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A Historical Geography of Lake Kampeska in the City of Watertown, South Dakota

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"Never forget that a small group of thoughtful, committed citizens can change the world. Indeed, it is the only thing that ever has."

Margaret Meade

ABSTRACT

Many alterations in the hydrology of Lake Kampeska began with the arrival of masses of Anglo settlers in the 1870s. Why the lake has been altered is a complex issue linked to various natural physical processes which would have occurred even without the introduction of those settlers into the ecosystem. Those processes include weather, climate, sedimentation rates, lakebank erosion, chemical and mineral transport from soils, and flooding, among others. Besides those natural physical processes, mankind's cultural processes have been at work. Disturbances in the lake's hydrology are linked to land use changes associated with cultural values, such as the introduction of agriculture and the expansion of Watertown's urban setting to include the nearby lake. Perceived water shortages, concerns about water quality, and the need for flood control have caused federal, state, county, and city officials, as well as concerned citizens, to search for answers. They are grappling with the ramifications of a slowly evolving ecosystems approach, collecting data to increase their base of knowledge about the complexities of the system, attempting to provide better management of the lake, and providing educational information to promote a sustainable ecosystem through appropriate change. In creating an historical geography, I analyze Lake Kampeska based on (1) its past land and water use history, including my lifetime of experiences at the lake, information obtained about the lake in oral history studies as Director of the Codington County Historical Society in 1975 and from 1982 through 1997, as well as the photographic record through time; (2) a look at a portion of the scientific knowledge base, relevant to lakes and rivers in general, searching for key concepts which could be used for education of the general public concerning this lake's future; and (3) summaries of four major scientific reports concerning the lake in 1971, 1994, 2000, and 2002.

CHAPTER 1

CONTENTS

INTRODUCTION

Whose Lake Is It?

Lakes and rivers around the world face many of the same problems as Lake Kampeska and the Big Sioux River. I was born and raised at Watertown, South Dakota and spent much of my life at Lake Kampeska and along the Big Sioux River. While they constitute my town and my lake and my river, in the larger view, they represent all hometowns, all lakes, and all rivers.

Why should anyone care? In short, a healthy and sustainable environment is in everyone's best interests. The best hope for the future seems to be in using an ecosystems approach, in forming a widened knowledge base, and through local, state, national, and international cooperation (Micklin 1996: 285). Some scientists recommend an interdisciplinary approach in regional research in order to understand linkages between physical and social components of the ecological system (Carpenter, et al. 2007: 334). Others encourage the input of social scientists in identifying "economic and social drivers" resulting in hydrological change (Eshleman 2004: 13-25). It is important to understand that land use change can and has created ecosystem responses, some of which are intended and direct, while others are unintended and indirect (Asner, et al. 2004: 337-39). William L. Graf, a former president of the Association of American Geographers, emphasized physical integrity for river systems with a "focus on change rather than equilibrium as a defining characteristic of streams." He favors "probabilistic rather than exclusively deterministic approaches. . . [with] . . . geographic representedness through hydrodiversity, geodiversity, and biodiversity" (2001: 1). Such systems thinking may be critical advice for science and for water managers.

There is a role for everyone to play, since we are all stake holders. Education of the general public and of the media is crucial in encouraging social change which is needed to encourage a view of interrelated world systems. That is what ecology is all about, the total system. Thus, all of the hard data from the physical sciences, by itself, will never save our rivers and lakes. Changing people's attitudes might. That is why social scientists need to play a larger role.

Simply looking at the data of physical science, concluding that urbanization has brought change, but that the majority of the pollution and degradation of Lake Kampeska comes from flawed agricultural practices, has not worked very well from a purely practical standpoint. The historical record shows that there is plenty of blame to go around. Those who live at the lake might continue their efforts to reduce the chemical load they introduce into the lake. There needs to be abundant media attention and public education showing that lake residents are making that effort. The installation of sewer and water around the lake in the 1970s was a good start. However, when I drove around Lake Kampeska on October 7, 2007, I could not help but wonder why anyone who really cares about the lake would continue to spray weed chemicals on his lawn, as I saw one resident doing. Those who live around the lake might consider leading by example, before asking farmers to change their long-entrenched practices.

Many people who live in and around Codington County understand the polarization between many lake residents and the local farmers whose behaviors they want to change. Scientific reports about the lake do not mention the feud that has been going on for decades between farmers in the watershed around the lake and those whose interests are more directly tied to the water quality in Lake Kampeska, particularly those who live at the lake. Official government studies generally lack input from local farmers, and they lack perspective from social scientists and from scientists who bridge the physical and social sciences. I wondered, as I read the reports, that if the objective was to convince government agencies to provide financial "incentives" to get farmers to change; was it simply to legislate farmers into compliance; or was it something else? They never suggested specifically making farmers part of the planning process. To my knowledge, no one reviewed how those farmers feel about the process and what they think should be done.

While farmers' attitudes may seem irrelevant and almost ridiculous to physical scientists and economists who see the problem in rather concrete terms, there is good reason to include farmers. Since ninety-eight per cent of the land in the Upper Big Sioux Watershed is privately owned (USDA 2000, 17), those considerations need to be part of any plan. While the USDA 2000 report quantifies many logical reasons why their suggested practices should be employed, and it estimates how much economic benefit it would provide, it is unclear about who would pay the dollars necessary to improve the system (37-41). If scientific reports for Lake Kampeska include changing farmers' attitudes under the heading of "public education" or "public input," success could be a long way off. Farmers in the Upper Big Sioux Watershed can be particularly prone to skepticism when a simple drive around the lake provides many examples where lake dwellers need to be responsible for their part in negatively impacting the hydrological system. For those who look at the hard data and conclude that most of the problems today are the result of inappropriate farming practices, it remains important for Watertown, particularly for lake residents, to lead by example and friendly cooperation. To do otherwise would only increase polarization, in my view. There is no denying that there are decades of hard feelings between the two groups, and those need to be overcome.

There is also a role for others to play in changing cultural attitudes. A look at the American psyche may be relevant (Graf 2001: 1, 24). If one looks at the impact of artists, song writers, film makers, and poets in the United States in the last sixty years, it seems probable that they have profoundly affected attitudes. They have played a role in race relations, the peace movement, the "green revolution," and the need for healthy rivers and lakes. For each person, there is a unique mix of information and experience which drives their social attitudes.

In my particular case, Lake Kampeska has been a part of my life since I was born in Watertown in 1947. Lake Kampeska is the place of my youth where I return in my mind's eye when I need to relax. What I remember, of course, is idealized and is a far cry from the reality of today's urbanized environment. Still, I want the best for a lake which I care about deeply—so deeply, in fact, that I may not have the objectivity necessary to write a truly good historical geography. Lake Kampeska is a part of me, and I am a part of the lake. One of my favorite photos of my early life shows me at age one, clad only in a diaper, sitting with a family group in shallow water at the lake. From 1947 through 1997, our family spent parts of most summers at our cabins at the lake.

As a youngster, I wrote a poem about the lake. I still send handwritten copies of it to my sister, Mikki, on Valentine's Day. I never forgot a line of poetry in a dusty book of works by a South Dakota poet of some importance. The particular line was something like, "My father's the western sky; my mother's the Coteau Prairie." Long after I had forgotten the book's title or the author of the poem, that line stuck in my mind. Since I was too young to understand the concept of plagiarism, I wrote my own poem, quite inappropriately "borrowing" that poet's single line. As I have written this research paper, the poem was never far from my mind. It has made me want the best for the lake, and it has caused me to tell the lake's story, even at the risk of annoying some of those about whom I write. The following is my youthful poem, with its loaned line. It has been my particular "social driver."

Just Mikki and Me

by Joanita Kant

I asked beautiful Lake Kampeska,
"How is it that you came to be?"
She said, "My father's the western sky;
My mother's the Coteau Prairie."

