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FLOODING PROSPECTS OF ILLINOIS BASIN OIL SANDS

BY

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Flooding Prospects of Illinois Basin

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THE success of applied floods in the Siggins, Patoka and Basin McClosky oil pools, which have produced more than $25 million worth of oil as a result of flooding, and the greatly increased production due to accidental floods and encroaching edge-water, have encouraged a search for other favorable flooding prospects. This article is an effort to examine and evaluate a number of such flooding possibilities.

As there are more than 300 oil pools in Illinois, to cover all of them becomes a long-range project. The present article treats pools having only one predominant sand. Such pools occur in the Waltersburg, Tar Springs, Cypress, Bethel, and Aux Vases sands and the McClosky lime. Examples of each have been selected.

These pools are shown in solid black

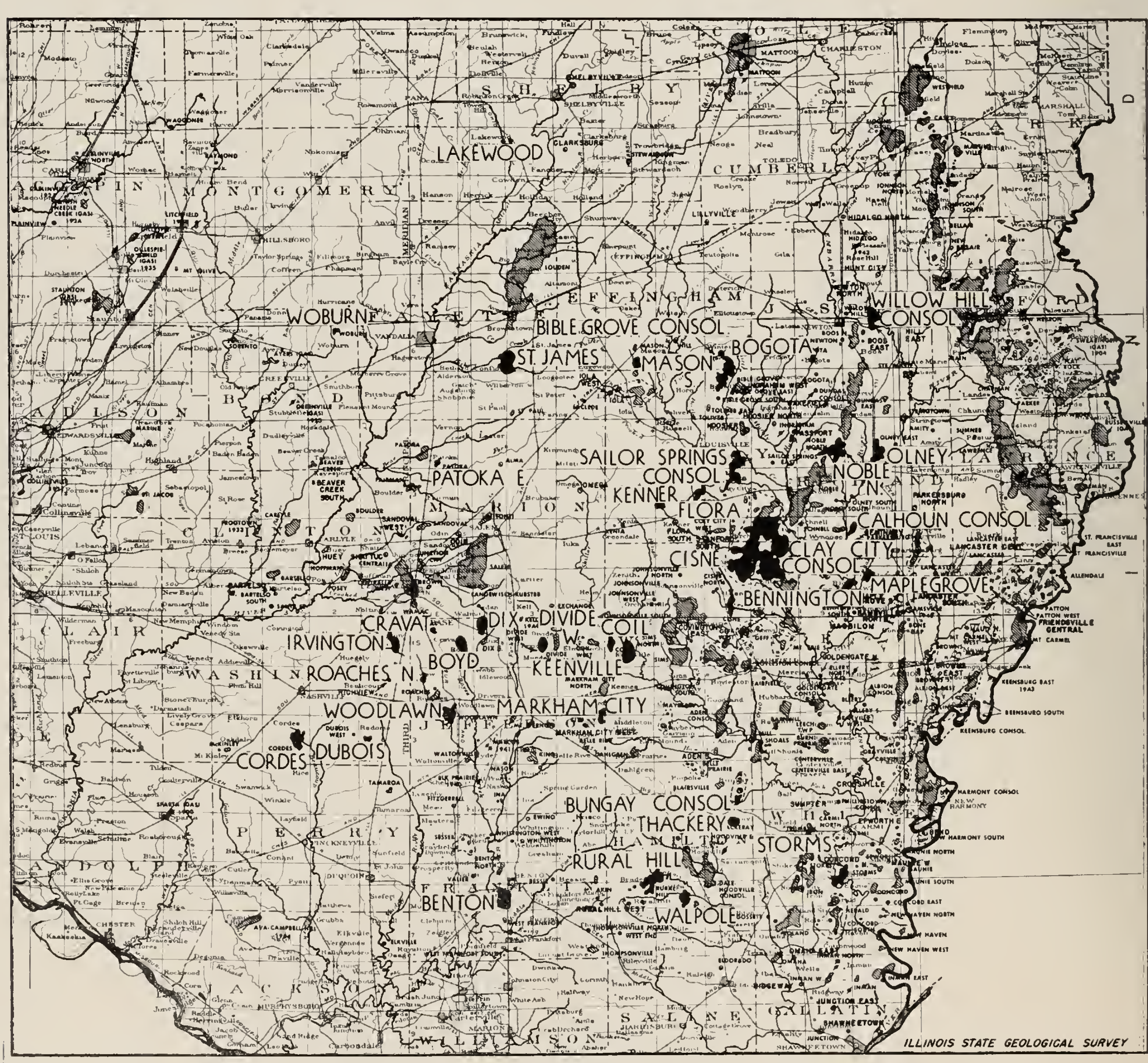


FIGURE 1. Map of the Illinois basin oil fields, with the pools described in this paper marked in solid black, showing positions of surface streams relative to oil pools.

