HYDROLOGY OF GLACIAL LAKES, FORT SISSETON AREA

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ABSTRACT

The "Glacial Lakes" area in Marshall and Day Counties in northeastern South Dakota contain hundreds of depressions in close proximity to each other. They are glacial kettles. Many are dry most years, but some contain ephemeral lakes and some contain perennial lakes up to several square miles in area. Most of this area is internally drained during typical years.

In 1995 many depressions filled up due to above-average precipitation. From 1995 to the present time (January, 1998) the lakes in the Fort Sisseton area have been overflowing one into another, finding an outlet at the western edge of Cattail Lake at an elevation of 1792 ft above sea level. The water then flows into Crow Creek and thence into the James River. This has happened only one time in recorded history, during the year 1916. The unusual flooding pattern being experienced during the last 4 years has caused hardships to local farmers who find their hay fields submerged. Numerous roads have been closed, and litigation over responsibility for the flooding is ongoing.

INTRODUCTION

The Prairie Coteau was formed as continental glaciers repeatedly advanced into South Dakota and Minnesota, dividing into two lobes by a drainage divide that existed between the present James River Valley and the lowland to the East. The Dakota Lobe extended down into South Dakota, following the present James River Valley, and the Des Moines Lobe extended down the present Lake Traverse region into Iowa. Lateral moraines accumulated in the area of the division of the glacier, forming the hilly land known as the Prairie Coteau (Koch, 1975; Rahn, 1975).

As the last of the glaciers melted approximately 20,000 years ago, blocks of ice left within the moraines melted, leaving depressions known as kettles. Small kettles are locally called potholes. Today many swamps and lakes in this area fill the depressions, occupying a single kettle or coalescing kettles. Figure 1 shows that the drainage basin that includes Fort Sisseton has a high density of kettles. Some of the larger lakes, such as Roy Lake, are not simply one large kettle, but were formed by constructional morainal development as well.

Inspection of topographic maps (Figure 1) indicates at first glance that most of the Glacial Lakes area has internal drainage. The land immediately adjacent to a typical kettle slopes into it and there is seemingly no outlet. But in extremely wet years, the kettles can fill up with water, and then overflow to adjacent kettles and lowlands. Some of the kettles probably have never filled up since they were formed some20,000 years ago. In 1995 an unusually wet spring led to the filling of numerous kettles in this region, and the lakes began to coalesce into a giant complex and they finally spilled over to Crow Creek and thence into the James River and into the Missouri River.

HYDROLOGY

The average annual precipitation at Britton, the county seat of Marshall County, was 18.81 inches as of 1995 (NOAA, 1995). This amount of precipitation is normally sufficient to produce some standing water in only the deeper kettles.

The annual precipitation in Britton was 5.55 inches above normal in 1994, 7.45 inches above normal in 1995, 0.89 inches above normal in 1996, and 0.87 inches above normal in 1997 (NOAA, 1996-97). During the early summer of 1995, heavy rains filled the many depressions to the point where they began to overflow. [A tremendous volume of water is necessary to accomplish this, because the elevation of the bottom of the Cattail Lake kettle complex is approximately 1782 ft, based on the USGS 7.5 minute topographic maps, and the elevation of the water surface at its maximum depth over the Cattail Lake complex was about 1794 ft.] The order of filling in this region was from northeast to southwest, so that Buffalo Lake overflowed into Red Iron Lakes, and thence to Clear Lake, Roy Lake, Lost Lake, Kettle Lake, and finally Cattail Lake. Ultimately the water reached an outlet along the western shore of Cattail Lake, and on July 19, 1995, began flowing westerly off the Prairie Coteau. This outlet, formerly an unnamed slough, is now referred to as Cattail Creek. From July 19, 1995 until present (January, 1998), water has discharged continuously out of the Cattail Lake complex, except for the period January through March, 1997, when Cattail Creek froze up (Dan Hook, pers. comm., January 2, 1998). Cattail creek gradually increases in gradient westerly as it descends off the Prairie Coteau, ultimately descending into Crow Creek at Hickman Dam (Figure 1).

