ERRATA
JANUARY 1985

Department of Water Resources Publication:
"Platte River Water Supply Downstream from Columbus"
February 1983 and September 1984

In the first printing, the title of the middle photograph on page 5 now reads City of Lincoln Sewage Treatment facility at Ashland. The title should be changed to read City of Lincoln Water Treatment facility at Ashland.

In printings one and two, in Table 1 on page 7, the discharge of the Elkhorn River for 1956 is given as 12,000 acre-feet and 1% of the total flow measured at Louisville. The discharge should be changed to read 300,000 acre-feet and 14% of the total flow. The reach gain now reads 315,000 acre-feet and 14% of the total flow measured at Louisville. This value should be changed to read 27,000 acre-feet or 1% of the total flow.

Platte River Water Supply Downstream from Columbus

The cover shot is of the Platte River from the Schramm Tract, Sarpy County.

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LIST OF ILLUSTRATIONS

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Second Printing-September 1984

The Lower Platte River Basin

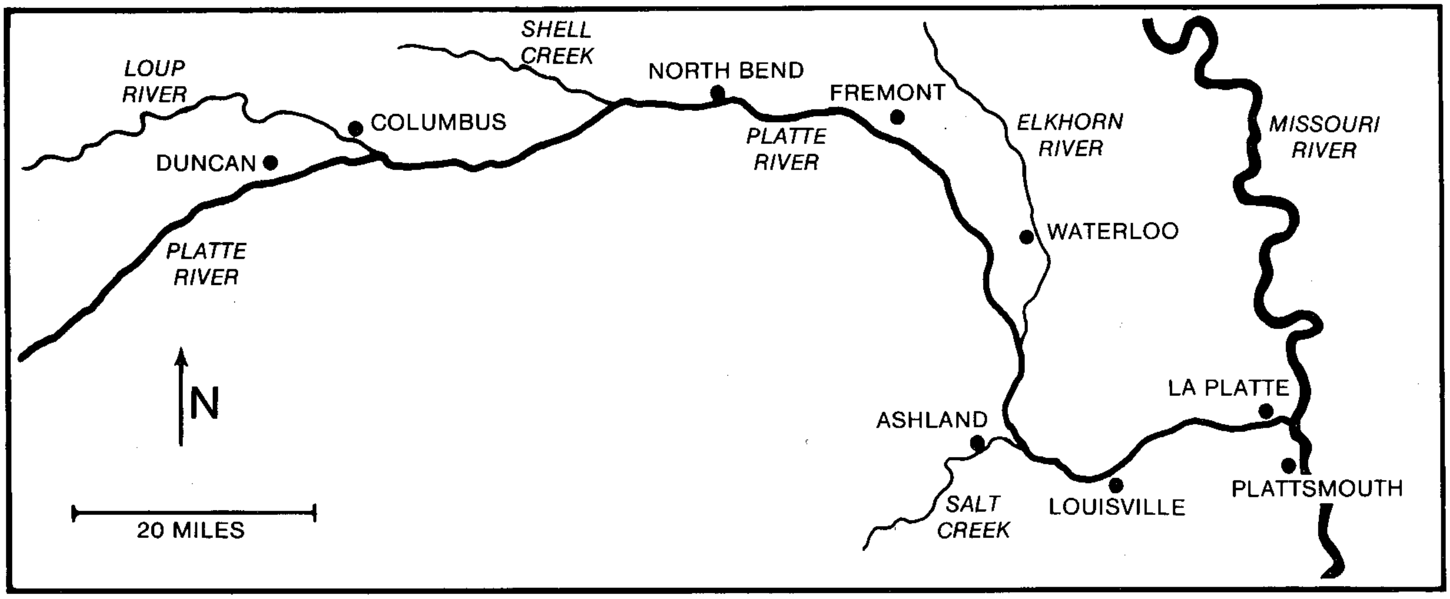


Figure 1

Introduction

As the value of water increases, greater attention will be focused upon all of Nebraska's streams and rivers. Large demands will continue to be made upon the Platte River, the largest of those waterways. This report examines the water supply of the lower reach of the Platte River which stretches over 100 miles, from the point where the Loup River flows into the Platte near Columbus to its mouth near Plattsmouth. This examination includes an analysis of tributary rivers and streams, and the demands placed upon the Platte River by various water users.

Hydrologic Setting

The flow of the lower portion of the Platte River is derived principally from three upstream sub-basins; the Upper Platte, the Loup and the Elkhorn. The Shell and Salt Creek watersheds also provide a small but significant flow to the reach. Minor ungaged tributaries and ground water inflow provide the rest of the water supply.

The Upper Platte Basin consists of the North Platte and South Platte watersheds, and the central Nebraska drainage area of the Platte River between the city of North Platte and the mouth of the Loup River. The major source of flow in the Upper Platte system is snowmelt runoff from the front range of the Rocky Mountains. Much of the snowmelt in this portion of the basin is trapped in a series of reservoirs during the months of May and June and is released for irrigation and power generation during the remainder of the year. For the purposes of this report, the measuring station at Duncan is considered the downstream termination of the Upper Platte. Over the years, the flow has varied from a raging torrent to extended periods without detectable flow.

Most of the Loup River basin is fed by seeps and springs draining the vast ground water "reservoir" underlying the Nebraska Sandhills. This reservoir (aquifer) is, to a large extent, made up of unconsolidated sands and gravels which absorb precipitation falling within the region. Water, thus stored, is slowly released to a network of tributary streams which drain into the Loup River. The flow of the Loup does not vary radically between wet and dry periods. This relatively steady flow is attributed to the large capacity of, and the resultant slow release from, the aquifer underlying the Sandhills. Total flow from the basin is computed by combining the flow record from the Loup River gages at Columbus and Genoa with the flow record for the Loup Power Canal diversion near Genoa. Although extremely high at times, the combined flow since 1943 has never yielded a mean daily discharge smaller than 64 cubic-feet per second.