Oil Sands

Determinations of porosity and permeability of the samples illustrated were made by Paul M. Phillippi. They show the following conditions:

Formation	Porosity (percent)	Permeability (millidarcys)
Waltersburg	16.43	130
Tar Springs	15.29	84
Cypress	17.32	27
Bethel	17.65	60
Aux Vases	13.33	0
McClosky	19.18	878

The Waltersburg has been successfully flooded in the New Harmony pool, the Tar Springs sand in the Maunie South pool, the Bethel in the Patoka pool, and the McClosky in several areas on the Noble anticline.

Table 1 gives the principal characteristics of each sand.

Figures 1 and 4 show known and possible fresh water supplies which are supplemented by Table 2, naming probable salt water-bearing sands above the oil in Figure 1 which also locates, by hachured lines, most of the other Illinois oil-producing areas.

The sequence in depth of the sands in the selected pools is shown in the geologic column, Figure 2.

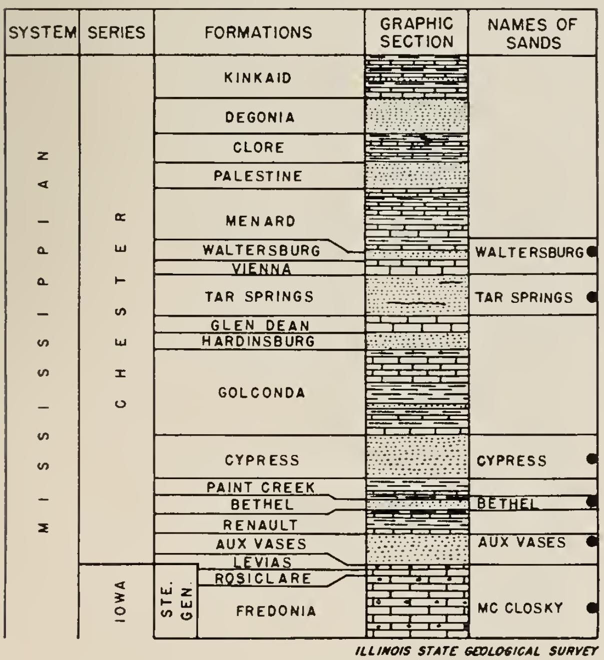
Since many of the characteristics of the sands, such as depth and thickness, in the fields discovered since 1936 are listed in Illinois Petroleum No. 58[1] these are not repeated in the present article, but the reader is referred to them. They are here amplified by additional information more pertinent to the evaluation of the pools for water-flooding: the viscosity and gravity of the oil, the porosity, permeability, water and oil saturation of the sand, and the initial position of edge water. Studies now in progress for the same pools include water analyses, gas-oil and water-oil ratios, and the degree of edge-water encroachment.

Photomicrographs of core samples from six formations . . . five sandstones and one limestone . . . are shown in Figure 3. In general these samples are from parts of the formation much less porous and permeable than the average.

