceous near base, lower part cherty.	Generally yields poor quality water.
ORDOVICIAN	Maquoketa (155-240')		Green to blue shale with limestone and dolomite beds.	Not water yielding at most places. Casing required.
	Galena-Platteville (320-380')		Dolomite, with shaly zone near the middle; some limestone in the lower part.	Not important as an aquifer. Creviced dolomite probably yields some water. Water quality good.
	Glenwood-St. Peter (115-135')		Sandstone, white, clean.	Dependable source of ground water. Water quality good.
	Shakopee (130-150')		Dolomite, with some shale and sandstone.	Not important as aquifer.
	New Richmond (165±)		Sandstone, with some dolomite.	May yield some water.
	Oneota (215±)		Dolomite, with some sandstone beds.	Not important as aquifer.

Figure 5 - Generalized column of upper rock formations in the Hennepin region.

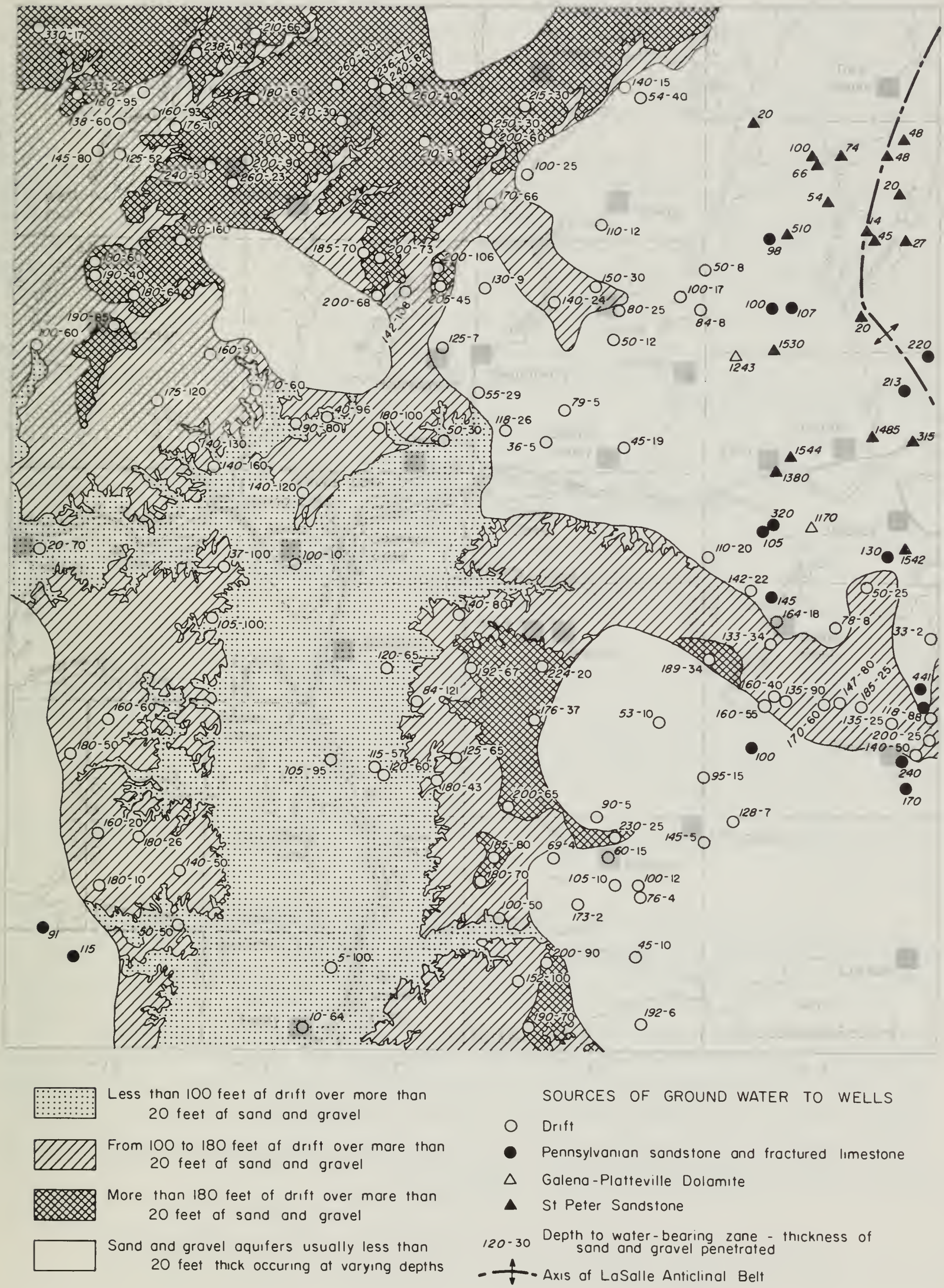


Figure 6 - Depth and nature of sand and gravel aquifers and sources of water in representative wells.

of Bureau, Negro, Allforks, and Spring Creeks, and the Vermilion River. The terraces (fig. 3) contain cleaner deposits of sand and gravel outwash with maximum thicknesses of 100 feet; these deposits are aquifers where they are at elevations low enough to be saturated. Large-capacity wells for LaSalle, Depue, Bureau, Henry, and Hennepin are developed in outwash terraces and coarse floodplain deposits.