"Oh what then is this fascination,
That makes me long so for you?"
"You well remember your childhood here.
Think of it and you'll find the clue."

We'd toss out our line.
The engine would whine.
I remember just Mikki and me.
We'd soar and we'd sail;
We'd row and we'd bail,
Pretending that we were at sea.

We'd toss and we'd dive.
Gale winds we'd survive.
I remember just Mikki and me.
Oh, the days were divine,
When I had turned nine.
I remember just Mikki and me.

CHAPTER 2

GEOGRAPHY: WHAT IS IT?

Historical Geography of Lake Kampeska

Historical geography is the study of changing geographical landscapes through time, encompassing both anthropogenic and non-anthropogenic causes. In *The Geography of South Dakota*, Edward Hogan and Erin Hogan Fouberg wrote that physical geography is a physical science, and cultural geography is a social science. Thus, it bridges physical and social sciences. "Geography is study of the earth as the home of humankind" (1998, 3). Geographers generally identify place, location, and the concept of region. They analyze the give and take between mankind's culture with both the physical environment and with place (1998, 3). Cultural geographers often look at these five themes: (1) location in terms of culture regions [characterized by one or more common traits: often formal, functional, or vernacular], (2) cultural diffusion [the movement of people, ideas, or materials], (3) cultural ecology [how humans have adapted to or changed the environment], (4) cultural interaction [how one aspect of culture influences another], and (5) cultural landscape [all the built forms that cultural groups create] (Jordan-Bychkov, et al. 2006, 5-25).

In this case, the place is Lake Kampeska. The location is within the city of Watertown, in Codington County, South Dakota. The relatively homogeneous vernacular region is the "Glacial Lakes Region" of northeastern South Dakota in the agricultural corn belt in the eastern half of the state. In reality, these designations are simply for convenience, since Lake Kampeska could be categorized in many ways. In order to gain a better understanding of the overall geographic picture of Lake Kampeska, it is instructive to define the physical environment and then to journey through time, observing and learning from mankind's cultural interaction with the physical environment and from mankind's cultural interaction with place.

Physical Environment

Lake Kampeska, part of the Upper Big Sioux River drainage basin, is one of many glacial lakes in northeastern South Dakota within a subdivision of the Central Lowlands Province of the Interior Plains of North America (Hogan and Fouberg 1998, 14). Glaciers ground over the region, the last of which receded about 10,000 years ago. The lake had its beginnings as the result of melting glacial ice near the end of the Pleistocene Era, formed by two lobes of the Wisconsin glacier (Hogan and Fouberg 1998, 12-17; USDA 2000, 52). In common parlance, it is an “ice block” lake. A tributary of the Big Sioux River, Lake Kampeska acts as a sink or sediment trap, particularly during periods of high flow. Flowing south, the Big Sioux River is a tributary of the Missouri River. In turn, the Missouri River is a south flowing tributary of the Mississippi River which eventually includes the flow of thousands of small drainage basins.

My article specifically concerns only the Upper Big Sioux Watershed, mostly including Watertown and areas north, since my focus is Lake Kampeska (Appendix A, Maps). The entire Big Sioux Watershed includes a much larger area drained by the Big Sioux River. The river extends from its source in Roberts County near Summit, South Dakota, to its mouth, a narrow delta region near Richland, South Dakota in Union County in the southeastern corner of the state, to the confluence with the Missouri River near Sioux City, Iowa.

The glaciation of eastern South Dakota formed the Coteau des Prairie or Prairie Plains, a plateau drained by the Big Sioux River. Thus, the topography of the coteau, including the character of the soil, sand and gravel deposits, potholes, creeks, rivers and lakes, are the result of glaciation during the Pleistocene (Hogan and Fouberg 1998, 16-17, 63).

The climate of Codington County is humid continental. With about twenty-two inches of annual precipitation, Watertown has had all-time high and low temperatures of 110 degrees F and -40 degrees F (1998, 37-39). Soils are Chernozem, some of the most fertile in the world. The bedrock is mostly Pierre shale in the study area for this article (1998, 16).

The Upper Big Sioux River Watershed and the Big Sioux Aquifer dominate official studies about Lake Kampeska (Appendix A, Maps; and Appendix B, Summaries of Four Studies). The Upper Big Sioux River Watershed, which drains into the Big Sioux River and Lake Kampeska, plays a major role in the hydrology of Lake Kampeska. The Big Sioux Aquifer, in a complex system including the Prairie Coteau Aquifer, the Lonesome Lake Aquifer, the Altamont Aquifer, and the Dakota Aquifer are beneath parts of the watershed (USDA 2000, 53-54). The Big Sioux Aquifer and the Prairie Coteau Aquifer are particularly vulnerable to contamination because they are shallow in some places (USDA 2000, 54).

Lake Kampeska's water levels and water quality are affected by surface water runoff in the watershed, groundwater availability in related aquifers, annual precipitation, and evaporation. In addition, other considerations include siltation levels, flooding patterns, slumping of the lake bank, and chemical composition caused by the dissolving of naturally occurring substances. Other aspects of the physical environment (which cannot be totally isolated from the impact of culture) were detailed in the USDA 2000 report of Lake Kampeska (Appendix B).

Cultural Environment

When large numbers of people and their culture entered the scene, water and land use patterns changed. Thus, also linked to Lake Kampeska's water levels and water quality are the impacts of agriculture, urbanization, business, and industry.

Agriculture dominates the economics of the state. Lake Kampeska is in Codington County. The predominant crops in Codington County are soybeans, corn, other small grains, and alfalfa. In addition, there are significant numbers of cattle (mostly cow-calf operations and feedlots), as well as hogs and dairy operations (Hougan and Fouberg 1998, 89-108). Agricultural impacts in other counties in the Upper Big Sioux Watershed vary only slightly from that pattern.

Lake Kampeska is within the city limits of Watertown, the fifth largest city in the state. The year 2000 population in the Upper Big Sioux River Basin (about 383 square miles in Roberts, Grant, Day, and Codington Counties) was about 19,000. Most of that population was within the city limits of Watertown

(USDA 2000, 1). The city has a fairly diverse economic base. Some of the largest employers include two industrial parks, service and retail industries, the school system, and a medical complex.

Since about one-third of the state's population, including Watertown, is located in a tier along the Minnesota border, the city is positioned for growth (Hogan and Fouberg 1998, 170). Watertown's transportation system includes both Interstate Highway 29 and Watertown Regional Airport, which provides accessibility.

The city has traditionally pumped water from the lake for municipal purposes. In 2000, about thirty to forty per cent of their water supply was from Lake Kampeska (USDA 2000, 36). In addition, the city relies on wells northeast of the lake. Currently, the city plans more wells near Rauville, South Dakota, north of Watertown in a relatively protected area (personal communication Watertown Municipal Utilities, October 2007).

It is instructive to see how the lake and land use patterns have changed through time. There are physical laws which govern the sustainability and health of the lake, as well as cultural impacts. Systems and patterns emerge when the interaction of elements, such as populations, economics, governments, and land use patterns change through time (Graf and Gober 1992, 234-35). Although difficult to implement, that is why there are advantages, in a regional, interdisciplinary, comparative approach in understanding physical and social linkages in an ecological system (Carpenter, et al. 2007, 207-334).

CHAPTER 3

LAND AND WATER USE CHANGE THROUGH TIME

American Indians

Kampeska is a Dakota Indian word meaning "shining shells," in reference to bivalve shells found along the shores of Lake Kampeska. It is unlikely that prehistoric and historic American Indian populations produced much change in the hydrology of Lake Kampeska. There is evidence of prehistoric American Indians at the lake, such as the burial mounds at Stony Point and the occasional projectile point or potsherd found in gardens around the lake, but many such sites have been destroyed in the process of urbanization. There are also identified prehistoric sites north of Lake Kampeska in the Big Sioux watershed, some near the spot where a retention dam was planned but never built.