TABLE 1

Principal Characteristics of Oil Sands

POOL	Sand	Porosity	Permea-bility	Water Saturation	Oil Saturation	A.P.I. Gravity	Viscosity Centipoises at 100°F.	Cumulative Bbls. per Acre
Storms	Waltersburg	19–25	28–1200	10–43	10–24	32.1	6.80	3379
Sailor Springs	Tar Springs	10–19	15–1680	28–52	11–41	37.0	5.26	1435
Benton	Tar Springs	15–23	16–2200	20–50	15–25	....	4.62	7954
Patoka East	Cypress	21–25	550–700	27–43	23–37	36.0	6.20	5788
Noble North	Cypress	12–20	10–6000	25–50	15–28	....	....	2078
St. James	Cypress	12–26	10–360	35–70	10–40	34.4	7.97	5171
Bible Grove	Cypress	11–23	10–42	31–62	10–33	....	.....	1649
Kenner	Bethel	11–16	14–100	19–58	11–22	....	6.20	900
Woburn	Bethel	.....	......	.....	.....	36.7	5.58	2455
Lakewood	Bethel	19–21	220–620	26–37	30–42	31.7	.....	720
Roaches North	Bethel	.....	....	.....	.....	....	.....	2185
Mason South	Bethel	10–19	13-276	24–49	10–30	....	.....	1844
Dix	Bethel	.....	......	...	..	38.0	4.30	2979
Woodlawn	Bethel	12–20	32–600	19–50	10–24	37.8	4.94	6227
Irvington	Bethel	15–21	20–2900	26–48	20–40	37.6	3.96	4410
Cordes	Bethel	13–25	22–2145	30–50	15–50	37.4	4.94	2257
Cravat	Bethel	15–18	72	27–37	36–38	35.4	5.26	2225
Dubois	Bethel	.. ..	....	.....	.....	31.0	8.54	1436
Boyd	Bethel	12–24	15–2200	15–47	15–25	....	4.30	3175
Rural Hill	Aux Vases	10–28	10–1202	30–64	10–21	....	.....	3124
Coil	Aux Vases	11–19	10-x	10–19	46–60	....	7.68	2098
Thackeray	Aux Vases	.....	....	.....	.....	....	.....	3028
Walpole	Aux Vases	10–21	11–200	44–65	17–33	38.4	5.26	2958
Bungay	Aux Vases	17–26	14–650	41-64	10–30	.. .	.....	2540
Flora	McClosky	.....	....	.....	....	37.2	4.62	1292
Calhoun Consolidated	McClosky	10–16	11–200	.....	10–13	....	5.90	1201
Maple Grove	McClosky	10–15	100–250	37–82	x–x	....	3.61	1453
Cisne	McClosky	15–20	189–590	10–12	28–34	....	.....	3008
Bennington	McClosky	x–x	x–x	x–x	x–x	....	.....	1522
Keenville	McClosky	12–17	10–x	40-54	16–27	....	.....	1500
Markham City	McClosky	10–16	12–2400	10-48	10–22	....	5.90	1465
Divide West	McClosky	.....	....	.....	.....	....	5.58	2153
Olney	McClosky	11–15	11–500	20–28	19–25	37.2	4.94	1969
Bogota	McClosky	.....	....	.....	... .	. ..	4.62	1790
Willow Hill	McClosky	.....	....	.....	.....	....	.....	909
Clay City	McClosky	10–26	45-9000	38–56	10–39	36–39.8	3.96–5.90	2017



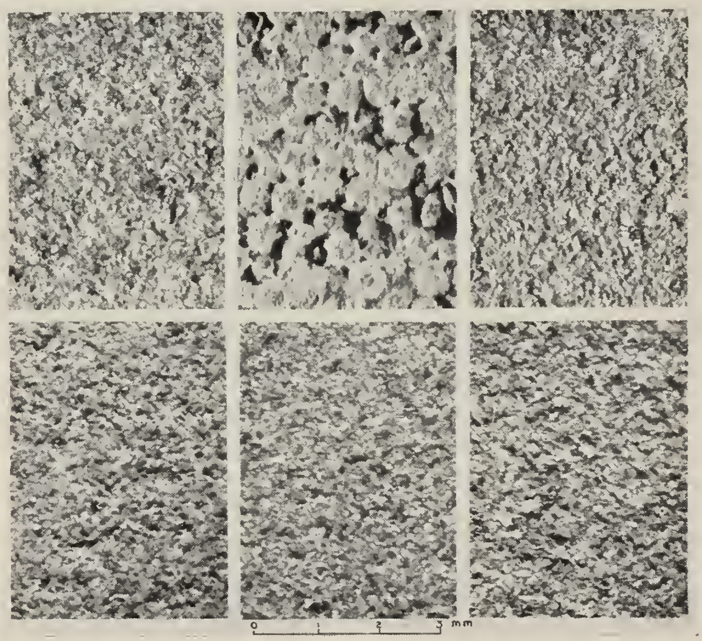


FIGURE 2. (left). Geologic column showing by black dots the producing sands which occur in the pools described.

FIGURE 3. (Right) Photomicrographs of core samples from the Waltersburg, Tar Springs, Cypress, Bethel, Aux Vases and McClosky sands.

sand for each selected pool. Figure 1 also shows the surface waterways. Only the larger of them will be adequate for intensive flooding throughout the year. Figure 4 indicates the areas of presumably water-bearing sands and gravels and fresh water-bearing Pennsylvanian sandstones.

Figures 5-9 illustrate the 36 pools described. On each is a line surrounding all wells which showed no water in their initial production. Wells outside these lines showed water initially. Those wells which are surrounded by a circle made more water than oil.

The Benton pool (Figure 5) is being made ready for flooding and has great promise. The Bethel sand pools shown in Figure 6 are likely to be under edge-water pressure. In this group the flooding operation at Patoka met with great success and Woodlawn seems to be very promising. In Figure 7, the Rural Hill pool covers a large area and its record in all respects seems favorable to flooding.