The thick basal sand and gravel deposits, mapped as more than 20 feet thick in figure 6, are in the buried bedrock valley system of the Ancient Mississippi River. The valley contains up to 200 feet of a water-bearing formation called the Sankoty Sand (Horberg, 1953). The Sankoty is mainly a coarse- to medium-grained sand with some fine-grained gravel. Many of the quartz sand grains are well rounded, polished, and pink. The thickness of overburden on the Sankoty Sand varies with the relief in the area. The overburden is thickest in the upland and consists mainly of clayey silty till. Ranges in the thickness of drift above the Sankoty Sand are shown in figure 6. The following driller's log illustrates the nature of the Sankoty Sand and overburden:

Location: E$\frac{1}{4}$ NE$\frac{1}{4}$ NE$\frac{1}{4}$ sec. 3, T. 16 N., R. 9 E., 2 miles northeast of Princeton

Strata	Thickness	Depth
Drift, yellow, and clay, blue	30	0-30
Sand	5	30-35
Clay, blue	130	35-165
Sand	5	165-170
Clay and sand	15	170-185
Sand, gray, and gravel	5	185-190
Sand, coarse-grained, and gravel (Sankoty Sand)	75	190-265
Clay	2	265-267
Water sand (Sankoty Sand)	19	267-286

Outside the area of the bedrock valley, only thin and discontinuous sand and gravel deposits are present. Local outwash deposits, usually less than 20 feet thick, can be encountered immediately above the bedrock as lenses in the drift or beneath the loess near the surface. The gravel usually consists of angular fragments of brown and gray limestone up to one-half inch in diameter, interbedded with grayish brown silt and clay. Early settlers in the area commonly dug wells less than 30 feet into the local shallow water-yielding beds. These shallow wells, however, are rarely used today because of poor quality water and low well yields.

The following driller's log of a well in Dalzell illustrates the nature of the glacial drift outside of the bedrock valley area:

Location: NW$\frac{1}{4}$ NW$\frac{1}{4}$ SE$\frac{1}{4}$ sec. 24, T. 16 N., R. 11 E., Town of Dalzell

Strata	Thickness	Depth
Soil	5	0-5
Clay, yellow	5	5-10
Clay, yellow, and sand	4	10-14
Clay, blue	10	14-24
Sand, clay	19	24-43
Clay, blue	10	43-53
Sand and water (four gallons per minute)	4	53-57
Clay, red (bedrock)	39	57-96
Limestone	4	96-100
Shale	4	100-104

Water in the glacial drift, which includes the Sankoty Sand and the shallow outwash sands, is characterized by a total dissolved mineral content of less than 500 ppm. The deeper water may commonly contain higher iron concentrations than the shallow water. The shallow water sometimes contains high concentrations of nitrate (Larson, 1950). Yields of wells in the Sankoty Sand range up to 700 gallons per minute (Princeton). Wells in coarse-grained deposits in the floodplain have yielded 300 gallons per minute. Wells in thinner and finer grained outwash deposits usually yield less than 50 gallons per minute (Hanson, 1950).

Bedrock Aquifers

Where sand and gravel aquifers are thin or absent, ground-water supplies are sometimes obtained from bedrock formations. The water-yielding rocks are mainly sandstones, but some water supplies are obtained from creviced limestones and dolomites, and fractured shales, coals, and cherts. A generalized column of the bedrock formations and their water-bearing characteristics is given in figure 5.

The Pennsylvanian rocks that underlie the drift everywhere in the region, except along the crest of the LaSalle Anticline, are usually poor aquifers. Locally, small quantities of water may be produced from thin sandstones or fractured limestones, but Pennsylvanian rocks do not yield sufficient water for municipal, industrial, or large farm supplies in the area.

No published records show the quality of water from Pennsylvanian rocks in the Hennepin area. In nearby areas, water from Pennsylvanian rocks is characterized by high chloride and low sulfate concentrations and relatively low hardness (Larson, 1950).

Silurian age dolomite, which underlies the Pennsylvanian rocks west of the LaSalle Anticline, usually yields water. However, chemical analyses show that water from the Silurian rocks is highly mineralized and is not desirable (table 1). The Village of Bureau, for example, obtains water with about 2000 ppm dissolved minerals from Silurian rocks; the water has a strong artesian flow (Hanson, 1950). Wells penetrating aquifers underlying Silurian rocks should have casing set through the Silurian to prevent the entrance of mineralized water into the well. The top of the Silurian is about 600 to 700 feet below the surface.

The Maquoketa Group, consisting mostly of green to blue shales, with occasional limestone stringers, underlies the Silurian rocks and prevents the mineralized

TABLE 1 — CHEMICAL CONTENT OF GROUND WATER IN THE HENNEPIN REGION (in ppm)[1]

Location	Depth	Deepest aquifer reached	Aquifers open to well	Chloride	Iron[2]	Sulfate[2]	Hardness[2]	Total dissolved solids
Princeton	245	Sankoty Sand	Drift	3.0	2.8	0.0	233	323
Cherry	33	Outwash	Drift	3.0	1.9	45	361	392
Tonica	250	Sankoty Sand	Drift	20	0.6	—	52	460
Hennepin	115	Sankoty Sand	Drift	8.0	3.0	39	280	350
Magnolia	65	Outwash	Drift	12	0.4	43	—	440
LaSalle	56	Floodplain sand and gravel	Drift	24	0.1	262	564	751
Ladd	163	Sankoty Sand	Drift	5.0	27.3	—	317	325
McNabb	192	Sankoty Sand	Drift	7.0	1.6	0.0	333	494
Peru	700	Silurian	Pennsylvanian-Silurian	2264	8.0	—	—	4523
Hennepin	800	Silurian	Pennsylvanian-Silurian	1180	2.0	191	63	2865
Bureau	305	Silurian	Pennsylvanian-Silurian	770	0.4	176	54	2008
Depue	1278	Galena-Platteville	Pennsylvanian-Silurian	79	—	52	—	520
Ladd	1860	St. Peter	Galena-Platteville & St. Peter	36	0.5	17	308	414
Lostant	1881	St. Peter	Galena-Platteville & St. Peter	570	3.6	225	—	1539
Standard	1767	St. Peter	Galena-Platteville & St. Peter	1675	0.2	—	—	3289
Granville	1741	St. Peter	Galena-Platteville & St. Peter	335	0.1	150	250	991
Spring Valley	1480	St. Peter	Galena-Platteville & St. Peter	198	0.2	54	152	743
Depue	1490	St. Peter	Galena-Platteville & St. Peter	72	3.2	64	232	528