Historians have noted the use of Lake Kampeska by the Yanktonnais Sioux, particularly the band of Chief Drifting Goose, as well as the Santee from the Sisseton-Wahpeton Reservation, the borders of which touch Lake Kampeska near the inlet-outlet of the Big Sioux River (Kant, et al. 1987, 1-3). The prehistoric and historic Indian population numbers were small, and their activities were sustainable for a healthy ecosystem. Thus, they are not the subject of my research.

Before Widespread Settlement

Soon after the early trappers, traders, and military men entered Codington County, the enormous buffalo herds quickly declined in numbers. The landscape was a sea of grassland as far as the eye could see. The prairie grasslands were nearly treeless except along waterways. Lake Kampeska's riparian habitat included native species of trees, shrubs, grasses, and other flora. Natural processes caused moderate siltation and changes in nutrient levels in the lake. When the Big Sioux River was at flood stage, water surged into Lake Kampeska at the inlet-outlet, but much of it was dispersed into wetlands around the lake, and there was lateral drainage overland, particularly to the north, east, and south. In this natural river ecosystem, wetlands and riparian habitat helped to slow the flow, to decrease the amount of sediment entering the lake, and to promote ground-water recharge through percolation.

Settlement Brings Agriculture and Urbanization

Great Dakota Boom: 1878 to 1887

In 1864, Col. McLaren reported that Lake Kampeska was unsettled (Tarbell 1949, 290). Codington County was founded in 1878 (Kant, et al. 1987, 13). The major transformations in the hydrology of Lake Kampeska began to change with the arrival of significant numbers of white settlers (see comparisons, Appendix C, Photos). It was a period in history when the word “ecosystem,” or the concept of “unintended consequences” as a repeating pattern in mankind’s adaptation to the environment, did not yet exist (Asner, et al. 2004, 337).

Surveyors divided the land into neat squares, forming townships. The railroads often brought settlers of German descent, as well as Norwegians in the northeastern part of the county (Chittick 1961, 104-5). Under the Homestead Act, the general pattern of land use was a small farmstead for every 160 acres of land, although it was possible to obtain more than one quarter section through time. This was the period called the Great Dakota Boom from 1878 to 1887 during which most of the land in the eastern part of the state was acquired by white settlers (Schell 1968, 159-69). The exception, in Codington County, was that portion of the county within the Sisseton-Wahpeton Reservation north of Lake Kampeska which was not allocated into individual ownership until the 1890s (Kant et al. 1983, 2, 19). The extensive grasslands of Codington County were either plowed and converted into croplands or into pastures for grazing cattle and sheep.

The city of Watertown, near today’s uptown area, was first founded as Kemp Post Office in 1878. At the request of the Kemp Brothers, the railroad named the town after their hometown of Watertown, New York. Another settlement called Kampeska or Kampeska City was founded that same year at City Park at Lake Kampeska (Appendix C, Photos). When the settlers found that the land grant from the railroad did not extend to the inlet-outlet at Lake Kampeska, but only to a more eastern point on the Big

Sioux River (in today's Riverside Park), they hauled their shacks across the frozen river to Watertown the following winter. In addition, other small settlements moved to be near the expected rail lines. Thus, Watertown as founded, officially.

Having settled-in, they awaited the coming of the railroad from Minnesota. With its arrival, came many more settlers, diverse ideas, and products shipped from the East. Watertown and Codington County boomed and were booming by the end of the Great Dakota Boom. By 1880, the county had 2,156 residents (Eleventh Census of United States 1880). By 1890, the number had increased to 7,037 (Census of South Dakota 1895).

Lake Kampeska was as clear as glass with good fishing, according to the earliest settlers, the first of whom settled near the inlet-outlet of the Big Sioux River on the lake's north side (Kant et al. 1983, 8, 12). When the future Governor of South Dakota, Arthur Mellette, moved to Watertown in 1879, he and his family stayed at the lake when they first arrived. Soon they bought enough land for a small subdivision at the lake. They built a second home there. It was a frilly Victorian structure with a roomy porch. Mellette quickly made plans to build his own railroad, which ran from his law offices in uptown Watertown at Kemp and Broadway, to his lots on the east side of Lake Kampeska. He hoped that the capitol of the state would be built at Derby Downs-rodeo grounds (halfway between Watertown and the lake). The railroad was built, but it only operated for a very short time. Since there was no way to turn around, once it reached the lake, it simply backed up all the way to Watertown for the return trip. From his home atop a bluff on the Big Sioux River in Watertown, Mellette could have viewed the capitol building, his railroad line, and a bit of the water at Lake Kampeska. That never happened, of course, because Pierre became the capital (Kant et al. 1983, 4, 6; Mellette House archives). The railroad and the small housing development drew early attention to the lake.

For many years, as a museum director, I visited with people who remembered the old days in Codington County. One such person was the late Dr. Ward Williams. He was born in the 1880s. His uncle, Charles Morgan Williams, homesteaded a quarter at Lake Kampeska where the family later founded Stony Point resort (Appendix C, Photos). In 1976, "Doc" told me about his first recollections of the lake. At the time, I collected oral histories for the Codington County Historical Society, and the University of South Dakota's oral history program had recently finished recording his recollections. He told me that as a young boy, he was amazed to see that nearly all of the trees had been cut down around the lake. While some large cottonwoods were spared, he remembered how odd it looked to see vast stretches of lakeshore surrounded by stumps. The wood was used for lumber and for heating by the earliest settlers.

As noted, an important early resort at Lake Kampeska was Stony Point. A descendant of the original homesteaders, Mike Williams, described Stony Point in an e-mail to me in 2007. He wrote that, while it began as a hunting and fish camp,

> [It] soon developed into a cabin area. The [Williams] family provided ice, landfill, café, boat rental, and electricity when the technology was developed early in the 20th century. Fishing and duck hunting were the main recreation activities until the "twenties." Will Williams began construction of a dance area, boxing and skating arena and parlor sports. During the "forties" it was a gathering area for thousands during the summer session. A bowery hall was converted to big band hall called the Spider Palace and soon renamed the Rainbow Room. Small carnivals spent several weeks at Stony Point and an annual water Carnival drew thousands during the 4th of July weekend. Following WWII, transportation improvements made travel to more exotic locations possible and liquor laws changed and the big band era ended. Attempts to continue as a youth attraction failed to earn necessary money to continue . . . . Thus ended the biggest resort west of the Mississippi.

Stony Point closed and the buildings were torn down by the early 1970s. It had been host to big name entertainers of their day, including Lawrence Welk, and rock and roller Bobby Vee. Today, the Williams family operates The Prop, a convenience store which supplies campers at the Stony Point campground, as well as lake residents and sight seers.

Other early commercial developments at the lake included Hotel Iahpaota at Sunset Beach in 1889, one of the earliest resorts. Close by, were individual cabins and a windmill for pumping surface water (Appendix C, Photos). Lake Kampeska had a steamship in 1889 which took the adventurous to Watertown-Moss Agate Bay. By this time, some of the first docks had been built to accommodate boats of various types. There was also ice-boating at Lakes Kampeska and Pelican with a type of sailboat by 1889 (Kant et al. 1983, 142, 144-145, 225).

1900 through the Dirty Thirties

By 1900, Watertown was the lake city with so many railroads that their pattern on a map looked like spokes in a wheel (Kant et al. 1983, 157). By 1913, the Meridian Highway (United States Highway 81) extended through Watertown. It connected the Gulf of Mexico with Winnipeg, Canada (Kant et al. 1983, 21). The county's population grew, and the lake became even more important for recreation. By the 1920s, there was a water slide at City Park, along with hundreds of people enjoying swimming and canoeing (Appendix C, Photos) (Kant et al. 1983, 22, 148, 150-51, 156). By this time, lake residents established lawns and landscaping, including native and non-native trees and shrubs. Disturbance of the riparian habitat at the lake continued.