Figure 8 shows McClosky production. Wherever tested this formation has responded to water-flooding. On it has been developed the unique process of using only old wells as input wells, the water being supplied from upper sands in the same flooding well affording

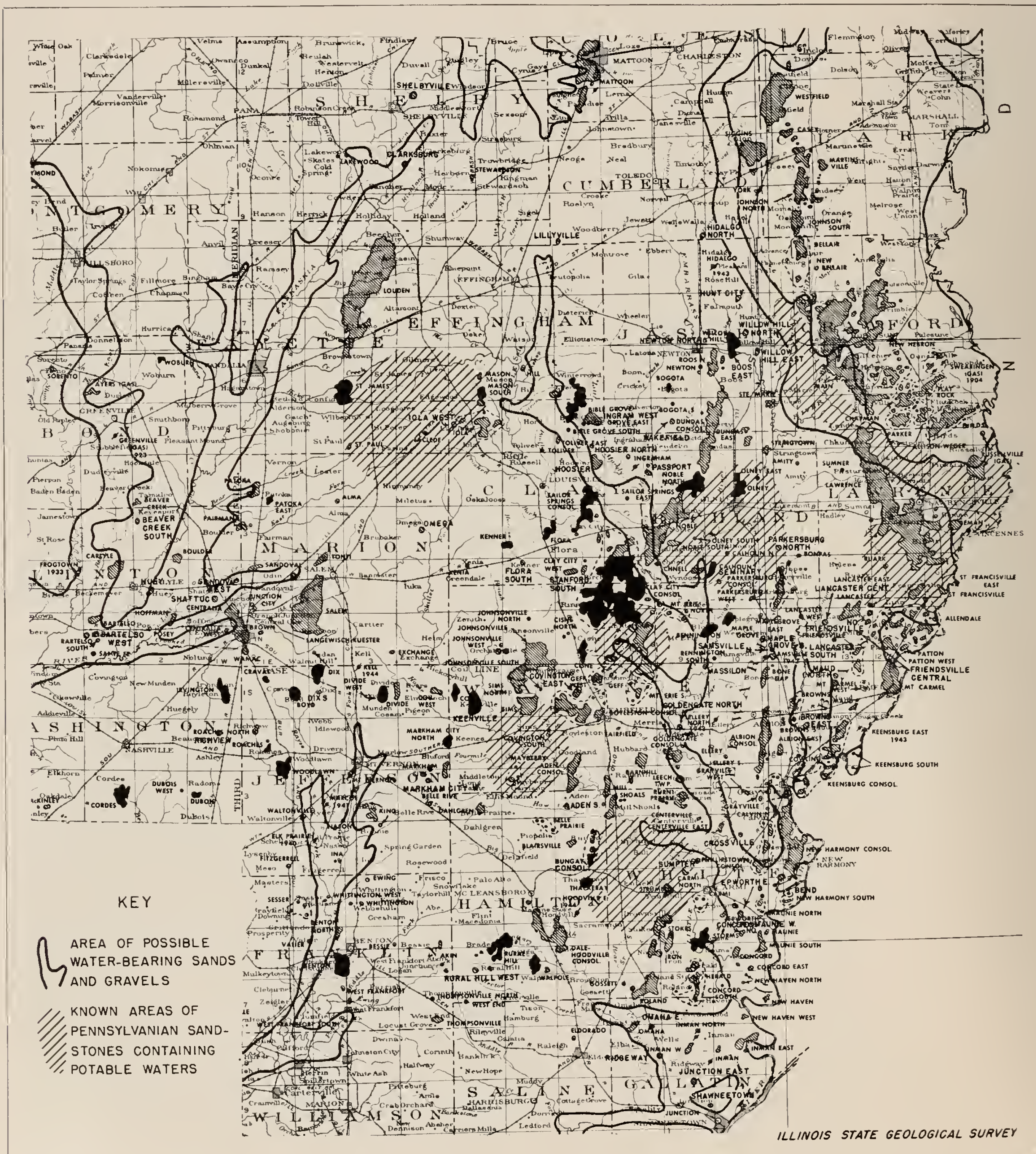


FIGURE 4. Areas of possible fresh water-bearing sands and gravels and the known areas of Pennsylvanian sandstones that contain fresh water. By C. A. Bays.