[1] ppm = parts per million (Hanson, 1950, 1958, 1961)
[2] —— designates no determination reported.

water of the Silurian from percolating downward into deeper aquifers. The shales of the Maquoketa Group cave during drilling and usually require casing.

The Galena and Platteville Groups, consisting of dolomite and limestone, underlie the Maquoketa. They are locally present directly beneath the drift along the LaSalle Anticline. They are about 1200 feet below the surface in the area west of LaSalle. Where directly under the drift, the Galena-Platteville rocks are well creviced and yield considerable quanitites of water to wells. Near Troy Grove, the Galena-Platteville rocks are common sources of water in farm wells. Beneath the Maquoketa, the Galena-Platteville is not well creviced and is not a dependable ground-water source. Water in the Galena-Platteville rocks at Depue contains about 500 ppm total solids (Hanson, 1950).

The principal bedrock aquifer in the Hennepin region is the Glenwood-St. Peter Sandstone of Ordovician age. The Glenwood-St. Peter is exposed along the LaSalle Anticline but is at a depth of more than 1500 feet west of the anticline (fig. 4). It is composed of medium-grained, loosely cemented quartz sandstone. The Glenwood-St. Peter is the source of municipal ground-water supplies for the towns of Lostant, Depue, Ladd, Standard, and Granville. The St. Peter Sandstone yields 1000 gallons per minute to wells in Peru and 60 gallons per minute to wells in Lostant (Hanson, 1950).

Deeper rocks of Ordovician age, including the Shakopee, New Richmond, and Oneota Formations, probably contain highly mineralized water west and south of LaSalle-Peru and have not been used for water supply. The New Richmond Sandstone east of the anticline is one of the main shallow aquifers where the Glenwood-St. Peter locally yields water of poor quality. The Cambrian age Ironton-Galesville Sandstone is used for water supply at LaSalle and east of the anticline.

Differences in quality of water in the deeper aquifers are related to structural features associated with the LaSalle Anticline. Where the St. Peter, New Richmond, and Ironton-Galesville aquifers are shallow along the LaSalle Anticline, their ground water is usually of good quality. Exceptions to this occur south of the Illinois River and east of LaSalle. In this area, the St. Peter Sandstone may be polluted by saline water from lower rocks moving upward along fractures (Willman and Payne, 1942). North of the river, the sandstone is exposed and is recharged by rainfall.

West of the anticline, where the St. Peter Sandstone is approximately 1500 feet deep, there is a change in the quality of water along the Illinois River. Water in the St. Peter aquifer north of the river has a low total dissolved mineral content (400 to 750 ppm) and a low chloride content (36 to 200 ppm), whereas south of the river the dissolved solids (1000 to 3500 ppm) as well as the chlorides (335 to 1675 ppm) are considerably higher (Hanson, 1950). Data from tests of the lower Ordovician and Cambrian aquifers at Hennepin indicate that ground water in the New Richmond and Ironton-Galesville aquifers contains a high content of dissolved minerals in this area.

Mineral Resources

Mineral resources in the Hennepin region include coal, clay and shale, silica sand, limestone, and sand and gravel. LaSalle County ranked second in Illinois in total value of minerals produced in 1965 (Busch, 1967), and Marshall and Bureau Counties ranked 63rd and 83rd. No mineral production was reported for Putnam County in 1965. The total value of the minerals produced by county was as follows: LaSalle, \$37,492,743; Marshall, \$1,086,480; and Bureau, \$522,000 (Busch, 1967).

Coal

Three coal horizons are present in the Pennsylvanian rocks in the Hennepin region: the Sparland (No. 7) or "First Vein" Coal, the Herrin (No. 6) or "Second Vein" Coal, and the Colchester (No. 2) or "Third Vein" Coal (fig. 7). Although no coal was commercially produced in 1965, the region led the state in coal production in the last years of the 19th century and up to about 1905 (Cady, 1919). The No. 2 Coal was extensively worked west of the anticline in shafts and east of the anticline by stripping. West of LaSalle, the commercial coals are deep and unstrippable (Cady, 1952). A large portion of the No. 2 Coal was mined by the longwall method, a caving method that permits nearly complete removal of the coal. The region is part of the so-called Longwall District. In some mines, in the vicinity of Spring Valley, Cherry, and LaSalle, the No. 6 and No. 7 Coals were worked by the room and pillar method. Surface subsidence is usually small and occurs soon after longwall mining, whereas collapse in room and pillar mines may take place some time after the mining and, subsequently, may be greater and more irregular.

Clay and Shale

Clays of commercial value in the Hennepin region are of Pennsylvanian and Pleistocene age. Shales of Pennsylvanian age crop out along the Illinois River and its tributaries near LaSalle-Peru. The shale below the LaSalle Limestone Member (fig. 7) has been used for the manufacture of Portland cement (Cady, 1919). The underclay of the Sparland (No. 7) Coal has been used in the manufacture of condensers in the smelting of zinc ores. The Pennsylvanian clays have been used for the manufacture of common brick and drain tile, and the loessial clays of Pleistocene age near Princeton have been used for the manufacture of drain tile.