Before refrigeration was common in every home, ice was regularly delivered in blocks. To provide the ice, an ice house was built on the north side of the lake. In the summer, straw packing preserved the ice. In addition, by 1930, American Sand and Gravel Company operated near today's 152 North Lake Drive (Kant et al. 1983, 150). Eventually, the company dug large gravel pits along the north side of the lake. Mining continued through the 1950s. Many of those pits exist today, although developers filled many to produce lots for homes. Most of the technical reports about the condition of Lake Kampeska do not mention the vast extent of the sand and gravel operations along the north shore of the lake. By the 1950s and 1960s there was a network of water-filled sand and gravel pits from west of the inlet-outlet, all the way to the northern edge of City Park. Those, as well as wetlands areas, were some of the last lots to be developed around the lake. It was an era when wetlands were considered a nuisance with little value.

There were later consequences other than the alteration of wetlands. For at least one homebuilder in the 1960-1970s, north of City Park, soil compaction was a problem after the filling of some of the old gravel pits. The example that I recall was a home built on private land. The nearly new home was moved off the site, because the building sunk on one end. It was many years before builders tried again. Today, those lots are filled with beautiful homes. There are still several water-filled gravel pits on the north side of the lake, on the north side of Highway 20. They are easily visible from the inlet-outlet.

During the Dust Bowl days of the 1930s, the lake was at all-time low levels because of a prolonged and severe drought. Blowing topsoil was everywhere, the result of too much land having been tilled in a system of poor agricultural practices. It was a time that locals called the "dust storm days" when blowing topsoil created a scene so dark that it seemed like night in the middle of the day (Kant et al.1983, 106). There was a major exodus of people from the state, escaping the harsh conditions.

By 1935, Brown Gable Tourist Camp was built near today's Sandy Shores State Park (Kant et al. 1983, 152). Later, it became Sunnyside Inn, a supper club where cabins could be rented. Sunnyside Inn went out of business in the 1990s, and today most of the commercial buildings have been torn down, providing some of the few undeveloped lots at the lake in 2007 (Appendix C, Photos). The condition of the lots today is a "zerolandscape," with sandy soil nearly devoid of vegetation (McPherson and Haip 1989, 448).

The Casino Ballroom was another large commercial venture at Lake Kampeska (Kant et al 1983, 148). Located near City Park, and the Casino was probably built much earlier than the 1940s, but by that period it operated and advertised "barn dances." It was the site of dances and carnivals through the 1960s. Now torn down, it was located next to the Casino Speedway which still holds stock car races near the site.

Other early developers at Lake Kampeska included S. X. Way, one of the town's early town-lot company investors and an early day owner of the Watertown Public Opinion newspaper which still exists. In short, he owned the north shore of Lake Kampeska, centered at Way Land, a family home, last occupied by Vera Way Marghab, S. X. Way's daughter. Because of his wealth and influence, many powerful figures visited Lake Kampeska. Ms. Marghab told me that Mount Rushmore was planned at the dining room table of that house when Gutzon Borglum visited her father. Many powerful leaders visited Way Land, drawing more attention to the lake.

World War II Era: 1940s

During World War II, an Army airbase was built at Watertown by the United States military. It is today's Watertown Municipal Airport. Certain parts of the airbase comprised slough land which handled overflow from Lake Kampeska and from the Big Sioux River and its watershed north of the lake. Some filling of wetlands occurred at that time. The airbase included many barracks, a hospital, support buildings, and landing strips for training pilots for World War II. The plan was that the pilot in training could abort the plane over Lake Kampeska if a crash were eminent. It was thought that the pilot would have a better chance of surviving over the lake than crashing on dry land.

The airbase brought many out-of-state people and their ideas to Watertown and to Lake Kampeska (Kant et al. 1983, 24-25). Those early airbase runways provided the basic foundation for Watertown's capability to land large planes to this day. One of the drawbacks for the hydrological system has been that the wetlands which would have handled some of the surface, over-land, water runoff during a flood, were filled so that floodwater does not now cross the airport.

A small wetland remains directly northwest of the airport. A housing development was planned for that particular site in the 1990s, but locals knew that the area was subject to flooding, and the project collapsed. Berms built by the developer remain today, so that locals can still see a marked landscape where the streets were planned, and the lot layout is fairly obvious to those who watched the project launch and fail.

1950s and 1960s

Through time, more and more lake cabins, mostly summer homes, showed up on the scene at Lake Kampeska. Many more non-native trees were planted by lake residents, and many volunteer trees grew around the borders of the lake, particularly cottonwoods. While the wealthy owned some beautiful homes at Lake Kampeska, it was generally not the rule. By the 1950s, there were many lots available for sale around the lake for as little as five hundred dollars. It was a time when many common laborers owned lots and little cabins and shacks around the lake. A local pattern was for those with "lake cabins" to live in or near Watertown and simply go to the cabin during the summer season. Sometimes those cabins were rented out during pheasant hunting season when they brought a premium price.

Outhouses were not an uncommon site at cabins around the lake by the 1950s. A few residents drained sewage directly into the lake. By the 1960s that practice was gradually stopped through social pressure and local government enforcement, and more and more septic tanks were installed around the lake as one step forward. Algae blooms remained fairly common by late summer. When the lake turned a beautiful shade of turquoise and pea green, it was called “dog days,” which often occurred in August.

Some of those with cabins believed that the lake could “flush itself” as some mysterious quality of nature. For those who had septic tanks, the tanks were often positioned within fifteen or twenty feet of the cabin and perhaps sixty feet of the lake shore. Many times, they did not have a drain field. It was thought that the sewage would simply move through the sand and that Mother Nature would handle the rest.

While the link has not been proven, it is likely that lakes and streams with increased levels of nitrogen and phosphorus, caused by runoff from agriculture and urbanization, are a major cause of algae bloom, called eutrophication (Baron, 2004: 126; Wohl, 2004: 148). With organic debris from algae, comes turbidity, a muddy or cloudy appearance of the water (Hem, et al., 1990: 200). Other causes of turbidity are suspended siltation particles. While flooding can increase turbidity, the use of gasoline powered boat motors churning up the lake bottom also contribute.

In addition, since the earliest days of white settlement, many cabins had their own wells. Often, they consisted of a sandpoint on a two inch metal pipe which was driven into the sand. In some cases, the well was “cleaned” once a year, at the beginning of the summer by pouring five gallons of chlorine bleach into the well. No one used the well for a few days, and then it was ready to go. The well water was used for bathing, cooking (when boiled), and for hand-rinsing of clothing. Drinking water was usually hauled from town – but not always.

During the 1960s, Dr. Ed Huppler and associates planned and carried out a large development project south of Stony Point. It was a place which was the “largest wetland area on the lake that was a fish rookery" according to a September 2007 e-mail from Mike Williams who lives nearby. It was truly a large undertaking at the lake. A substantial area was dredged to provide lots with canals for boaters to access Lake Kampeska. It remains today, nearly fully developed, known as Hidden Valley.

Another dredging canal project installed later on, and probably patterned after Hidden Valley, was built at the south end of the lake, but it only included about twenty homes and a condominium. Landfill at various places around the lake created lots where there were formerly wetlands, gravel pits, and riparian habitat. By the end of the 1960s, most of the road around the lake was paved.