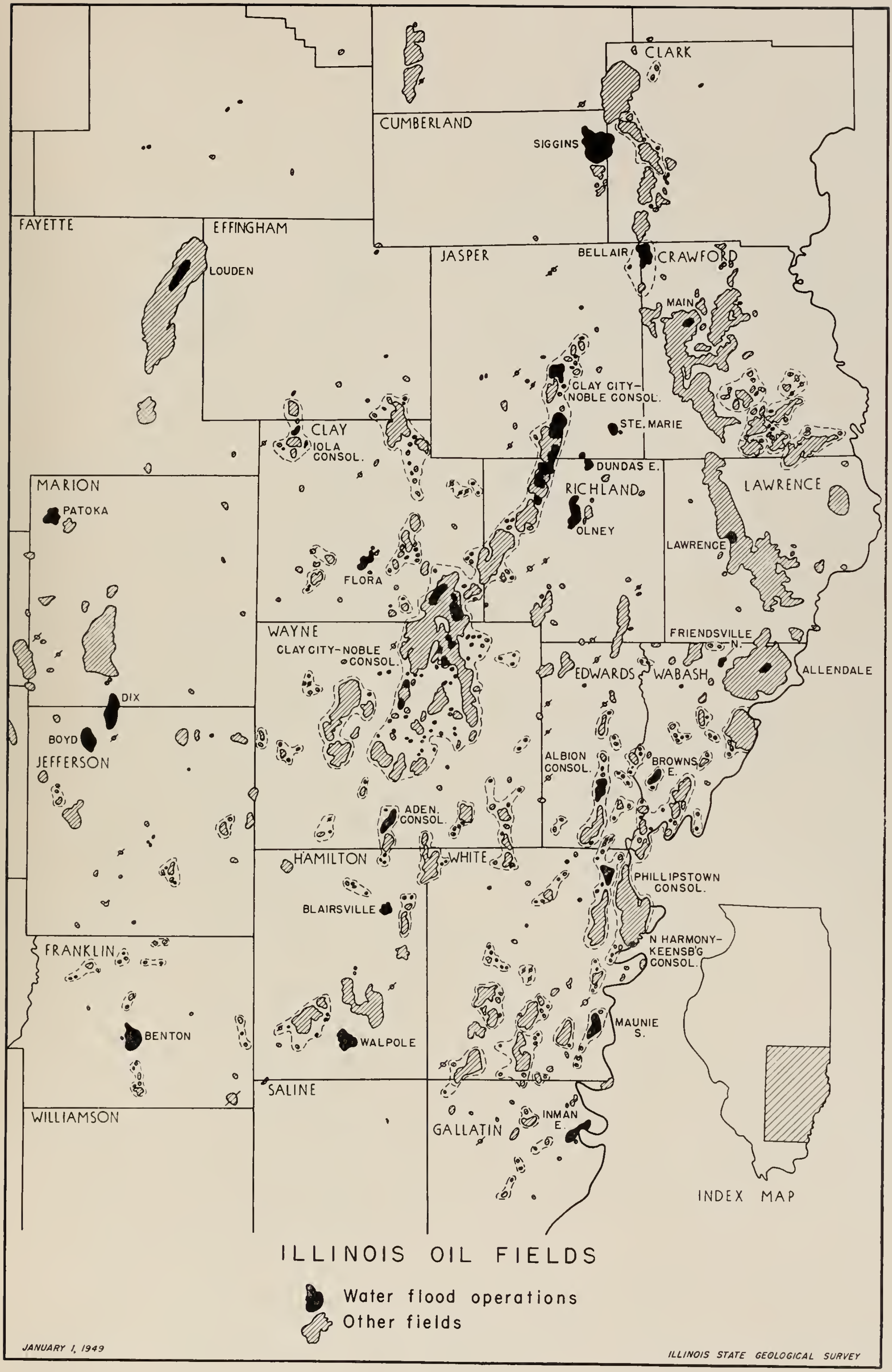
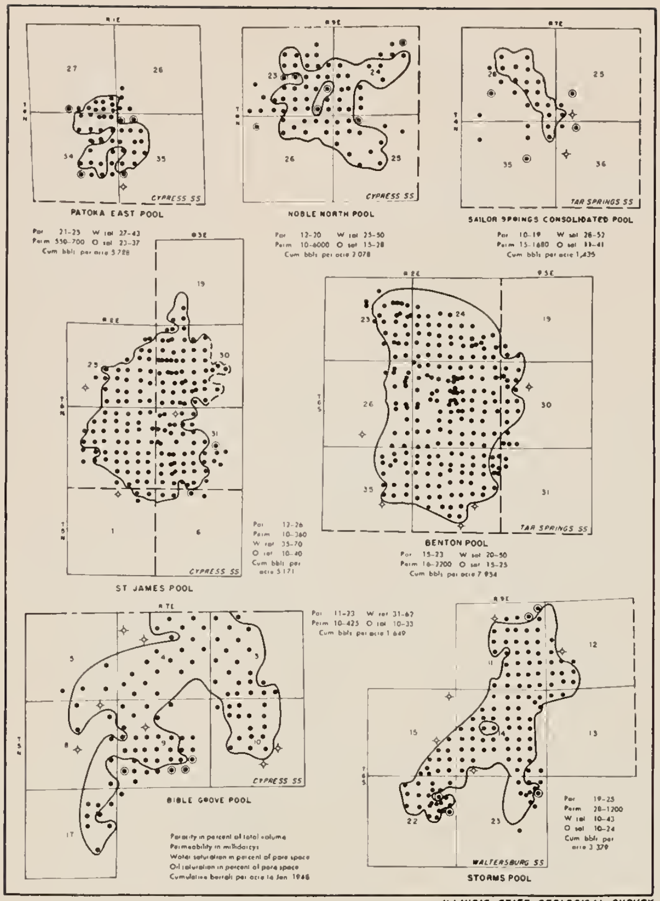


FIGURE 10. Map shows in black pools being flooded and in preparation for flooding.