The Elkhorn River also rises in the Sandhills. In addition, it drains a considerable portion of the more humid and less permeable loess hills region of northeastern Nebraska. Large localized runoff events are common in the summer in the rolling hills of the Lower Elkhorn watershed. As a result, the flow of the Elkhorn River measured at Waterloo shows substantial variability. Minimum flow conditions occurred in November, 1940, when a discharge of 50 cubic-feet per second was observed. A flow of approximately 100,000 cubic-feet per second was estimated to have occurred during the flood of June, 1944.

The minor tributaries of the Lower Platte, which include Shell and Salt Creeks, drain a physiographic region similar in nature to the loess hills of the Lower Elkhorn Basin. As a result, they periodically go dry in their headwater reaches during the summer. During wet years, flash floods often produce flows greatly exceeding the average discharge. The flow measured at Louisville includes all upstream tributary inflows and reflects induced infiltration losses to Lincoln's well field at Ashland. Salt Creek inflow to the Platte River, which passes the Louisville gaging station, includes return flow from Lincoln sewer outfalls.

Analysis of Tributary Components

The relative significance of the contributions provided by tributary basins is illustrated by the discharge records available from the stream gaging stations in the region. Figure 2 illustrates, as a percentage, the quantities of flow provided by each major source to the Platte River at the North Bend station. During the 30 years that the gage has been in operation, 36 percent of the flow originated in the Upper Platte River above the mouth of the Loup River, and 60 percent of the flow came from the Loup. Shell Creek, several unmeasured tributary streams, and river gains (or losses) from valley ground water contributions, account for the balance of the flow.

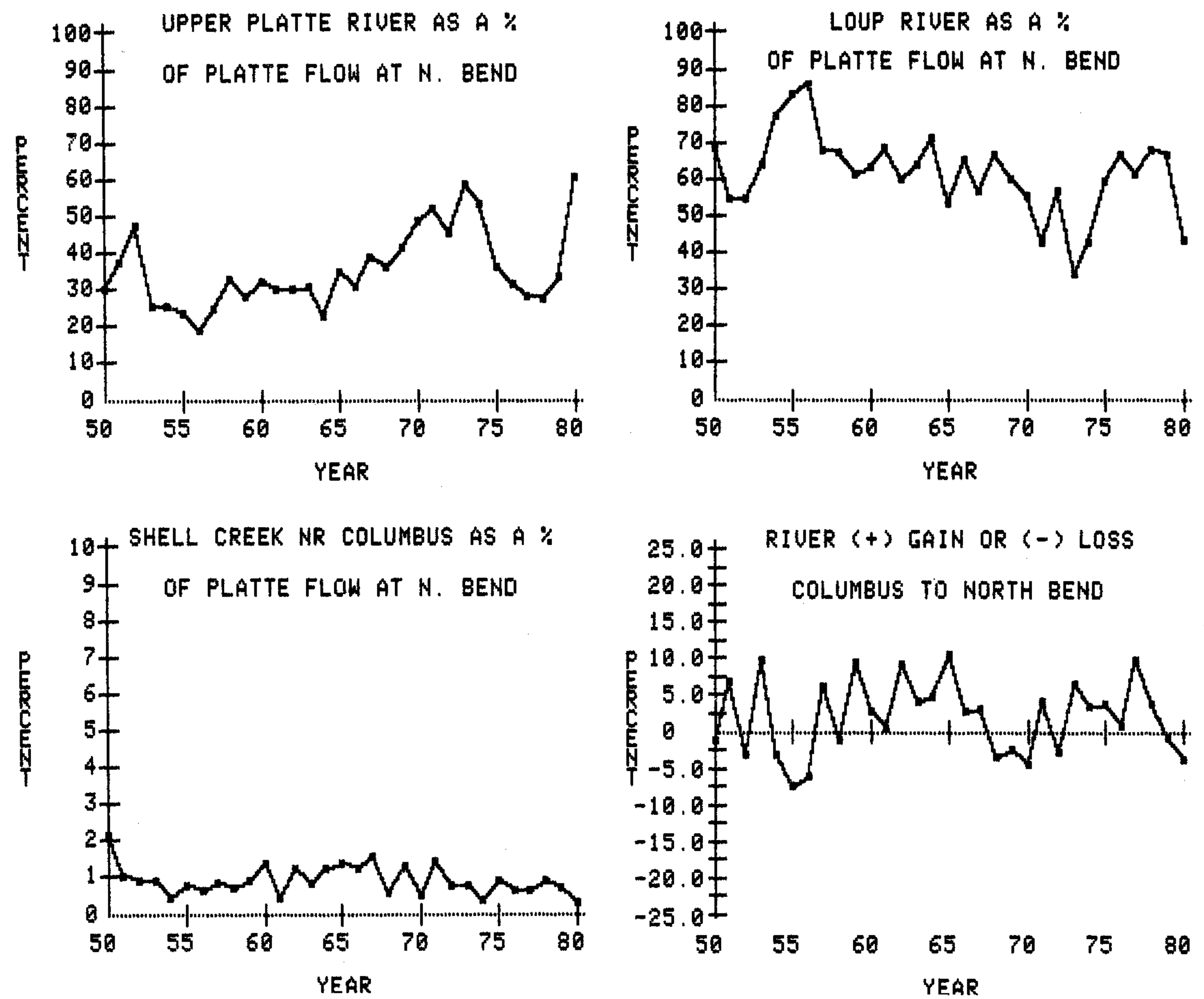


Figure 2

Platte River near the Schramm Tract, Sarpy County. Photo courtesy of the Game and Parks Commission.

Because it was operated during the 1930's and 1940's, the record from the Ashland gage provides a longer historic perspective than the North Bend record. Since the gage near Ashland was discontinued in May, 1953, historical analysis necessitated estimation of missing data through 1980 by hydrologic simulation techniques.