Wake-up Call: 1970s

By the 1970s, it was increasingly obvious to many people, including myself, a former tomboy who played Tom Sawyer around the lake in the 1950s and 1960s, that something was terribly amiss at Lake Kampeska. Fishing was not as productive at the lake. Impacts on fish populations were later included in studies of the lake (Madison 1994). Recently, other scientists studying fish populations at other lakes noted the impacts of urban stressors and water temperatures (Moglen, et al. 2004, 41, 57).

The sheer number and variety of native flora and fauna around the lake declined by the 1970s as compared, for example, with the 1950s. Where there had been an abundance of the frogs, toads, garter snakes, dragon flies, butterflies, moths, mosquitoes, spiders, mud turtles, snapping turtles, and flocks of songbirds and other birds, lake residents noticed the decrease in those populations. It did not take a scientific study, for those who knew the lake, to recognize that there had been some major shift in nature's balance. That a river-lake ecosystem slowly "self-adjusts" made itself known, although a fuller understanding of that fact took decades (Wohl 2004: 8, 11).

There were fewer adjacent wetlands. The abundance of poison ivy was also gone. The lake was now truly an urban setting. Lake lots for building purposes were difficult to find. The prices for lots, homes, and cabins at the lake were quickly rising as demand outstripped supply. Noise levels increased at the lake. There were, in my view, simply too many jet skis (the bane of the lake), speedboats, fishing boats, sailboats, canoes, and other watercraft, all vying for the available space at certain key times.

Since the age of thirteen (1960), I operated a speedboat at the lake. By the 1970s, it was not nearly as much fun because of too much traffic on the lake. Since I had paddled a little boat, all alone, since age eight, and I had operated a little two horse gas motor with a small boat since age nine, I was not happy with the changes which had occurred. I wanted the same experiences for my daughter which I had as a child. That was not to be.

On weekends, we mostly discontinued boating (speedboat, canoe, and paddleboat) because we did not enjoy the lake “traffic.” We went to our cabin as an escape to nature, and we disliked the “crowded” conditions. They were probably only crowded by South Dakota standards. We longed for the good old days. We stopped going to our cabin altogether on the busiest days such as the Fourth of July and Memorial Day. We rented our cabin to others on those occasions, thereby adding to the problem. We received a premium price in rent from those who enjoyed that much “togetherness” at the lake. The best days for us to visit our lake cabin were during the week, when we sought peace and quiet with low traffic on the lake surface. Even then, one contended with close neighbors “fogging” with chemicals for bugs or spraying their lawns for weed control or barbecuing with charcoal and lighter fluid which the wind carried to our lot. We longed for the mythical experiences described by Emerson and Thoreau. It was not to be. We began to believe that such a place only existed in the brochures about Lake Kampeska, because the place was not what it once was.

Cabins and homes were so close together because of a lack of zoning and regulations through time. Restrictions came later—but much too late. Particularly during the lake’s earliest days of development, that a lack of planning was glaring. Occasionally, when there was a house fire in the 1970s, the adjacent house would catch on fire, too. It was no wonder. They were spaced too closely, because lots on the lake were at a premium. More and more tiny cabins were torn down or converted to year round homes. Because lots were so expensive, the new homes were sometimes crowed onto a small lot with the narrow end of the structure facing the lake.

It was a period when it dawned on residents of Watertown and Lake Kampeska that ecosystem responses could be surprising. Locals began to wonder about the effects of septic tanks around the lake.

The 1970s were crucial years for Lake Kampeska. It was during the mid-1970s, as noted earlier, that the City installed sewer and water around the lake (Madison 1994). Finally, there was no longer a need for septic tanks and drain fields as well as outhouses which fed nutrient loads into the lake. Another problem with nutrients entering the lake came from lawn chemicals, because of the desire for lush green lawns around the lake. A simple drive around the lake showed that there was no serious attempt to control yard chemicals entering the lake with surface water runoff. The ideal was to have a yard which looked something akin to a golf course.

For many years, from about the 1960s through 2007, some lake residents pumped water directly from the lake with electric or gas-powered motors to water their beautiful lawns and trees, most of which were and are non-native species. There has not been a serious attempt to stop lawn chemicals from entering the lake as runoff, since reports show that the majority of the chemical load results from agricultural activities.

It was around 1970 when Interstate 29 reached Watertown from Sioux City, Iowa. Eventually, it connected Watertown to the Canadian border. Obviously, it created greater accessibility and the prospect of even greater long term growth. Public access points are scattered around the lake where boats are launched or loaded. In addition, there are other public areas (some of which included launch ramps), such as Memorial Park, Sandy Shores State Park, Stokes Thomas Lake City Park, and Jackson's Landing, among others.

Recent Era: 1990s to 2007

Many of the commercial ventures were gone from the scene by the 1990s. Remaining were Stony Point campground and the Prop convenience store; Kampeska Lodge, a supper club; a convenience store with groceries, gasoline, and a few cabin rentals; Watertown Country Club; and the Municipal Golf Course. However, by the 1990s there were very few undeveloped lots on Lake Kampeska. Many of the small shacks and cabins had been torn down or were converted to year round homes. Since there was little zoning in place while development occurred at the lake, many dwellings were very close together, certainly not meeting today's standards in the remainder of the city of Watertown. The trend has been to build larger and more costly homes at the lake. The road around the lake has been paved (with very few exceptions). Such improvements raised taxes to the point where many of those who owned modest cabins could no longer reasonably afford to have their second home at the lake. While it improved the quality of the water by removing septic tanks and wells at the lake, it accelerated the change from summer cabin to year round home. The problem was further complicated because formerly the lake had mostly part-time occupancy, and now the occupants were there to stay. That has precipitated many changes which are complicated and interrelated.

The few vacant lake lots left at Lake Kampeska in 2007 are very costly. Driving that cost higher is the city's restriction of minimum lot size at the lake to seventy-five feet of lake front property for building. Thus, those who want a place near the lake are beginning to build "lake view lots." "View" simply means that one can see the lake from the lot. Therefore, a second tier of homes is beginning to show up at the lake. These are across the road from homes on the lake.

In addition, housing developments and individual homes have been and are being built between the old city of Watertown, proper, and the "newly" annexed part of the town which is Lake Kampeska. County commissioners and city planners have made some attempt to control development. For individual homeowners, the county rule is that one needs to purchase a minimum number of acres in order to have a single home in the country. That has stopped some would-be country dwellers; however, it has not impeded those with ready cash.

Currently, the city of Watertown is planning a series of new wells near Rauville to supplement other wells and water pumped from Lake Kampeska. It remains to be seen how that will impact the total hydrological picture.

The Future

The future of Lake Kampeska is a complex issue. One of the considerations is that we do not know all there is to know about managing hydrological systems. At present, we depend on the totality of the knowledge base we have, including studies by physical scientists and social scientists. The most recent hard physical science data, specifically about Lake Kampeska, its watershed and its aquifer, is from studies done in 1971, 1994, 2000, and 2002 with little social science emphasis (Appendix B, Summaries).

Assad Barari's 1971 report shows Lake Kampeska's hydraulic connection to its aquifers, along with recharging and discharging patterns. It explains what happens during flooding, and why it is not possible to build a water control device directly at the inlet-outlet. It recommends that a reservoir be built north of the lake. It advises soil conservations all around the lake and in areas north of the lake to reduce nutrient loads. In addition, it recommends that a municipal sewer and water system be built around the lake. [That was done in the mid 1970s.] It concludes by noting that the lake's problems are interrelated and that there needs to be a joint effort of government and the public to solve the lake's problems.

Ken Madison's 1994 report first summarizes earlier work done by the Izaak Walton League from 1989 to 1991 in determining the extent of siltation in Lake Kampeska. Results of Madison's report show that some of the lake's problems include turbidity, lack of appropriate aquatic plants and shoreline vegetation, excess algae blooms from an overabundance of nitrogen and phosphorus, and too many nutrients entering the lake, particularly from agricultural sources. During high water periods, there is excess phosphorus, nitrogen, sedimentation, and fecal coliform bacteria from surface runoff (including problems from local feedlots). Levels of nutrients and solids were high. There is excess sediment and shoreline erosion. Madison's 1994 report and the USDA 2000 report provide a lengthy list of recommendations for restoration (Madison 1994, USDA 2000, see Appendix B, Summaries).