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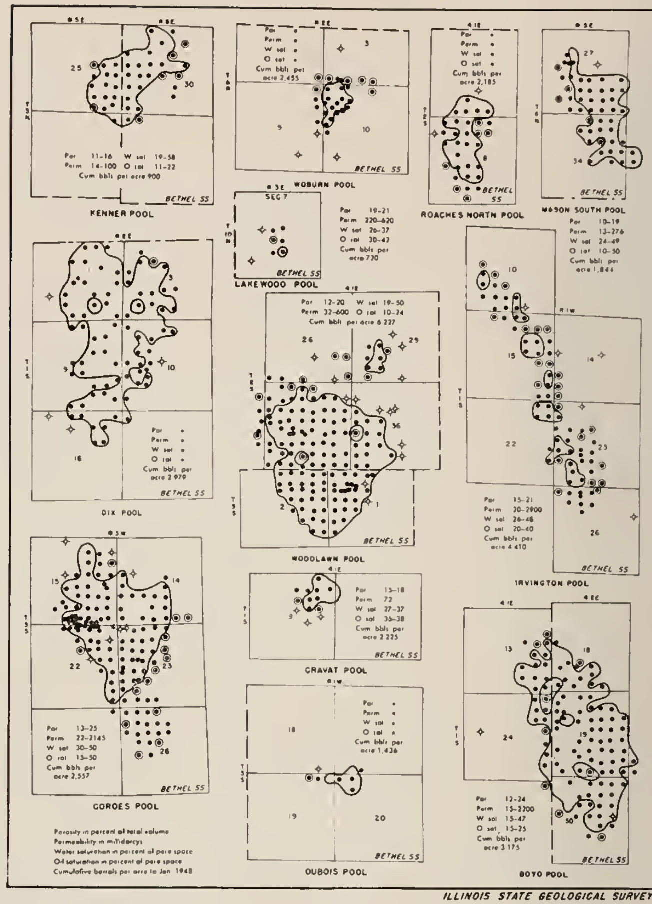

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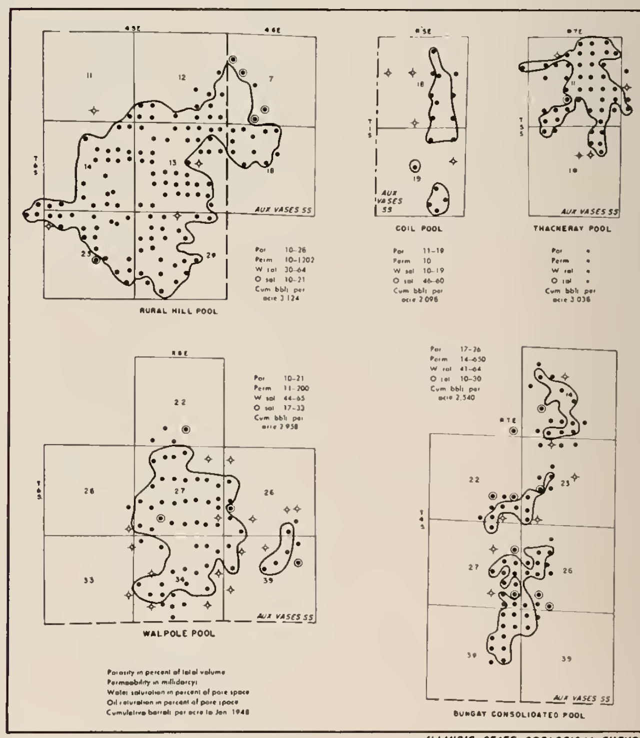
FIGURE 5. (Above left). Four pools in the Cypress sand, two in the Tar Springs sand, and one in the Waltersburg sand.

FIGURE 6. (Above, right). Twelve Bethel sand pools.

FIGURE 7. (Lower right). Five Aux Vases sandstone pools.



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KEY TO SYMBOLS USED IN FIGURES 5-9.

Solid dot: Producing oil well.

Open circle with arms: Dry hole.