Limestone

The LaSalle Limestone Member of Pennsylvanian age has been used for many years in the manufacture of Portland cement. The cement industry is a major factor in LaSalle County's second ranking position in the state for total mineral production. The LaSalle Limestone is a dense nodular limestone containing shaly beds (Krey and Lamar, 1925). The CaO content ranges from 36 to 53 percent and the MgO content from .66 to 4.3 percent

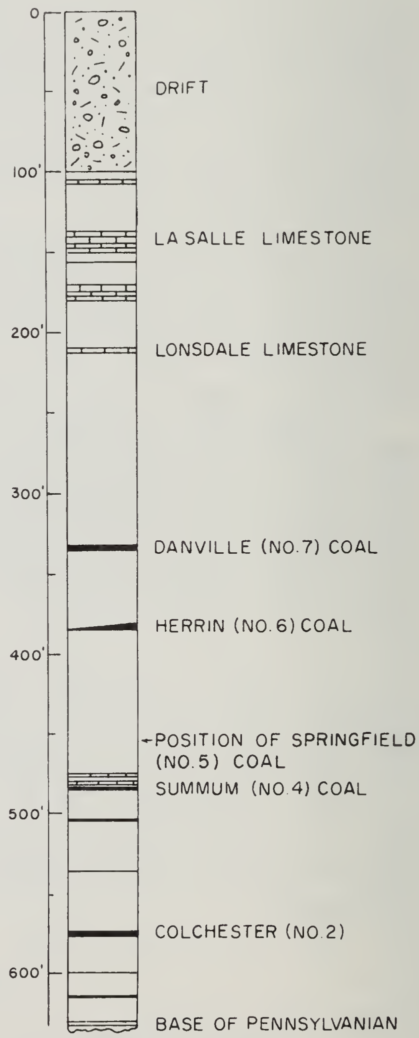


Figure 7 - Generalized Pennsylvanian column for the Hennepin region.

(Cady, 1919; Lamar, 1957). The LaSalle Limestone has also been used for building stone and crushed rock for railroad ballast.

Some crushed stone for road rock and agricultural limestone is produced from the Galena-Platteville and Shakopee Dolomites. The Galena-Platteville is quarried at Troy Grove. The Shakopee is exposed in the bluffs along the north side of the Illinois River between LaSalle and Utica and is quarried at Utica. It was formerly used in the manufacture of natural cement.

Silica Sand

The St. Peter Sandstone, which is an excellent aquifer, is also an important source of silica sand (Willman and Payne, 1942). The St. Peter is presently quarried for silica sand near Troy Grove in the valley of the Little Vermilion River (fig. 3).

Sand and Gravel

The occurrence of sand and gravel deposits with less than 10 feet of overburden is widespread. The material in the river floodplain and in the low level terraces is generally fine grained and overlain by silt and clay. The thickness of these deposits varies considerably within the area.

The materials of the higher terrace deposits along the Illinois River (Hennepin and Henry Terraces) range in size from medium-grained sand to coarse-grained gravel, with scattered cobbles and boulders. Gravel pits in the high terrace commonly expose 30 feet of the deposit. The thickness is as much as 100 feet near the town of Hennepin and is more than 100 feet in some areas.

Dune sand covers a large part of the Hennepin Terrace (fig. 3). Most of the individual dunes have coalesced into a sheetlike deposit that may be as thick as 40 feet. Natural bonded molding sand has been produced from dunes near Buda and Wyanet, about 10 miles west of Princeton (Littlefield, 1925). The material used for the molding sand is from the weathered zone on the dune.

GEOLOGY AND LAND USE

Construction

In the region of thick drift in eastern Bureau County and in parts of Putnam and Marshall Counties, the materials at or near surface generally are sand and gravel on the lowlands and tills and loess on the uplands. The sand and gravel deposits have textures that range from poorly sorted on the terraces to uniform in the dunes and in Sankoty Sand outcrops. Soils on thick loess usually are highly plastic and drain very slowly. The bearing capacity of loess may be very high where it is located permanently above the water level (Terzaghi and Peck, 1948). Problems that may be encountered in the loess-covered areas are erosion of slopes, frost heaving, and seepage where a cut intersects the loess-till contact or the water table (Thornburn, 1963). The till deposits generally are easily excavated and usually are suitable for borrow material.

Geologic factors unfavorable for many types of construction are low bearing strength of certain earth materials, high ground-water levels, and, in some cases, bedrock exposures.

A considerable number of mined-out coal areas are found in the Hennepin region (fig. 8). In these areas, land subsidence usually has occurred. The effect of this subsidence on foundation conditions is not known; however, these areas are potential problem areas and should be carefully investigated prior to construction of large buildings.

On the low terrace of the Illinois River several areas of exposed organic deposits (peat and muck) are present up to 30 feet thick (Mosier et al., 1921), which are very compressible and would be unsuitable for most types of construction (fig. 8). Peat deposits are present on the uplands at depths from 10 to more than 100 feet below the surface. Peat deposits below the surface could be a significant factor in heavy construction, and engineering boring investigations should be carried out for site evaluations. Scattered thin deposits of peat and muck are present throughout the upper 25 feet of unconsolidated material on the river floodplain.

High ground-water levels are present in the lowlands of the Illinois River and its tributaries (fig. 8). These regions can be considered as flood-hazard areas. Land drainage by gravity would be difficult, as these areas are sites of ground-water discharge.

Although bedrock at shallow depths and outcrops of limestone, shale, and sandstone may hamper construction of basements or water and sewer mains (fig. 8), the shallow depth of the bedrock would be an advantage for the foundations of many structures.