There is some good news for Lake Kampeska and the Big Sioux River. First, attention has been focused by concerned citizens, conservation organizations, and governmental agencies, all of whom care about the health of the hydrological system. They understand that one element affects another in a complex relationship. There is less understanding that both physical science and social science aspects probably need to be considered. There is an ongoing attempt to increase the knowledge base from which water managers work. Scientists recognize that while remote sensing, a relatively new technology, cannot provide much historical data for the lake and river, it has been important in recent years. It holds great potential for the future, along with supplement fieldwork (Loveland and DeFries 2004, 231-32).

There is some good news and some bad news for Lake Kampeska's hydrological system, in general. The water quality of the Big Sioux Aquifer is generally good, and acid rain is not currently a problem for the locale (Madison 1994; Meyer, 1989: 539). Of concern, on the other hand, is Watertown's dependence on Lake Kampeska for thirty to forty per cent of its water, with increasing levels of nitrogen and phosphorus which cause problems when algae are excessive. While the city can depend on wells northeast of the lake, the well water is more costly (USDA 2000, 36-38).

Managing water resources and land use patterns is a complex mix of systems and patterns, including social drivers such as attitudes, economic considerations, governmental regulation, and an expanded knowledge base largely derived from the physical as well as the social sciences (DeFries, et al. 2004, 1-2; Graf and Gober, 1992, 234-35). Public education is a driving force which is particularly important in changing social attitudes so that there is understanding of an ecosystems approach to restoration of impaired habitats. How can a sustainable system be created if the public does not will it to be so? Farmers need to be a key part of future planning, since changing their attitudes and agricultural practices is recommended in reports with plans for improving Lake Kampeska.

Useful sources for educators are Ellen Wohl's book, *Disconnected Rivers: Linking Rivers to Landscapes* (2004) which provides a sensitive look at why we should all be concerned about rivers. Also instructive for educators is a report by Kenneth Potter and others explaining that feasibility matters, and that some changes to an ecosystem may be fairly easily repaired, while others are more difficult (2004, 31, 36-37). In addition, key concepts for general, long range strategic planning include recommendations by Mark I. L'Vovich and others. The following is their advice.

> The emphasis would then turn to circular rather than linear systems of handling water, just as water in nature is a cycle that regenerates its quality. We stress that water- management measures should be based on principles that aim at preventing further deterioration in quality and at reducing present contamination. To achieve this will require persistent hydroecological assessment before repair, retrofitting, and new construction are undertaken (1990, 249).

Another important resource for developing public education is the recent *Geography of*

South Dakota (Hougan and Fouberg 1998). Geographer William L. Graf said it best when he wrote, “Our multi-century legacy for future generations can and should be to establish physical integrity for rivers that are as natural as possible, thus insuring that as a system they are parts of the infra-structure for a vibrant national economy, continuing threads of our cultural heritage, and quality natural environments” (2001, 1).

Currently, the best source of up-to-date information about progress being made at Lake Kampeska is a web page, *Lake Kampeska Water Project District*, http://www.lakekampeska.org/history.htm. It is edited by Mike Williams (2007).

The 1994 study by Ken Madison and the USDA 2000 report, summarized in Appendix C, show that Lake Kampeska has many of the same problems as lakes in other places. For example, Carpenter and others have reported similar problems at other lakes, as well as similar linkages showing a complex web of causes. Their charts and tables are particularly relevant (Carpenter et al. 2007, 323-35)

While there has been emphasis, in studies of Lake Kampeska and its watershed, on the adverse effects of agricultural chemicals and feedlot byproducts as sources of pollution in the system, there has been much less emphasis on the negative impacts of urbanization. Those include such aspects as air quality, yard chemicals, and heat increases which can result from impenetrable surfaces. A host of other quality of life issues should be included, such as those addressed by Ellen Wohl in her article, “The State of Our Nation’s Rivers” in *Disconnected Rivers: Linking Rivers to Landscapes* (2000, 123-165).

Another aspect which has been underemphasized in research concerning Lake Kampeska (Appendix B, Summaries) has been how residents around the lake could change the types of flora used for landscaping their yards. In observing what is in place, other choices could perhaps better fit an overall ecosystems approach. It need not result in a “zerolandscape” where the only consideration is water conservation. The use of “appropriate plants” is an important concept in this regard (McPherson and Haip 1989: 448-449).

One of the biggest challenges for Lake Kampeska may be in finding a way for all of the various players to work together in the best interests of the entire ecosystem with the goal of a sustainability which benefits everyone. Hopefully, Watertown and Codington County have learned a lesson in conservation considering their past record of struggling with major pollution of the Big Sioux River in the second half of the Twentieth Century, at a huge poultry processing plant and at the city's sewage treatment plant.

Who are some of the players in the challenges facing Lake Kampeska, the Big Sioux River, and its watershed and aquifer? They are listed here in no particular order because they are all have a role to play.

- Farmers
- Residents and business owners around Lake Kampeska and within the watershed
- Recreational users
- Politicians at all levels
- Government at all levels
- Voters
- Conservation organizations
- Chamber of Commerce
- Concerned citizens
- Physical scientists and social scientists
- Residents of Watertown and Codington County
- Artists, film producers, poets, and song writers
- Educators and students
- The media
- Community leaders

In Appendix C, I compared various historical photos of Lake Kampeska with photos taken from the same spot in 2007. While some show little change, others reflect major changes caused by land use changes such as urbanization, loss of wetlands, and the major damage that wind plays when ice breaks up at Lake Kampeska in the spring. The photos show the past in comparison to the present, and they remind us that there are consequences in the future.

Acknowledgements

Dr. Ward Williams, interview with author, 1976; Mike Williams, Coordinator of Upper Big Sioux Watershed Project, City of Watertown, Watertown, South Dakota 57201, several e-mails: mikewill@iw.net, September 2007; Jay Gilbertson, Manager, East Dakota Water Development District, 132 B Airport Driver, Brookings, South Dakota 57006, interview with author, September 2007; and Arlene Brandt-Jensen, District Conservationist, Codington County Conservation District, Watertown, South Dakota; Kevin Bailey, Director, Codington County Historical Society, Watertown, South Dakota, permission for all historical photos in Appendix C; Mellette Memorial Association, Inc. archives, Watertown, South Dakota.