An analysis of the data recorded and synthesized over a 51-year period for the Ashland station is depicted in Figure 3. Similar to Figure 2, it illustrates the annual flow derived from each major tributary. The Elkhorn River contributed approximately 22 percent of the total during the past half century. For the 51-year period, the Loup River's share at Ashland amounted to 48 percent of the total. The Upper Platte contributed approximately 28 percent. Valley ground water inflow and the surface water inflow from other tributaries accounted for the remainder. Because the Elkhorn River enters the Platte downstream from North Bend, it should be noted that the proportionate share of the various tributary streams at Ashland is significantly different than for the North Bend station.

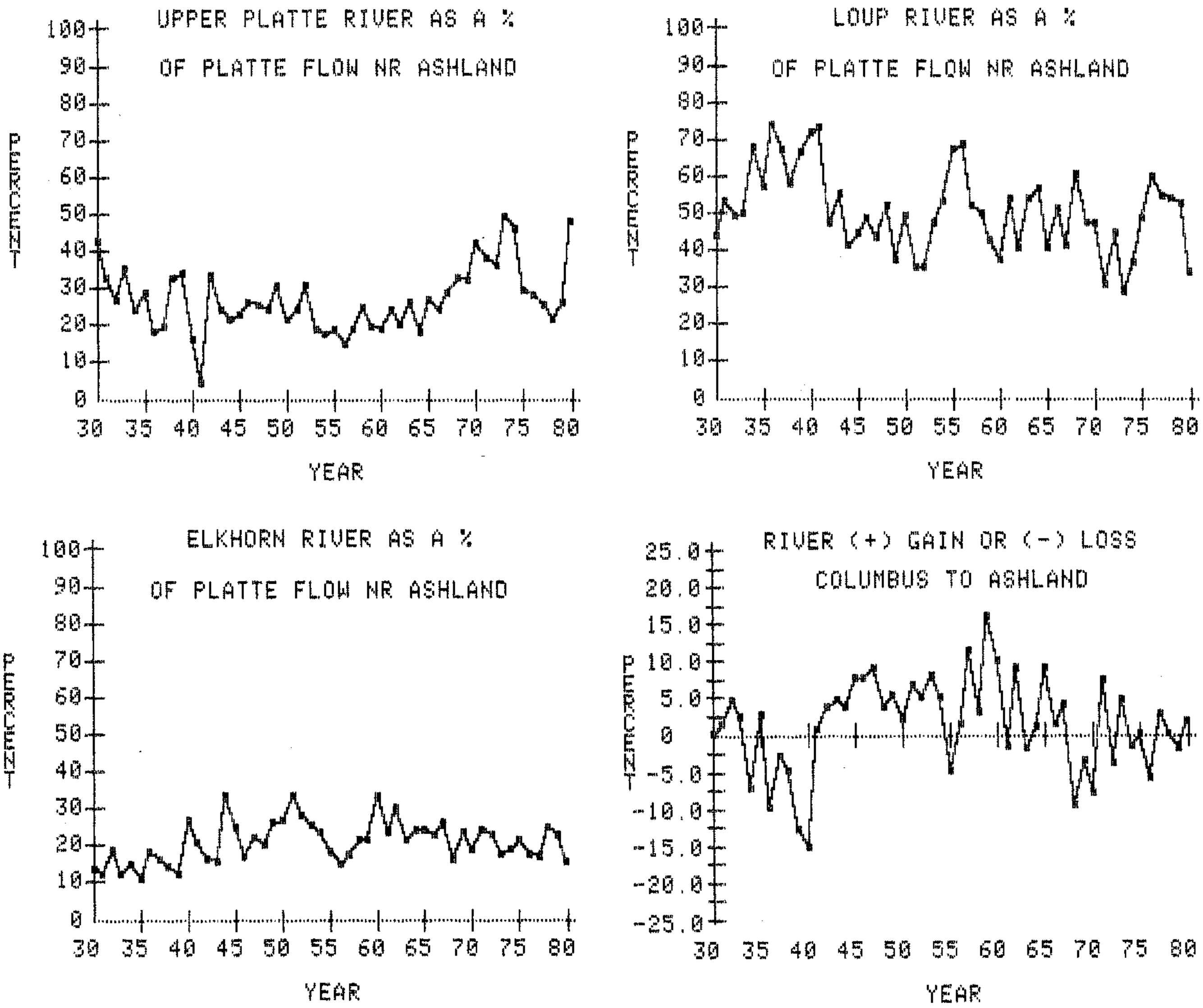
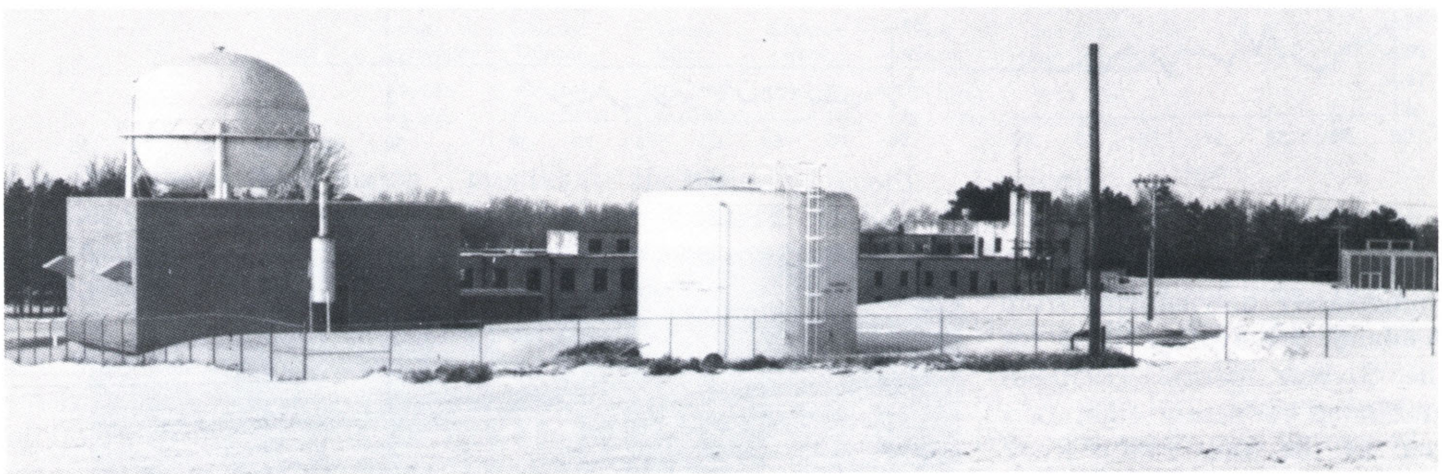