Feasibility studies on the potential for water-supply reservoir construction in the Hennepin region indicate four potential sites in the Bureau and LaSalle County portion of the area (Dawes and Terstriep, 1967). In Bureau County, potential sites are on East Bureau Creek ($W\frac{1}{2}$ sec. 31, T. 16 N., R. 10 E.), Senachwine Creek ($SW\frac{1}{4}$ sec. 34, T. 15 N., R. 9 E.), and Plow Hollow ($NE\frac{1}{2}$ sec. 19, T. 15 N., R. 9 E.). In the upland region, construction materials for earth-fill dams are readily available in the glacial drift. Seepage problems might be encountered at the reservoir sites because each overlies the Sankoty Sand, the upper part of which data indicate to be unsaturated. The widespread loess in Bureau County could cause reservoir bank instability or siltation problems in the reservoir (Smith, 1966). In LaSalle County, a potential site on the Little Vermilion River ($NW\frac{1}{4}$ sec. 11, T. 33 N., R. 1 E.) is underlain by the permeable St. Peter Sandstone, which might cause seepage problems (Dawes and Terstriep, 1967).

Waste Disposal

Due to the presence of favorable aquifers in the Hennepin region, ground water is the principal source of water for the municipalities, industries, and residences. It is imperative, therefore, to prevent ground-water pollution by refuse, industrial wastes, or sewage effluents. Areas most susceptible to pollution are those where permeable materials overlie the aquifer and those where highly fractured and jointed bedrock is near the surface.

The thin sand beneath the loess and the shallow sands and gravels in the floodplains, the valley flats and terraces, and the St. Peter Sandstone along the LaSalle Anticline (fig. 9) are near-surface aquifers overlain by permeable materials. In these areas, water-borne contamination would move downward through the unsaturated materials and laterally through the saturated zone (aquifer) to a point of discharge. Thus, the aquifer beneath the source of contamination as well as a considerable distance from the source could be affected by pollution. The Sankoty

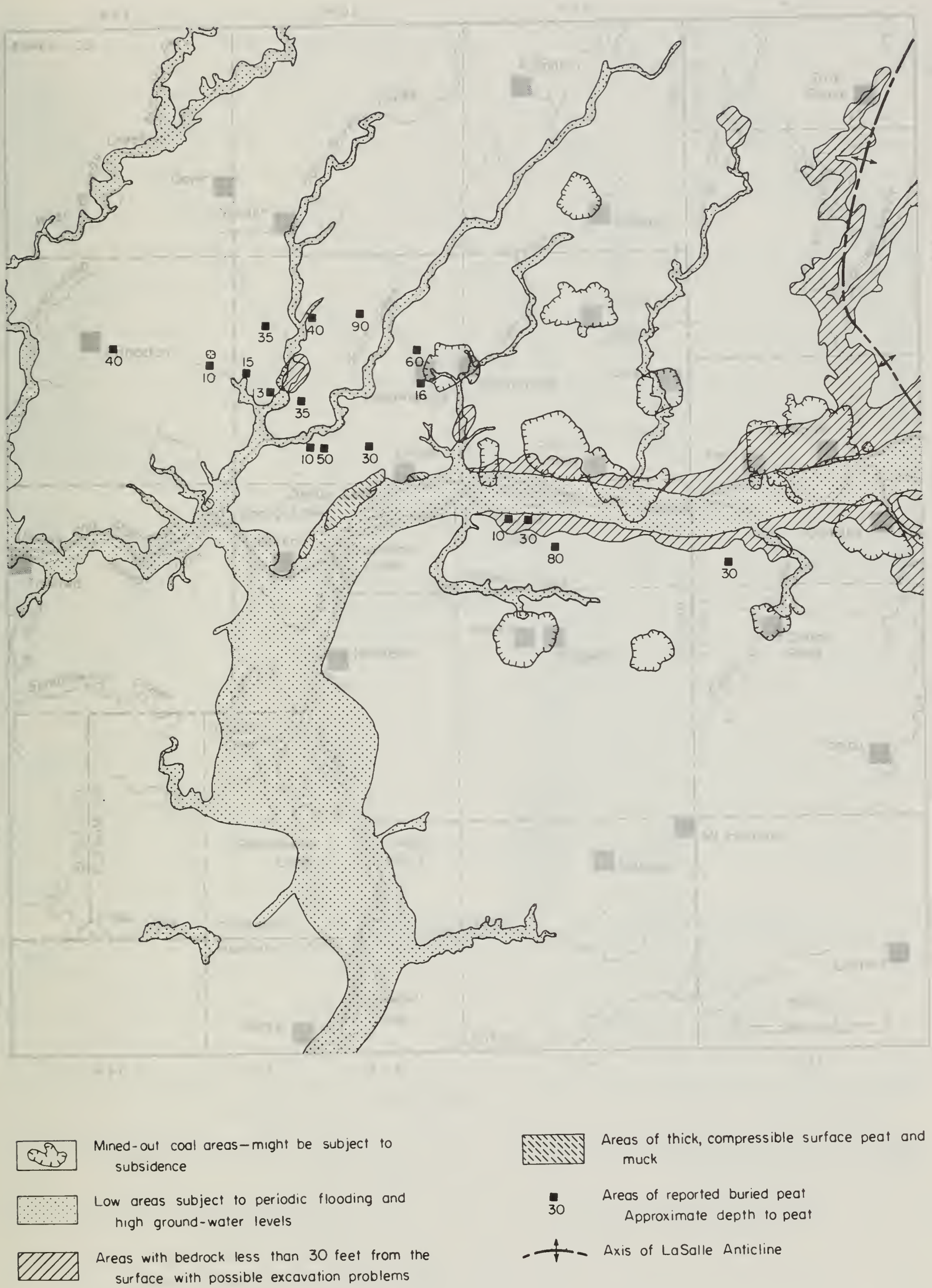


Figure 8 - Areas that might present problems for construction.