APPENDIX A

Maps

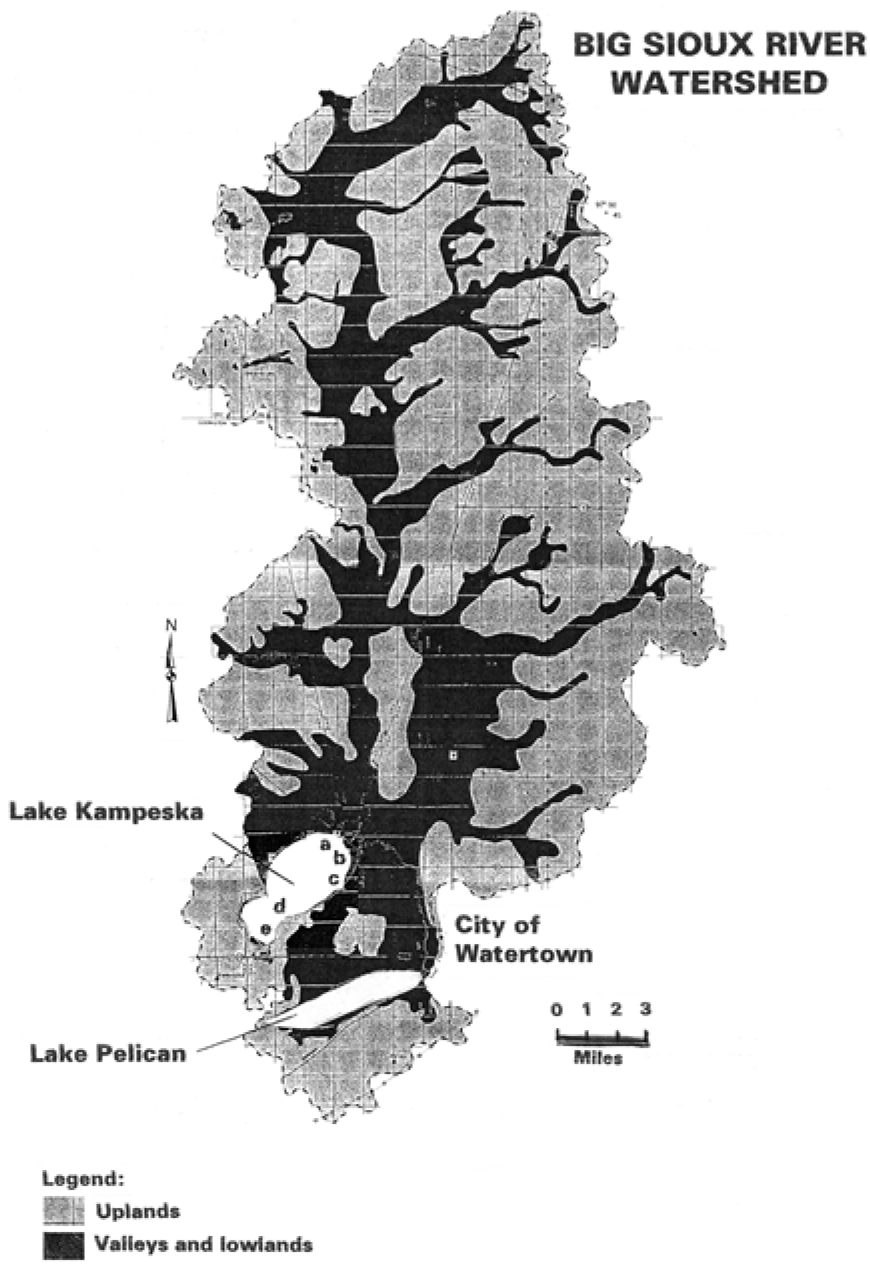

Figure 1. Big Sioux River Watershed (USDA 2000, 14).

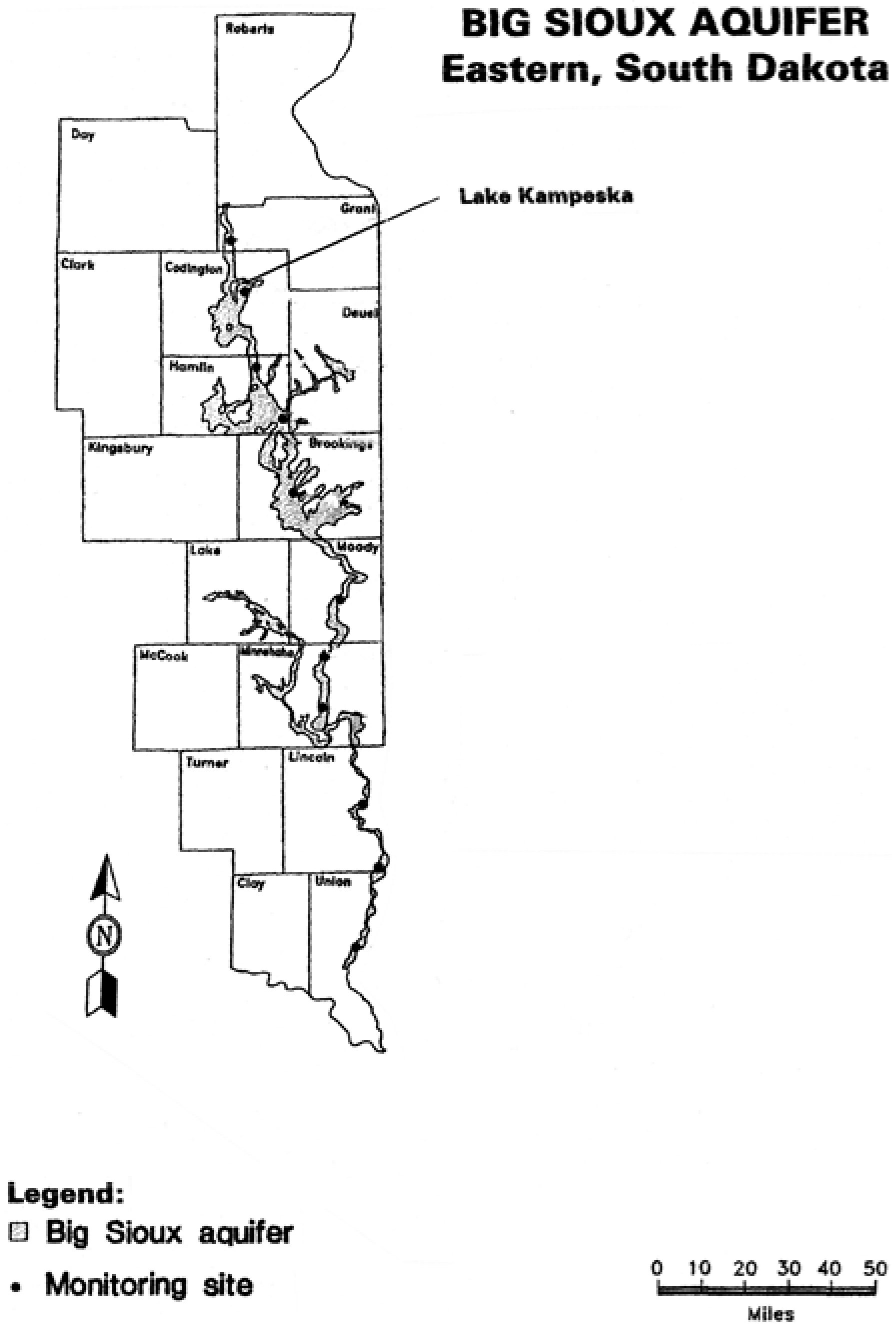

Figure 2. Big Sioux Aquifer, Eastern South Dakota (Hammond 1994, 3).

APPENDIX B

Summaries of Four Studies Related to Lake Kampeska

1971, *Hydrology of Lake Kampeska*

Assad Barari of the Science Center at The University of South Dakota prepared a major report entitled *Hydrology of Lake Kampeska* in 1971. It was financed by South Dakota Game, Fish and Parks under the direction of the State Geologist. The purpose of the study was to determine the amount and quality of water recharging and discharging from the lake, along with fluctuation levels, water use, and possible methods of stabilization of water levels. He acknowledged earlier relevant reports done by others from 1933 to 1965. I have summarized Barari's results as follows (1, 31-2).

There is a hydraulic connection between Lake Kampeska, Gravel Creek, and the Big Sioux River with an aquifer northeast of the lake, based on test holes drilling. Ground water and surface water recharging of the lake occurs when the lake's water level is below that of the Big Sioux River and the aquifer connection. Surface water is also recharged through direct precipitation at a rate of 20.52 inches per year.

Discharging results from municipal water use by Watertown at a rate of about 3.2 inches per year. Another 33 inches of water is lost to evaporation and artificial discharge.
When the lake is higher than the river and the aquifer, both ground and surface water leaves the lake through the aquifer and at the inlet-outlet (the point where the Big Sioux River both enters and exits Lake Kampeska on its north side).