Figure 3

Wahoo Creek gage at Ithaca

Salt Creek gage at Roca



City of Lincoln Water Treatment facility at Ashland

(Below) Salt Creek at Greenwood

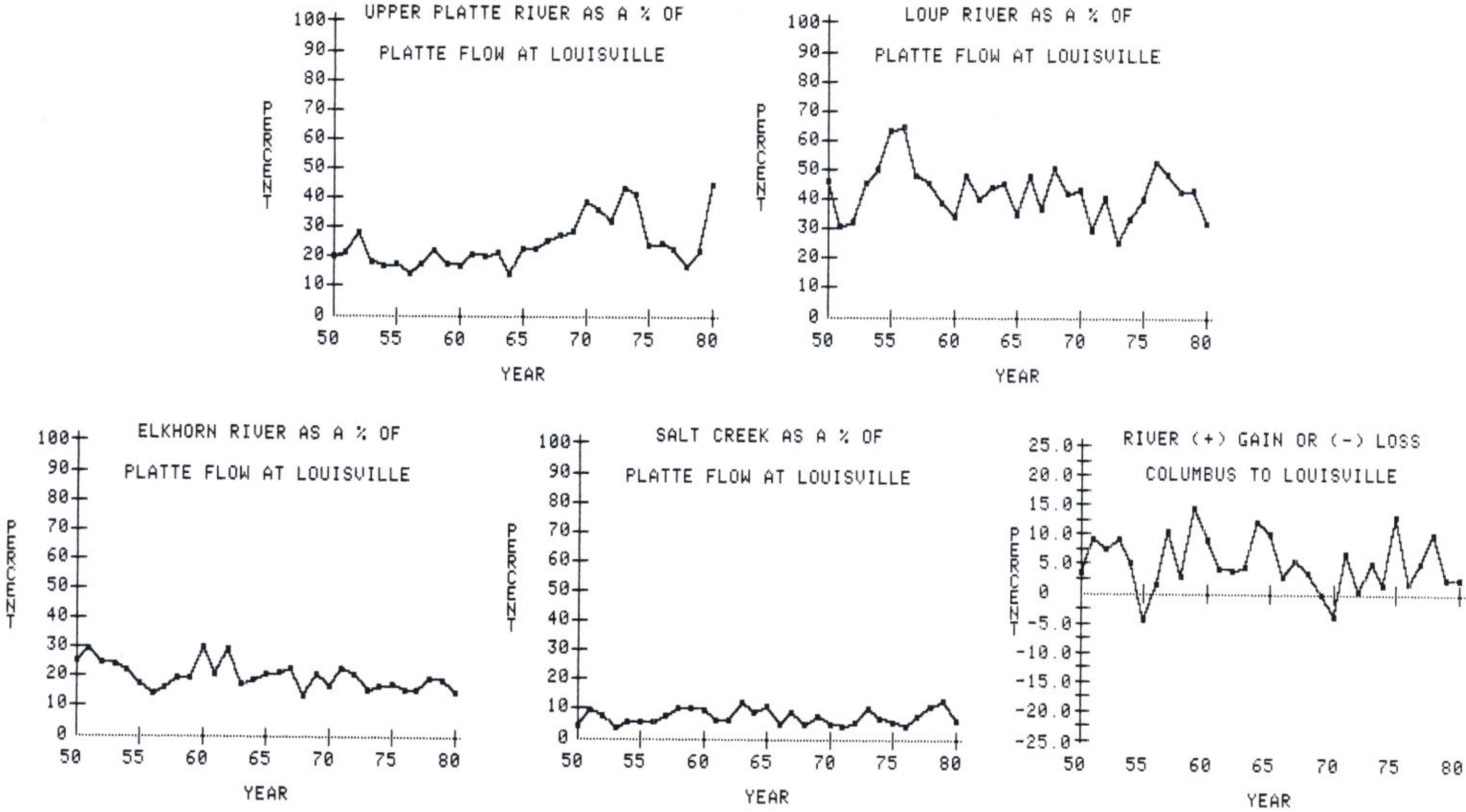
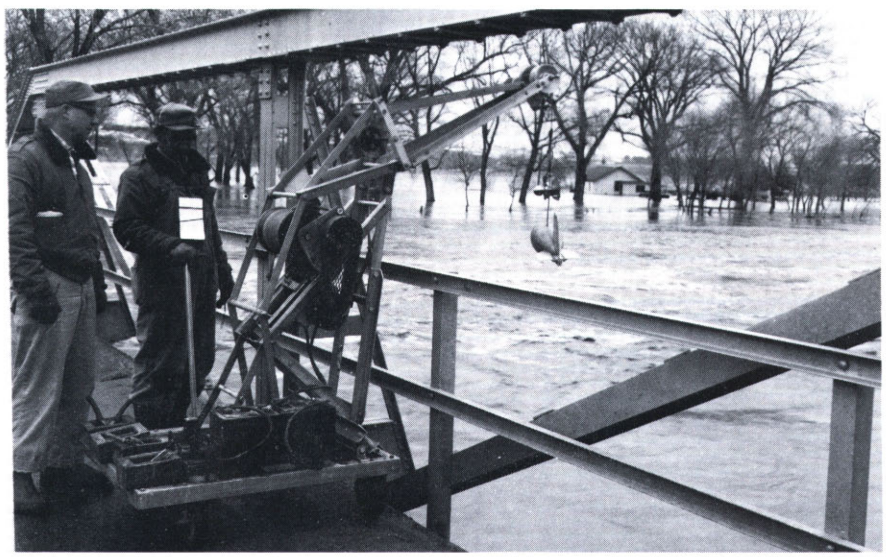


Figure 4

Salt Creek enters the Platte immediately downstream from Ashland. Its average flow for the 31-year period (1950-80) amounted to nearly eight percent of the total Platte River discharge measured at Louisville. The Upper Platte share was one-fourth of the total, while the Loup provided some 41 percent. The Elkhorn, with 21 percent of the total measured at Louisville, supplied nearly as much of the flow as the Upper Platte. Shell Creek, other unmeasured tributaries, and valley ground water contributions supplied an additional six percent. Figure 4 illustrates the relative significance of each component of the total flow in the Platte River at Louisville.