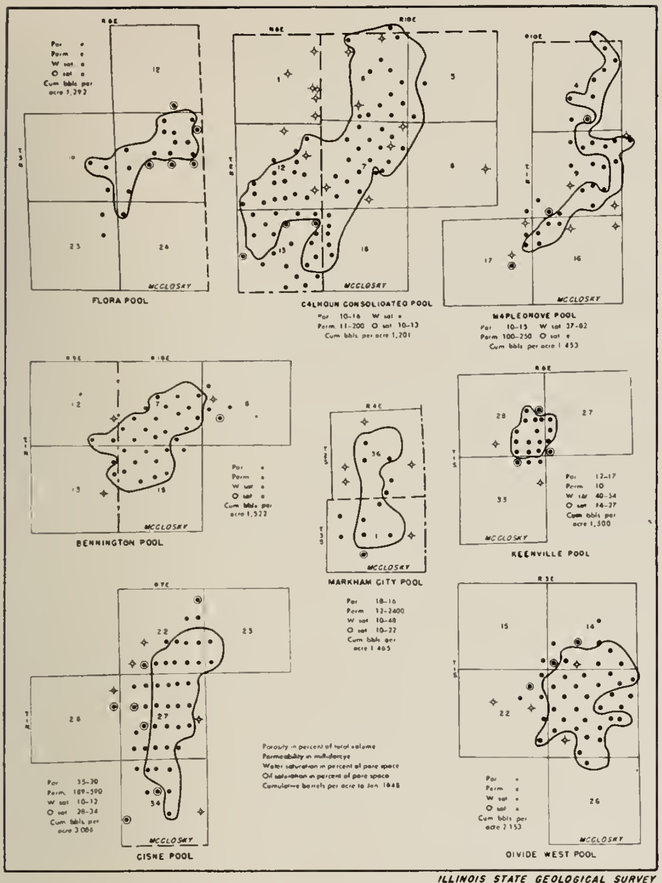
Solid dot within circle: Well initially produced more water than oil.

Boundary line: Boundary of pools which made no initial water. A second boundary in a few pools surrounds interior wells which produced initial water.

the cheapest possible means of flooding and representing an investment even less than gas injection.

The large Clay City Consolidated pool and three smaller pools are shown in Figure 9. Clay City is part of the McClosky production found by The Pure Oil Company on the Noble anticline where several successful McClosky water floods have been developed.

Figure 10 shows the areas now being flooded or being made ready for flooding. The characteristics of their sands may be compared with those of unflooded areas as a test



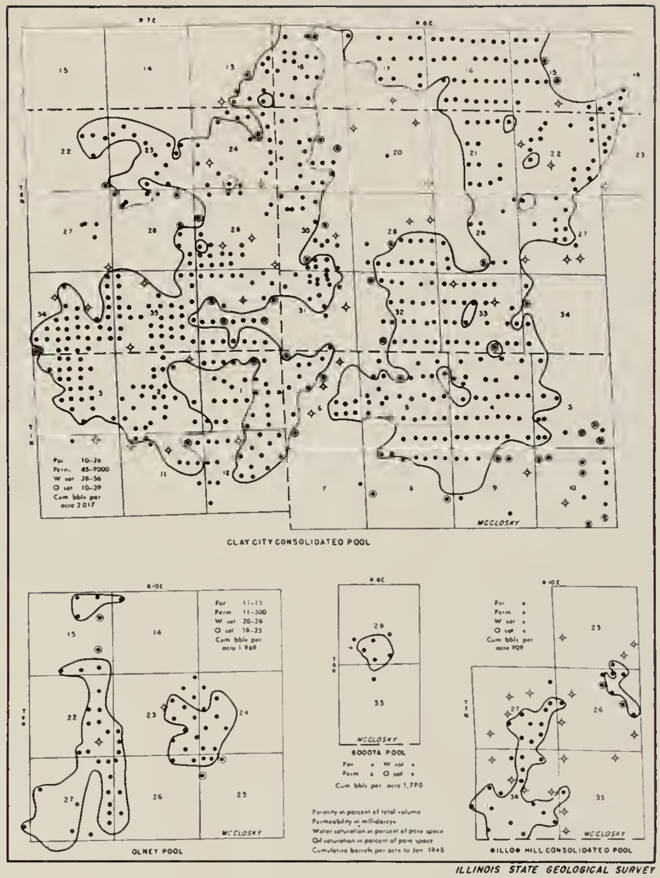


FIGURE 8. (Left). Eight McClosky limestone areas.

FIGURE 9. (Right). The large Clay City Consolidated pool and three smaller pools.