CONDITIONS PROBABLY UNFAVORABLE FOR WASTE DISPOSAL SITES

- Unsaturated sand and gravel over shallow ground-water reservoir
- Surficial sand and gravel in flood-hazard area and area of high ground-water level
- Less than 20 feet of impermeable material over limestone, shale, or sandstone
- Less than 20 feet of impermeable material over St. Peter Sandstone

AREA MOST LIKELY TO CONTAIN SUITABLE WASTE DISPOSAL SITES

- Area with more than 20 feet of clay and silt over ground-water reservoir
- Axis of LaSalle Anticlinal Belt

Figure 9 - Hydrogeologic conditions relating to waste disposal operations at land surface.

Sand could be polluted widely along Bureau Creek and below the bottomland and along terraces of Illinois Valley below Bureau. Incidents of pollution of the aquifer beneath the loess are mostly due to leachates from feed lots, septic tanks, or heavy fertilization. Leakage from industrial wastes has resulted in at least one serious instance of pollution on the high terraces. Where the aquifer is overlain by impermeable layers of clay or till, as is the Sankoty Sand near Princeton, the downward movement of contaminated water is retarded and some flow continues down gradient on the top of the impermeable layer. In the upland areas, the potential for pollution of the Sankoty Sand and lower aquifers is low.

In fractured or jointed bedrock, as locally present along the LaSalle Anticline, contaminated water moves through the openings in a manner similar to flow in a pipe. Pollutants can be carried long distances rapidly in this type of rock. Rocks most likely to have fractures and joints are limestone and dolomite of the Galena-Platteville near Troy Grove, of the Shakopee east of the Little Vermilion River, and of the LaSalle Limestone Member, exposed north of LaSalle and west of the Little Vermilion River (fig. 9). Where these potential aquifers are overlain by shales of the Maquoketa and Pennsylvanian, the pollution hazard from surface water is low.

Water Management

At the present level of industrial, municipal, and residential ground-water use in the Hennepin region, there appears to be an adequate supply to meet current demands. The present water demand for the four-county area is 68.18 million gallons per day (mgd); the projected demand in 1980 is 116.66 mgd, and in 2020, 208.82 mgd (Peterson, 1967, p. 105). The potential ground-water supply for the four counties is 341.2 mgd (table 2) (Peterson, 1967, p. 105).

Theoretically, the potential ground-water supply is considerably greater than the projected demand; however, there may be heavily populated areas within the counties where the local demand could exceed the practical sustained yield of ground-water reservoirs. Here, the use of surface water would be a reasonable way to make up the deficit. Surface water could be used directly by constructing water supply reservoirs or indirectly by artificially recharging heavily pumped or depleted ground-water reservoirs.

The diverting of excess water on the land surface into ground-water storage is effective in land drainage problems and in control of flood flows as well as in replenishment of ground water. Artificial recharge would be geologically feasible in areas where the Sankoty Sand, the St. Peter Sandstone, or fractured limestones and dolomites are overlain by 25 feet or less of permeable material (fig. 10). In the floodplain and on the low terraces, the Sankoty Sand is either exposed or thinly covered by permeable river alluvium. If exposed, artificial recharge can be accomplished by spreading the water in a surface basin; if overlain by thin layers of impermeable material, recharge can be accomplished by construction of channels through which water could enter the aquifer (Landon, 1967; McDonald and Sasman, 1966). In the high terraces and upper stream valleys (fig. 3), the Sankoty Sand is covered by up to 25 feet of clay, silt, and sand. The excavation of large pits or the utilization of existing gravel pits is necessary for recharge in these areas. If heavy demands on water from the Sankoty Sand create overpumpage problems near Princeton, where the overburden is thick, the aquifer might be recharged by wells.

Recharge of the St. Peter Sandstone and the limestone and dolomite reservoirs could be accomplished in a way similar to that of the Sankoty Sand. The large area

TABLE 2 — EXISTING AND POTENTIAL WATER SUPPLIES AND DEMANDS BY COUNTIES (in mgd)[1]

County	Municipal, industrial, and rural demand			Existing water-supply reservoirs	Potential water supplies		
	1965	1980	2020		Ground water	Stream flow	Reservoirs
Bureau	5.98	9.31	22.86	—	147.2	2,801	60.9
LaSalle	60.17	104.16	176.36	—	85.9	3,047	23.1
Marshall	1.63	2.21	6.01	—	60.3	2,700	7.3
Putnam	0.40	0.98	3.59	—	47.8	2,700	27.4

[1]mgd = million gallons per day (State of Illinois, 1967, p. 105).

of the sandstone east of the Little Vermilion River (fig. 3) is covered by 10 to 50 feet of drift. However, in order to effect artificial recharge of the St. Peter Sandstone aquifer, individual site investigations would be necessary to determine the most feasible method.

Near Troy Grove, the Galena-Platteville is an aquifer. Recharge could be accomplished by the diversion of treated surface flows into abandoned rock quarrys (fig. 2).