Flood flow (high water) measurement taken in the Elkhorn River at Waterloo. Photos courtesy of USGS.

The amount of annual flow and the relative proportions provided by each basin vary widely from the averages shown in Figures 2, 3 and 4. As can be observed in Table 1, which contrasts historically wet and dry years, the significance of each sub-basin's contribution varies widely. For example, the Loup Basin provided most of the total flow at Louisville during 1956. Although Loup flows in 1973 were greater than in 1956, the more stable-flowing Loup's contribution declined to 25 percent of the total for wet year 1973. During wet years, the Upper Platte has become more predominant. The proportion of the total flow provided by the Elkhorn has been greater during wet years. For the two extremes, the Salt Creek portion of the total varied less than the proportionate share of either the Upper Platte or Elkhorn Rivers. Wastewater return flow from the city of Lincoln contributed to the stability of Salt Creek flows.

Table 1

Flow Distribution at Louisville
During Years of Greatest (1973) and Least (1956) Flow
(1,000's of acre-feet)

Year	Total Flow at Louisville	Platte R. Above Duncan	Loup River	Elkhorn River	Salt Creek	Other Tribs. and Reach Gain or Loss
1973	7,690	3,356 (44%)	1,956 (25%)	1,211 (16%)	772 (10%)	395 (5%)
1956	2,133	300 (14%)	1,384 (65%)	12 (1%)	122 (6%)	315 (14%)

The flow in all three major sub-basins varies throughout the year. Actual monthly flow distribution, especially during low flow times, underscores again the importance of the Loup River contribution to the total flow of the Lower Platte River. The distribution of flow in the Platte River at Louisville during the wettest and driest months for the period of record is shown in Table 2. During August, 1955, when the Platte River at Duncan was essentially dry, the Loup provided more flow to the Platte River at Columbus than was measured in the Platte at Louisville. Evidently, much of the Loup River flow was lost to seepage and evaporation and thus failed to reach Louisville.

Table 2 also demonstrates that the Lower Platte River has been both a gaining and losing reach. During the dry month of August, 1955, the loss was 16,900 acre-feet. During June, 1967, the reach gain amounted to 205,000 acre-feet.

Table 2

Flow Distribution at Louisville
During Months of Greatest and Least Flow
for the Period 1954-1980
(1,000's of acre-feet)

Mo-Yr	Total Flow at Louisville	Platte R. Above Duncan	Loup River	Elkhorn River	Salt Creek	Other Tribs. and Reach Gain or Loss
6/1967	2,168	468 (22%)	523 (24%)	686 (32%)	286 (13%)	205 (9%)
8/1955	32	0 (0%)*	33 (103%)	12 (38%)	4 (12%)	-17 (53%)

* 1 acre-foot was measured in the Platte River near Duncan in August 1955.

In a statistically average year, the largest monthly flow in the Platte River at Louisville occurs during March, while the minimum occurs in August. The greatest variability exists in the discharge of the Upper Platte River. The Loup accounts for a much larger share of the total flow in both the spring and summer. Its more steady flow causes the proportionate contribution to increase in the low-flow month of August. During August less than ten percent of the Louisville flow is derived from the Upper Platte basin. Average flows for March and

August, and the proportions provided by each basin, are depicted in Table 3.

It is important to note that reach loss and gain in the Lower Platte is not purely a condition of water transfer between the river and shallow aquifers. During periods of extensive runoff, tributaries such as Shell Creek can produce a significant gain between gaging stations. Most of the reach gain during normal and wet years comes from surface runoff. During drought years, however, the sandy bed of the river is the most probable recipient of water vanishing between gages. Evaporation and water use demands along the length of the river also consume undetermined amounts of flow.

Table 3

Flow Distribution at Louisville During Months of Greatest and Least Flow (1,000's of acre-feet)

Month	Total Flow at Louisville	Platte R. Above Duncan	Loup River	Elkhorn River	Salt Creek	Other Tribs. and Reach Gain or Loss
March	626	173 (28%)	240 (38%)	125 (20%)	52 (8%)	36 (6%)
August	170	12 (7%)	85 (50%)	48 (28%)	24 (14%)	1 (1%)

Analysis of Historic Trends

Although flow in the Lower Platte River varies both seasonally and annually, long-term changes in annual flow are not evident in the records of the Platte River gages. Figure 5 shows the annual flow at North Bend, Ashland and Louisville. The hydrographs do not show a significant upward or downward tendency.