TABLE 2. Probable Sources of Salt Water for Flooding
(By DAVID H. SWANN)

POOL*	Sand	Occurrence of Upper Salt Water
Storms	Waltersburg	Probably available from lower Pennsylvanian sandstones around 1500 feet in depth. The Tar Springs has been a well-developed "water sand" in some of the surrounding dry holes.
Sailor Springs Consol.	Tar Springs	
Benton	Tar Springs	May be available from several lower Pennsylvanian sandstones at a depth of 1100 to 1800 feet, but none are continuously developed. The Hardinsburg sand, 2200 to 2300 feet, may be a possible source beneath some parts of the field.
Patoka East	Cypress	Tar Springs sandstone, about 1100 feet, and Cypress sandstone.
Noble North	Cypress	Available in lower Cypress sandstone, about 2600-2700 feet, Tar Springs sandstone about 2300 feet, and several sandstones in lower Pennsylvanian, 1600-2000 feet.
St. James	Cypress	Probably available in some parts of pool from Tar Springs sandstone, about 1400 feet, and from an upper Pennsylvanian sandstone, McLeansboro group, about 500 feet.
Bible Grove Consolidated	Cypress	Available in most parts of pool in lower Pennsylvanian sandstone, about 2000 feet.
Kenner	Bethel	In Cypress sandstone, about 2600 feet.
Woburn	Bethel	In Cypress sandstone, about 900 feet.
Lakewood	Bethel	Cypress sandstone, about 1600 feet.
Roaches North	Bethel	Probably in Tar Springs sandstone, about 1500 feet, and possibly in several lower Pennsylvanian sandstones between 1000 feet and 1300 feet.
Mason South	Bethel	Possibilities from Tar Springs sandstone about 1900-2000 feet, Cypress sandstone, about 2200 feet and various lower Pennsylvanian sandstones around 1400 feet; none continuous.
Dix	Bethel	Possibly in some parts of pool from Cypress sandstone, about 1800 feet, and in some parts from Tar Springs sandstone, about 1500 feet.
Woodlawn	Bethel	In Tar Springs sandstone, about 1500 feet, and in lower Pennsylvanian sandstones, 1000-1200 feet.
Irvington	Bethel	In Tar Springs sandstone, about 1100-1200 feet.
Cordes	Bethel	From lower Pennsylvanian sandstones, 600-700 feet and Tar Springs sandstone, about 800 feet.
Cravat	Bethel	In Cypress sandstone, about 1900-2000 feet.
Dubois	Bethel	In Tar Springs sandstone, about 900-1000 feet.
Boyd	Bethel	From Tar Springs sandstone, 1600-1700, and in parts of the pool from Cypress sandstone, about 1900-2000 feet.
Rural Hill	Aux Vases	In Cypress sandstone, about 2800-2900 feet.
Coil	Aux Vases	In Cypress sandstone, about 2600-2700 feet.
Thackeray	Aux Vases	
Walpole	Aux Vases	Probably available in portions of the pool from Cypress sandstone, about 2800 feet and from Pennsylvanian sandstone, about 1500-1700 feet.
Bungay Consolidated	Aux Vases	From Cypress sandstone, about 3000-3100 feet.
Flora	McClosky	From Cypress sandstone, about 2700 feet.
Calhoun Consolidated	McClosky	In Cypress sandstone, about 2700-2800 feet.
Maplegrove	McClosky	Possibly available in Cypress sandstone about 2900-3000 feet, and probably in lower Pennsylvanian sandstones, 1600-2000 feet.
Cisne	McClosky	From Cypress sandstone, about 2800-2900 feet.
Bennington	McClosky	In Cypress sandstone, about 2900-3000 feet.
Keenville	McClosky	In Cypress sandstone, about 2800 feet.
Markham City	McClosky	In Cypress sandstone, about 2700-2800 feet.
Divide West	McClosky	Possibly in Cypress sandstone, about 2400 feet, in some parts of the pool, possibly in Pennsylvanian sandstones about 1400-1600 feet.
Olney	McClosky	From lower Pennsylvanian sandstones, 1700-1900 feet, and Cypress sandstone, 2700-2800 feet.
Bogota	McClosky	From Cypress sandstone, 2800-2900 feet.
Willow Hill Consolidated	McClosky	From Cypress sandstone, 2400-2500 feet.
Clay City Consolidated	McClosky	In many spots from Cypress sandstone, about 2700-2800 feet, or Tar Springs sandstone, about 2400 feet.

* For location, see Figure 1

for their probable reactions.

Summary

Thirty-six pools have been selected for study, positions of which are marked on a key map. Many of the characteristics of their producing sands are shown in Illinois Petroleum No. 58 for 1947. Other qualities more directly connected with water flooding, such as the position of surrounding water, the measure of viscosity of the oil, porosity, permeability, water and oil saturations of the sand, and the position of water for flooding in relation to the position of the pools are shown on maps and explained in the text. A map gives the locations of existing flooding operations, and deductions are made as to likely flooding prospects.

ACKNOWLEDGEMENTS

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REFERENCE

[1] Bell, Alfred H., and Kline, Virginia, Oil & Gas Development in Illinois in 1947. Ill. Geol. Survey, Ill. Pet. 58, 1948.