Figure 2 shows the high waters surrounding Fort Sisseton State Park. Mallard Slough is shown as a perennial lake on the USGS 1:24,000 scale topographic map, but Fort Lake is shown simply as a lowland swamp. In this 1996 photo, both depressions are completely full of water, and flow into and are merged with the Kettle Lake/Cattail Lake complex. Figure 3 shows the same depressions during the normally drier conditions which existed in 1975. Note the absence of Fort Lake.

Figure 4 shows the County Road #5 crossing of Cattail Lake. This location is close to the outlet of the Cattail Lake complex as it existed om 1996. There is a culvert under the road at this location, and the operation of it was a factor in a

litigation brought about by landowners who claimed their lands were being inundated to some degree by roads constructed by the County Highway Department (Steiner et al. vs. Marshall County, South Dakota Supreme Court, 1997). The areas covered by water in Figure 4 are shown as hayfields in 1975 photos (Figure 3).

FLOODING FREQUENCY

Figure 5 is a detailed topographic map of the Cattail Lake and surrounding areas. The ground elevation of fhe outlet of Cattail Lake is 1792 ft above sea level. Outlined is the shoreline of the Cattail Lake complex based on the water surface elevation of 1794 ft. Waters remained at approximately this level from 1995 through 1998. Local residents do not recall the Cattail Lake complex filling ever before, although it reportedly did occur in 1916, the year the U.S. Soil Conservation Service (Schultz, 1975) reported as the wettest year in 54 years of record.

Fort Sisseton was built in 1864, and most likely was founded at this site for the natural protection from Indian attack that was afforded by the surrounding lakes. Thus Fort Lake, Mallard Slough, and the Kettle Lake/Cattial Lake complex were probably full at that time.

From the above data, the frequency of inundation can be roughly deduced. It can be assumed that the lakes were full in 1864, then dry for 52 years until 1916 when it filled then dry again for the following 79 years, then full during the past 3 years. Thus the cycle is roughly that of 2 years full, with water discharging to the James River, followed by 65 years of internal drainage.

CONCLUSION

The Glacial Lakes area of the Prairie Couteau area is unique in that it is one of the few areas of the Midwest that lacks external drainage. The surrounding areas are drained by stream systems, generally flowing off the Prairie Coteau to the west, north, and east. To the south, the headwaters of the Big Sioux River extends to near the town of Waubay Lake, about 10 miles south of the drainage of the Cattail Lake complex shown in Figure 1. But the exceptionally wet years of 1994-98 show that the Glacial Lakes can fill up and overflow to an external drainage, in this case via Cattail Creek to Crow Creek and thence into the James River. In the future geologic time, perhaps as little as 10,000 years, the gradient of Cattail Creek will probably increase as it erodes a channel coming off the Prairie Coteau into Crow Creek. It would then cause the outlet of Cattail Lake to be eroded below 1792 ft, and thus eventually integrate the Cattail Lake complex from a quasi-internal drainage to a more normal stream/lake system connected to the James River.

Flood damage to eastern Soiuth Dakota during the wet years of 1995 to 1998 was severe. Damage during 1996 alone reached an estimated $46 million during the paralyzing blizzards and spring floods (Figure 6). Watertown was one of the

communities most severely impacted by flooding as the Big Sioux River spilled over its banks. The high precipitation of 1994-98 caused hardship to the farmers in the Glacial Lakes area who owned hayground in the bottom of kettles which are usually dry. The outflow from the Cattaiil Lake complex into Crow Creek added to the misery of farmers in the James River valley who were already being flooded by the James River. The total lost productivity and road damage is difficult to assess.