Figure 6 shows the cumulative annual flow for each Platte River main-stem station within the Lower Platte Study area. Extending back as far as 1930, in the case of Ashland, none of the graphs shows a noticeable break in the long-term trend. Bentall (1982) states that, "If the trend of the line proves to be straight, no change in annual mean discharge is indicated. On the

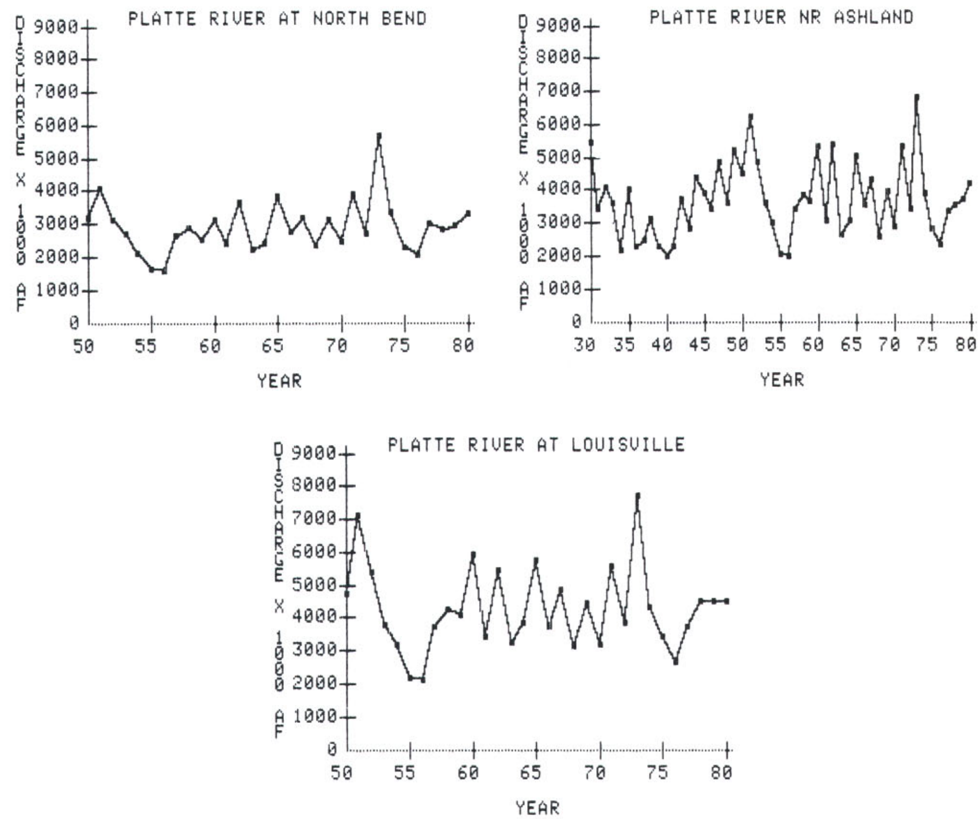


Figure 5

other hand, such a change is indicated if the trend of the line includes a definite flexure or a progressive veering of the graphed line to the right or left". Similar curves developed for the measured inflow tributaries (Figure 7) point out that mainstem flows have remained relatively stable for at least 50 years. The minor fluctuations in the slope of the curves reflect short-term climatic changes between wet and dry conditions.

The Platte River at the Ashland gage. Photo courtesy of USGS.