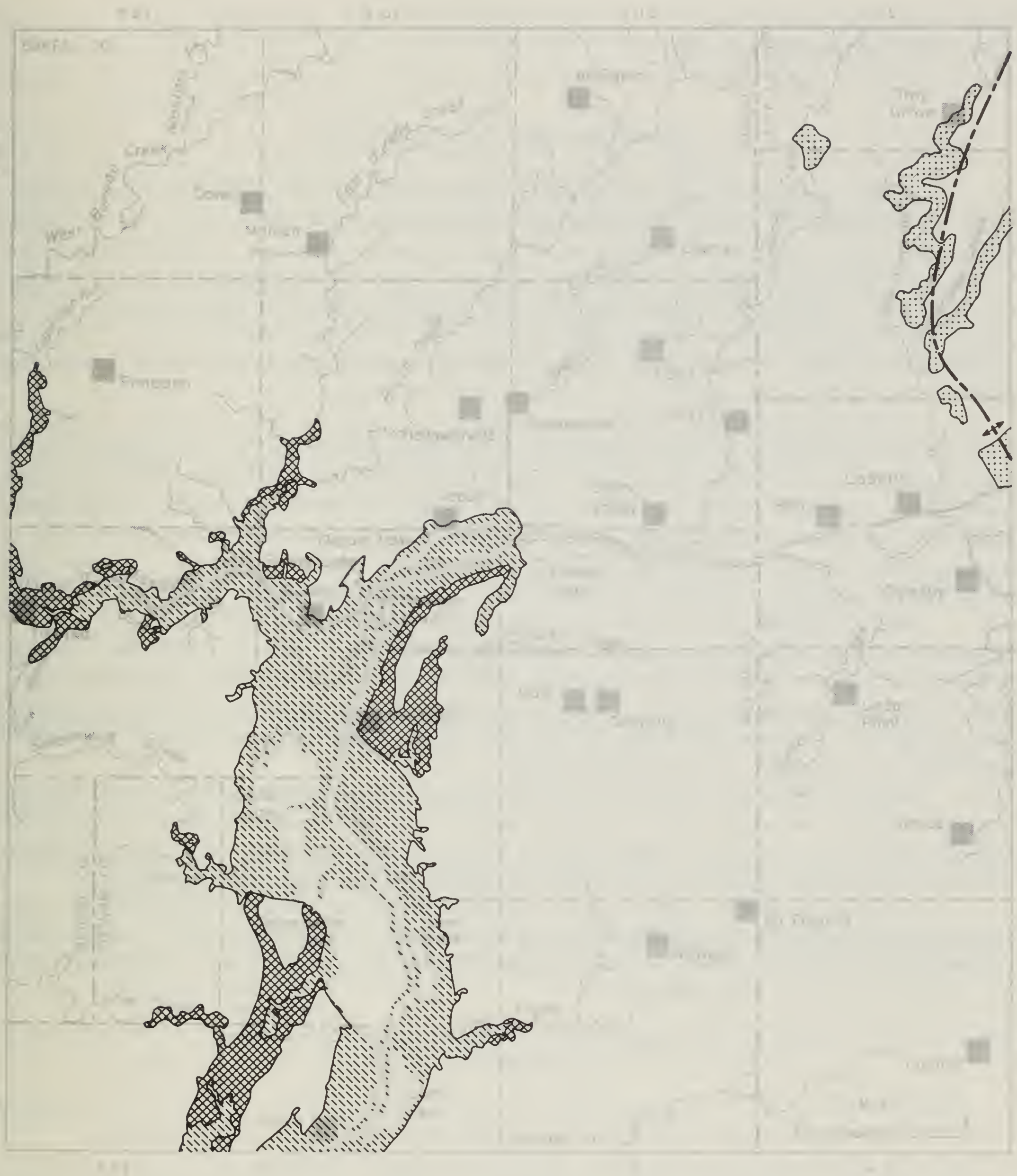
Multiple Uses of Resources

Many sites in the Hennepin region have conditions or resources that could be utilized to achieve several benefits for the area, either simultaneously or sequentially. These benefits include water supply, flood control, water recreation, waste disposal, and pollution control.

The reservoir sites described by Dawes and Terstriep (1967) on East Bureau Creek, Senachwine Creek, and Plow Hollow Creek, as well as areas on Bureau Creek near Princeton, Allforks Creek north of Hennepin, and Crow Creek northwest of Henry, have potential for multipurpose projects. The reservoirs would be constructed primarily for water supply, but because the Sankoty Sand is near or at the surface, a certain amount of seepage would take place. The seepage would be beneficial for artificial recharge. The construction of dams on the tributaries would also serve to impound flood flows and control downstream discharges for low-flow augmentation. Ultimately these areas are also potential water recreation sites.

On the Hennepin and Henry Terraces, numerous abandoned sand and gravel pits are found (fig. 3). The pits are believed to be hydrologically connected to the Sankoty Sand aquifer and could serve as artificial recharge pits. Sand and gravel pits can be developed as lakes where they are excavated below the level of the ground water. Pits on the low terraces and floodplains of the area usually would become lakes. Borrow pits on till uplands have been developed into fishing lakes in other parts of the state. Gravel or borrow pits that are not hydrologically connected to aquifers might be developed into waste disposal sites, as a measure of land rehabilitation.

Along the LaSalle Anticline, in the LaSalle-Peru and Troy Grove areas, there are many abandoned quarries. Near Troy Grove, the quarries usually contain water and might be developed as recreation areas. Quarries in the Galena-Platteville dolomites and pits in the St. Peter Sandstone should be considered as potential recharge areas and be kept free of any pollution. Dry quarries in Pennsylvanian limestone near LaSalle-Peru might be incorporated into parks that could be used to exem-



Glacial drift aquifer less than 25 feet from land surface

Glacial drift aquifer overlain by 25 to 50 feet of permeable material

St. Peter Sandstone aquifer less than 25 feet from land surface

Drift aquifer or St. Peter Sandstone overlain by more than 50 feet of earth material, or absent

Axis of LaSalle Anticlinal Belt

Figure 10 - Areas possibly favorable for artificial recharge of glacial drift and St. Peter Sandstone aquifers.

plify biological and physical features of the area. Less desirable sites can be considered for waste disposal.