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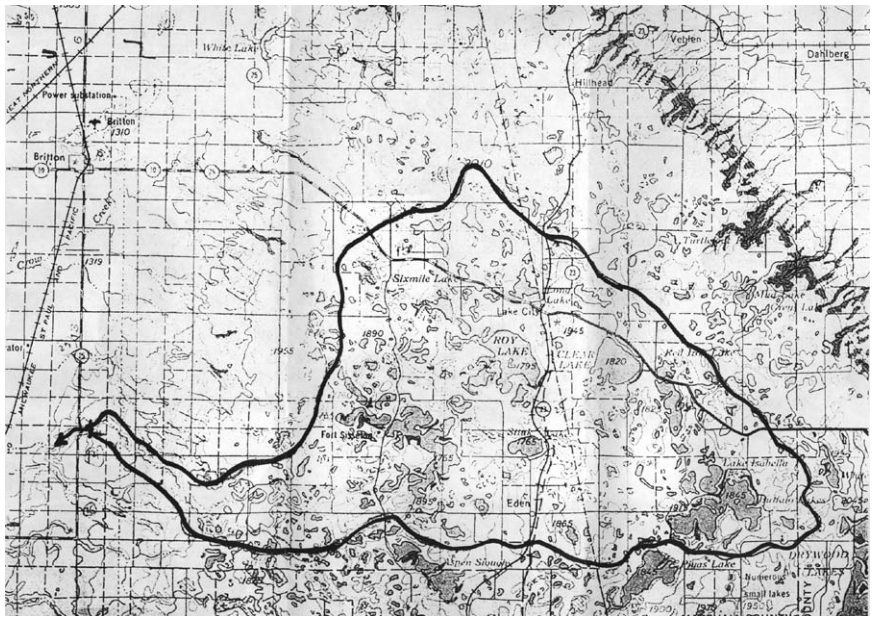

Figure 1. Topographic map of part of the USGS Milbank quadrangle, South Dakota, originally at 1:250,000 scale. The drainage basin of Crow Creek above Hickman Dam is outlined, representing an area of 170 sq. miles.

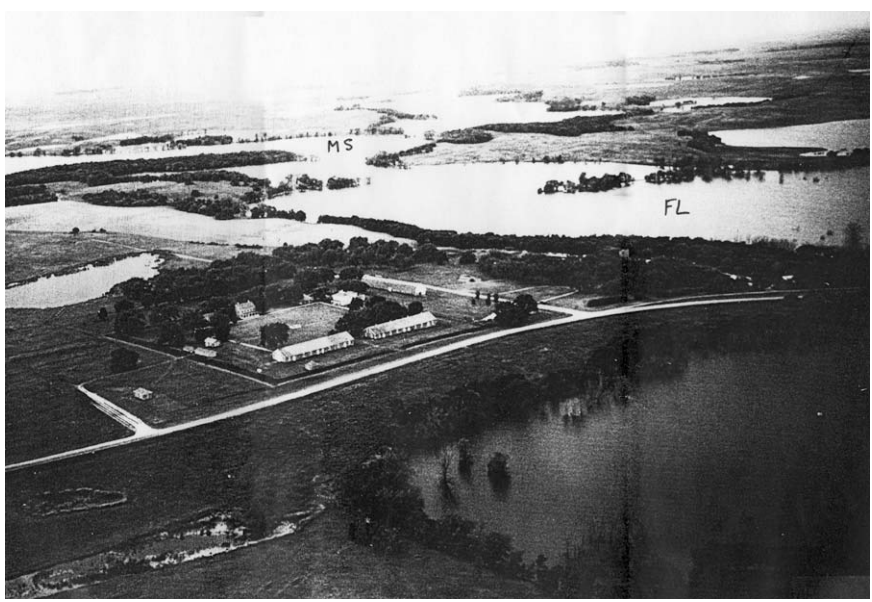

Figure 2. Oblique aerial photograph of Fort Sisseton, looking northwesterly. "Fort Lake" (FL) and "Mallard Slough" (MS) are full of water at the time of this photograph, July 17, 1996.

Figure 3. Vertical aerial photograph of Fort Sisseton area. The soil unit abbreviations are explained by Schulz (1975). "FS" is Fort Sisseton. "OL" is the outlet of the Cattail Lake complex. Fort Lake is dry at the time of this photograph (1975), but Mallard Slough has some water in it.

Figure 4. Oblique aerial photograph of Cattail Lake, looking westerly. This photograph was taken on July 16, 1996, and shows the lake has nearly submerged County Road #5. The outlet (Cattail Creek) is shown as "OL".

Figure 5. Portion of several USGS topographic maps, originally 1:24,000 scale. The Cattail Lake complex is shown, based on a 1794 ft. elevation from published contour lines. "OL" is the outlet from Cattail Lake.

Figure 6. County Road #16, approximately 3 miles west of Lake Eden. This July 17, 1996 photograph shows the road submerged by an arm of Cattail Lake.