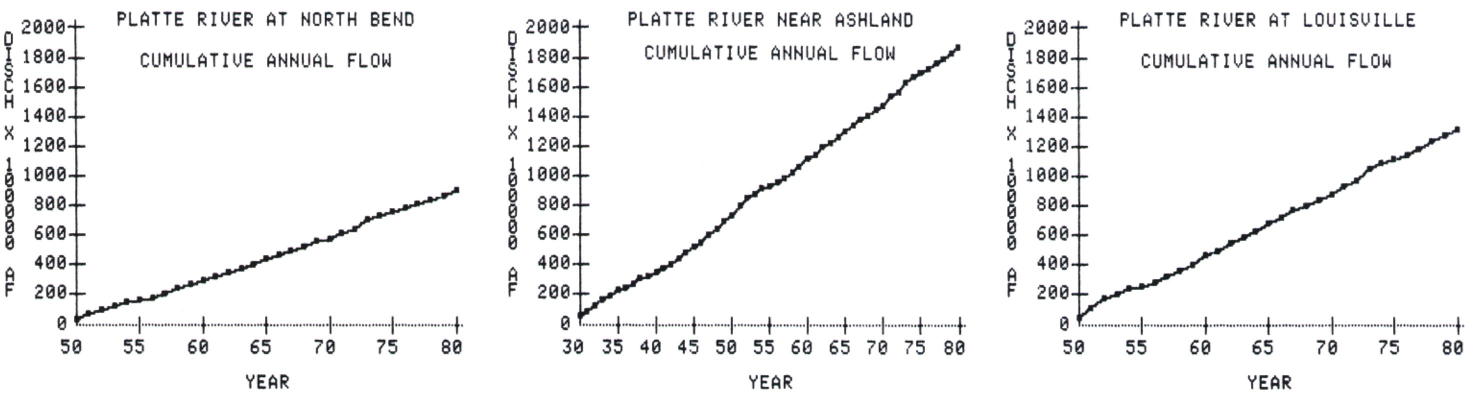


Figure 6

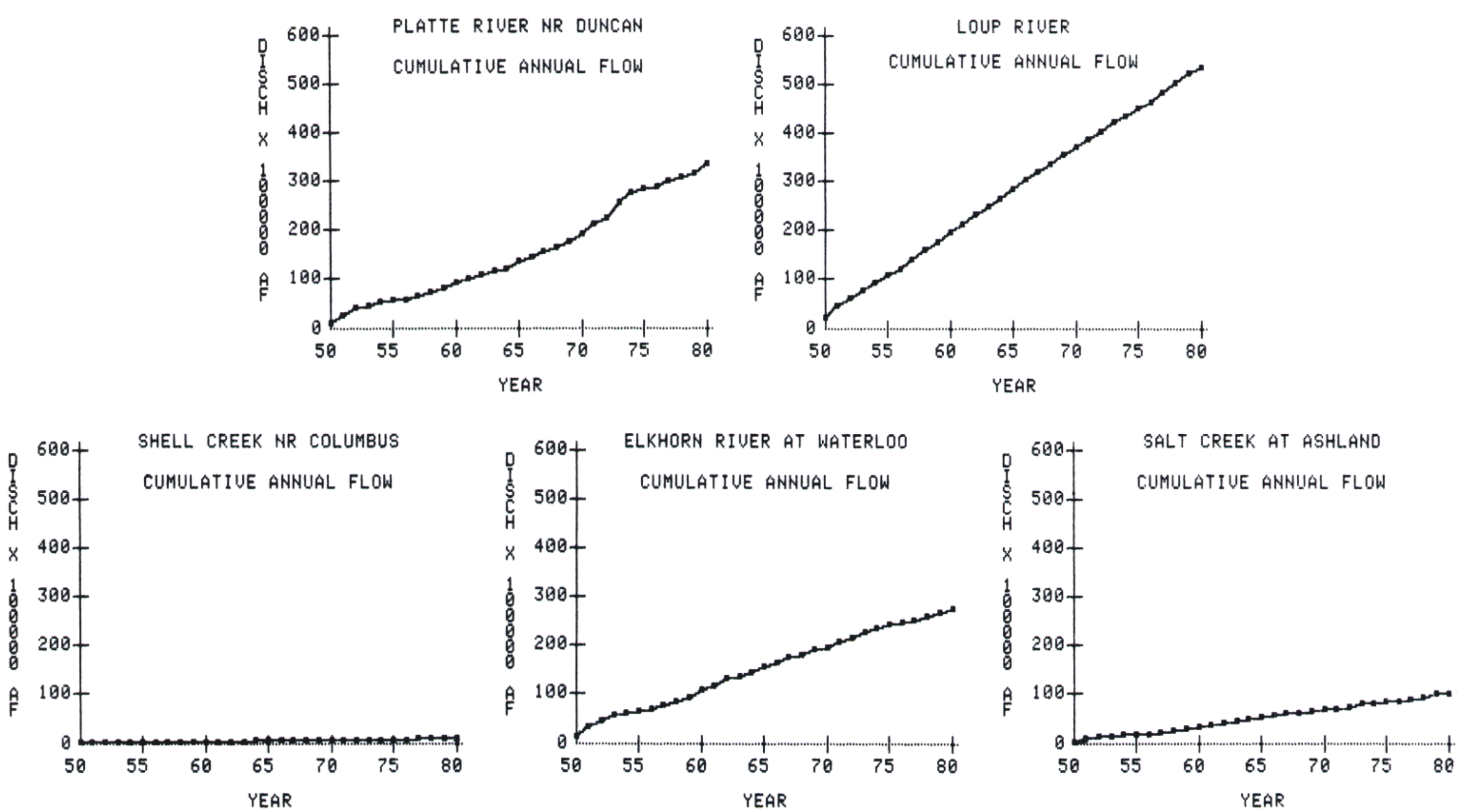


Figure 7

Water Supply Demands

Most of the water consumed by municipal and industrial water users along the Lower Platte valley is obtained from the river through induced recharge to ground water wells. Induced recharge is the process by which water withdrawn from wells near a stream is replaced by stream water filtering through the porous sands and gravels of the flood plain. In effect, well fields relying upon induced recharge are thus able to obtain a steady supply of filtered river water. In the Lower Platte valley, the shallow sand and gravel aquifer is capable of supplying wells during periods of low flow or even short-term dry river conditions.

Stream flow records gathered during the past half-century show that the Platte River, downstream from the mouth of the Loup River, has always carried substantial quantities of flow, even during drought years. In fact, minimum flows in the Lower Platte River greatly exceed demands. For example, the minimum monthly flow for the Platte River at North Bend was 23,400 acre-feet in July, 1974. This quantity is substantially greater than the pumping demand of Fremont's downstream municipal well field located along the river southeast of the city. By comparison the Fremont Platte River well field's pumping rate has amounted to only several hundred acre-feet per month during recent high-use summers.

Downstream at Lincoln's well field, located parallel to the river southeast near Ashland, the same holds true. Minimum monthly flow in the river at Ashland has always exceeded the maximum monthly pumping rate from the well field. The largest monthly withdrawal from the well field was 5,850 acre-feet during July, 1974. This figure compares with the minimum monthly flow of 28,020 acre-feet during August, 1955.

A comparison using two and three consecutive month's minimum river flows at the Lincoln well field is less extreme than the one-month comparison. The maximum two-month pumping demand amounted to 10,390 acre-feet in July and August, 1974. This quantity is equivalent to 13 percent of the minimum two-month Platte River flow of 80,500 acre-feet for August and September, 1955. The largest three-month pumping rate of 14,200 acre-feet for June through August, 1974, amounted to only 8 percent of the lowest three-month river flow of 174,100 acre-feet for July through September, 1976.

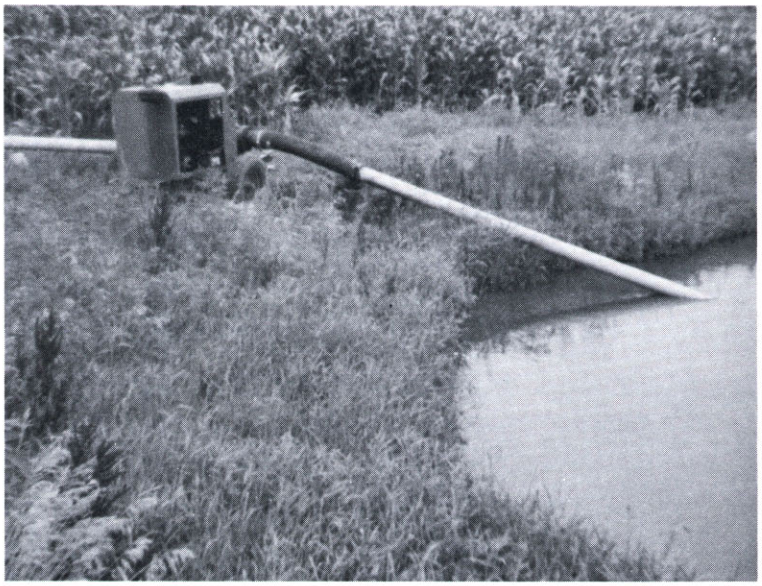
Two other major well fields are located along the lower Platte River. They are Omaha's Metropolitan Utilities District (MUD) well field and the Allied Chemical Company well field. Both are located near LaPlatte, downstream from Louisville. A comparison of the maximum monthly withdrawals by these well fields, and the minimum monthly river flow at Louisville, reveals findings similar to those at the Fremont and Lincoln well fields. The sum of the largest monthly pumping rates by the two well fields is approximately 6,760 acre-feet. This figure is roughly 21 percent of the minimum monthly flow of 31,930 acre-feet recorded at the Louisville gage. It should be noted that these extreme values did not occur simultaneously. The minimum river flow occurred in August, 1955, while the maximum monthly withdrawal by MUD occurred in July, 1974. The largest reported withdrawal by Allied Chemical Company occurred in June, 1980. An examination of well field pumping rates and river flows for two and three-month durations yields results similar to that found in the case of the Lincoln well field.