SUMMARY AND CONCLUSIONS

In the Hennepin region there will undoubtedly be considerable future industrial development in view of the selection of Hennepin for the site of a large steel mill. The area is one of abundant water and mineral resources. Ground water can be fairly easily obtained in moderate quantities from drift aquifers as well as from the bedrock. The Illinois River serves as a reliable source of water as well as a means of transportation. The mineral resources in the area include coal, limestone (of quality suitable for Portland cement and crushed stone), silica sand, sand and gravel, and shale and clay.

In the upland areas, which are covered by up to 15 feet of loess, settlement and seepage may present problems to building construction. Possible construction sites over mined-out areas should have specific evaluation of foundation conditions. On the valley flat adjacent to the Illinois River and some of the larger streams, the possibility of high water table should be considered as well as the hazard of flooding. Because of high permeability of sediments in most of the lowland areas, seepage problems may occur in the construction of reservoirs.

Waste disposal practices for municipal, industrial, and residential purposes should be carefully planned, especially near urban areas where there is significant ground-water withdrawal and in areas of high ground-water supply potential. Disposal of solid or liquid wastes could result in serious pollution of groundwater supplies in several areas. There are many readily accessible areas where the potential for pollution is considered low.

Opportunities for conjunctive use of ground water and surface water are present. In several regions, major aquifers are at or near the surface and could be artificially recharged. Excess water during flood stages could be used for artificial recharge; this would also decrease flood problems on the tributary lowlands.

The use of water resources and natural resource sites for multipurpose projects might ameliorate those problems of water supply, flood control, water-related recreation, sewage disposal, and pollution that might result from a relatively rapid urban and industrial development.

REFERENCES

Busch, W. L., 1967, Illinois mineral production by counties, 1965: Illinois Geol. Survey Min. Econ. Brief 16, 10 p.

Cady, G. H., 1919, Geology and mineral resources of the Hennepin and LaSalle Quadrangles: Illinois Geol. Survey Bull. 37, 136 p.

Cady, G. H., 1952, Minable coal reserves of Illinois: Illinois Geol. Survey Bull. 78, 138 p.

Dawes, J. H., and Terstriep, M. L., 1967, Potential surface water reservoirs of northern Illinois: Illinois Water Survey Rept. Inv. 38, 86 p.

Hanson, Ross, 1950, Public ground-water supplies in Illinois: Illinois Water Survey Bull. 40, with Supp. I, 1958; Supp. II, 1961.

Horberg, Leland, 1953, Pleistocene deposits below the Wisconsin drift in northeastern Illinois: Illinois Geol. Survey Rept. Inv. 165, 61 p.

Illinois State Sanitary Water Board, 1966, Water quality network, part II—Illinois River and tributaries: Springfield, Ill., 171 p.

Krey, Frank, and Lamar, J. E., 1925, Limestone resources of Illinois: Illinois Geol. Survey Bull. 46, 392 p.

Lamar, J. E., 1957, Chemical analyses of Illinois limestones and dolomites: Illinois Geol. Survey Rept. Inv. 200, 33 p.

Landon, R. A., 1967, Geologic studies as an aid to ground-water management: Illinois Geol. Survey Env. Geol. Notes 14, 9 p.

Larson, T. E., 1950, Ground water in the Peoria Region, Part 3—Chemistry: Illinois Geol. Survey Bull. 75, 128 p.

Littlefield, M. S., 1925, Natural-bonded molding sand resources of Illinois: Illinois Geol. Survey Bull. 50, 183 p.

McDonald, C. K., and Sasman, R. T., 1966, Feasibility of artificial recharge in the Park Forest-Chicago Heights area: Illinois Water Survey, unpublished special report, 38 p.

Mitchell, W. D., 1954, Floods in Illinois—Magnitude and frequency: Div. of Waterways, U. S. Geol. Survey, Washington, D. C., 386 p.

Mosier, J. G., Holt, S. V., Alstine, E. V., and Garrett, F. W., 1921, Bureau County soils: Univ. Ill. Agr. Exp. Sta. Soil Rept. 20, 72 p.

Peterson, Helen (ed.), 1967, Water for Illinois, a plan for action: State of Illinois, Springfield, Ill., 452 p.

Smith, W. C., 1966, Geologic factors in dam and reservoir planning: Illinois Geol. Survey Env. Geol. Notes 13, 10 p.

Terzaghi, Karl, and Peck, R. B., 1948, Soil mechanics in engineering practice: John Wiley and Sons, New York, 566 p.

Thornburn, T. H., 1963, Surface deposits of Illinois, a guide for soil engineering: Univ. Ill. Eng. Exp. Sta. Circ. 80, 135 p.

U. S. Geological Survey, 1964, Compilations of records of surface waters of the United States, October 1950 to September 1960, Part 5—Hudson Bay and Upper Mississippi River basins: U. S. Geol. Survey Water Supply Paper 1728, 576 p.

U. S. Weather Bureau, 1962, Decennial census of United States climate—Monthly normals of temperature, precipitation, and heating degree days, Illinois: Climatography of the United States No. 81-9, Washington, D. C., 2 p.

Willman, H. B., and Payne, J. N., 1942, Geology and mineral resources of the Marseilles, Ottawa, and Streator Quadrangles: Illinois Geol. Survey Bull. 66, 388 p.

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