In addition to the water used by the four major well fields, small quantities of flow in the Lower Platte River are used for irrigation and other uses. Those amounts are negligible compared to the municipal and industrial uses, and are too small to be detected by the river gages.

Conclusion

The flow in the Lower Platte River is composed of inflow from several major sources. Between Columbus and the Platte's confluence with the Elkhorn, the Loup contributes roughly three acre-feet of water for every two acre-feet contributed by the Upper Platte. Downstream from the Elkhorn, the ratio is roughly two to one to one for the Loup, Upper Platte and Elkhorn, respectively.

There should be little concern that the Platte River will be unable to supply the demands placed on it within its lower reaches in the foreseeable future. There are several reasons for this optimistic assessment. River flows have and will likely continue to exceed demand. Despite periodic ups and downs the total supply of the Lower Platte River gives no indication of long-term, progressive depletion. Dry periods often have been followed by strong recovery. Total loss of Platte River flow as a source of water supply downstream from Columbus would require a catastrophic drought of greater magnitude and duration than those which have occurred during the period in which records have been kept.



Pumps taking water from the river for irrigation.

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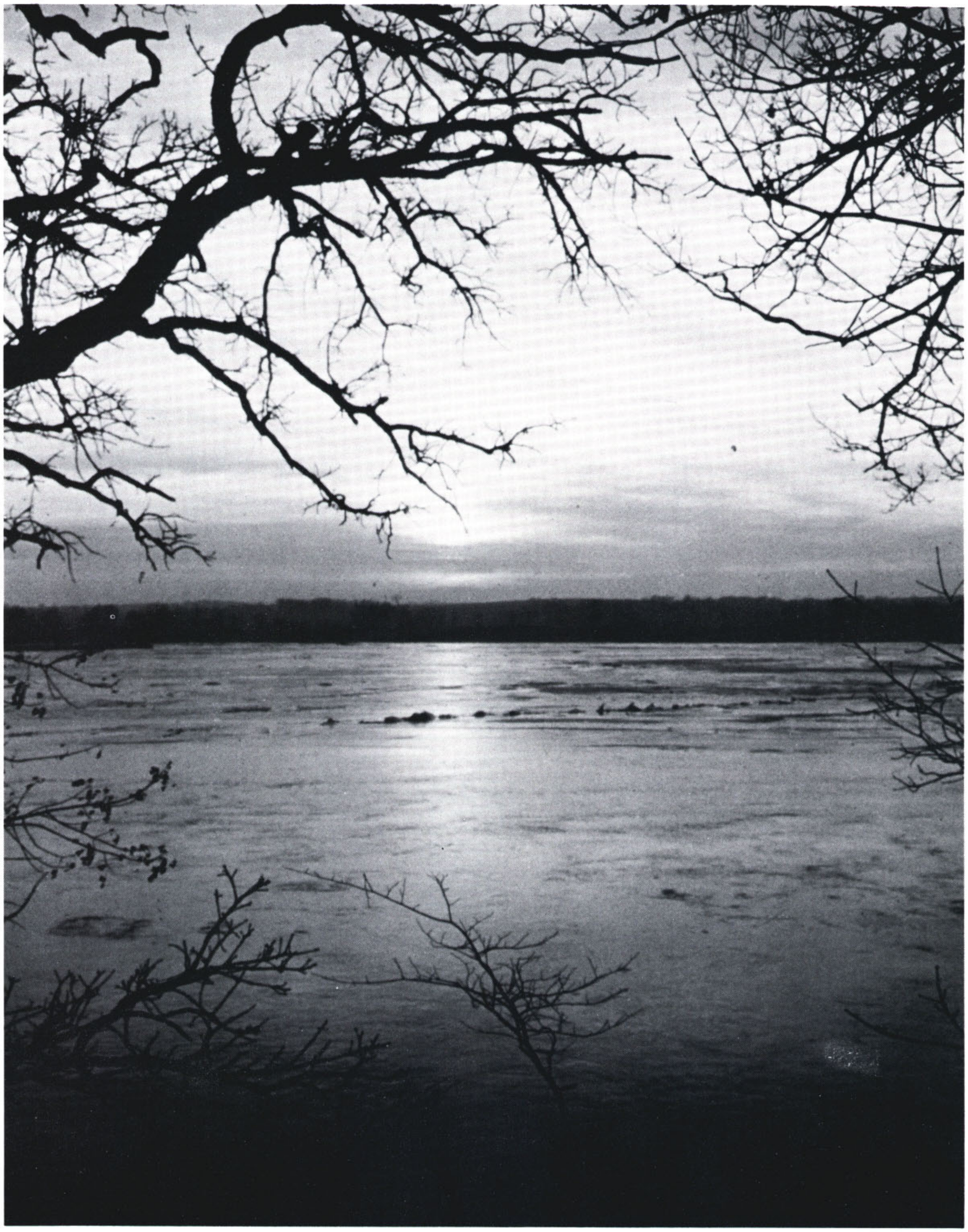

Sunset on the Platte River at Schramm Tract, Sarpy County. Photo courtesy of the Game and Parks Commission.