During periods of flooding, nutrient laden water pours into Lake Kampeska at the inlet-outlet, eventually raising the lake level above the level of the river. That causes lake shore flooding. At that point, lake water flows back through the inlet-outlet in an attempt to equalize as it moves toward those parts of Watertown not adjacent to the lake. Since the Big Sioux River flows through the center of the city of Watertown, proper, the result is widespread flooding. It is not possible to build a structure to control floodwater from the Big Sioux River at the inlet-outlet because the area is low and sandy. In any event, it would cause even more serious flooding along the Big Sioux River within those parts of Watertown adjacent to the river.

Barari recommended that floodwater be stored in a reservoir in an area north of Lake Kampeska. The result would be flood control for the lake and the city of Watertown. In addition, the stored water would eventually discharge in a way that would produce more water, during summer and fall, in both the aquifer and the river. It would have the potential to decrease discharge and increase recharge for the lake. It could also reduce the amount of silt entering the lake. In combination, those measures could be helpful in addressing fluctuations in lake water levels.

The report advises that soil conservation efforts be implemented all around the lake and in areas to the north to reduce nutrient loads. Finally, municipal sewer and water needs to be installed around the lake to serve businesses and residences. [Such a system was installed in the mid-1970s.] In conclusion, it is recommended that the lake's problems are interrelated and that solutions need to come from a coordinated effort of government and the public (1971, 1, 31-32).

1994, *Diagnostic/Feasibility Study, Lake Kampeska*

The 1994 report was produced by Ken R. Madison , a Natural Resources Scientist with the South Dakota Clean Lakes Program, Division of Water Resources Management, South Dakota Department of Environment and Natural Resources. He prepared a major report concerning Lake Kampeska in January 1994, entitled *Diagnostic/Feasibility Study, Lake Kampeska, Codington County, South Dakota.*

Because of information supplied from a study by the Kampeska Chapter of the Izaak Walton League from 1989 to 1991 concerning sediment depth at Lake Kampeska, a grant was obtained by them from the United States Environmental Protection Agency for a major study of Lake Kampeska to be conducted by Madison from 1991 to 1993 (Madison 1994, 1).

First, Madison summarizes the results of that earlier study. He then produces an expanded report on the following topics related to Lake Kampeska in his 1994 report: water quality standards; geology, topography; soils, and ground water hydrology of the drainage basin; access points; population demographics; lake use summary; degradation effects; lake uses; pollution; land use; erosion; water quality; sediment survey; ecological relationships; and others. Finally, he supplies a summary, conclusions, and recommendations in his 1994 report.

In summarizing the work of the Izaak Walton League group, Madison notes that their work showed the extent of siltation in Lake Kampeska as it existed from 1989 to 1991.

> The results of the survey indicated that over 35% of the lake volume was filled with silt. In addition it was found that 83% of the lake contains measurable silt deposits, and 64% of the lake had silt deposits in excess of 9 feet deep (Madison 1994, 1).

In short, Madison's 1994 report showed that,

> . . . the great majority of the lake's water quality problems originate in the watershed area. A complicating factor is that the original lake outlet was blocked in the 1940's to build the Watertown Army Airbase. Consequently, the inlet of the Big Sioux River into the lake also serves as the outlet. This results in the lake acting as a surge pool for floods, with associated loadings of solids and nutrients (Madison 1994, 1).

The purpose of the 1994 study had been to determine water quality of the lake and its watershed, to find the sources of nutrients and sediments in the lake, and to provide a restoration plan which could be feasible. That study was based on water samples collected at Lake Kampeska and its watershed in 1992 and 1993. In short, the objective of the 1992-1993 fieldwork was to discover whether or not there were problems at Lake Kampeska, as was suspected, and if they existed, to suggest solutions that were possible.

In summary, Madison showed that Lake Kampeska suffered from turbidity partly because of its shallow depth. Bottom sediments were stirred by "boat motors, the wind, and bottom feeding fish." He added that algae production and increased sedimentation entering the lake made the water look even muddier. "Because of high turbidity there was an absence of macrophytes, or aquatic weeds." Less than five per cent of the shoreline had emergent vegetation, and "submergent vegetation was sparse to non-existent (Madison 1994, ii)."

Lake Kampeska had significant algae blooms which collect and decompose along the shore causing an unpleasant smell. He noted that in 1993, the City intermittently stopped taking water from

Lake Kampeska, as one of its sources for domestic consumption, because of odor during algae bloom (Madison 1994, ii-iii).

Too many nutrients in the water had caused Lake Kampeska to be hypereutrophic. An overabundance of nitrogen and phosphorus, in particular, resulted in algae and macrohytes. Since over ninety-four per cent of the watershed was used for agriculture, it was assumed that it was the cause of most of the unwanted nutrients entering the lake at the inlet-outlet. It seems unlikely that the excess nutrients were coming from the Big Sioux Aquifer's recharge of the lake, because water sampling generally showed a low level in ground water (the aquifer), compared to surface water (Madison 1994, iii).

There were two periods of high water during the study. During both, there were high levels of phosphorus, nitrogen, sedimentation, and fecal coliform bacteria. They were the result of surface water runoff in the watershed. It was most likely that the fecal material was the result of livestock feedlots, since there were at least seventy-five in the watershed. It is possible that failing septic system in the watershed could have also added fecal byproducts (Madison 1994, iii).

When testing the water in Lake Kampeska, the levels of nutrients and solids were high. Concerning sediment load, in areas where water depth was greater than twelve feet, there was an average of nine feet of sediment depth. The study showed over 2,000 feet of eroded shoreline, adding to sedimentation problems (iv). Madison recommended the following based on the study.

Primary Activities:
1) Lake shoreline stabilization/management
2) Construction of small ponds and dams on watershed tributaries
3) Construction/repair of grassed waterways in cropland fields
4) Planting of vegetative filter strips/grass seedlings along watershed streams
5) Construction of animal waste management systems
6) Streambank stabilization/riparian area management on watershed tributaries
7) Information/Education program to promote Best Management Practices
8) Wetland restoration on prior converted wetlands or farmed wetlands
9) Promotion of the Conservation Reserve Program (CRP)
10) Identification and correction of failing septic systems in the watershed area
11) Investigation into the feasibility of constructing a flow control structure to divert water away from Lake Kampeska during periods of high flow.

Secondary Activities:

12) Selective in-lake sediment removal
13) Economically feasible methods of flood control in the Big Sioux River drainage basin
14) Investigation into the feasibility of constructing a new lake outlet (Madison 1994, iv).

2000, *Upper Big Sioux River Basin Study Final Report*

This USDA report has a long list of "contributors," including representatives of federal, state, county, city, and tribal governments, along with the Izaak Walton League. Preparers included sixteen individuals, with several engineers, soil conservationists, a soil analyst, two biologists, an economist, and a self-employed outdoor recreation specialist.

The report covers a multitude of topics describing the study area, mostly within the above specialties. The study was spawned by Madison's 1994 report which identified part of the Upper Big Sioux River Basin as a "high priority area" of concern for water quality (USDA 2000, 1). Conclusions in the USDA report were as follows.

1. Ephemeral and classic gully erosion are the primary sources of sediment. Additionally, stream bank erosion in some subwatersheds is a major source of sediment that is contributed directly into the stream system.
2. Sheet and rill erosion and classic gully erosion contribute the majority of the phosphorus. Animal feeding operations, classic gully erosion, and rangeland are the major sources of dissolved phosphorus.
3. The deterioration of riparian areas along channels and stream banks, a result of livestock grazing pressure or the intensity of cropping practices, accelerates gully formation and reduces the sediment and nutrient filtering effects of vegetation (USDA 2000, 2).

There were four purposes for the study.

1. identify and quantify areas needing treatment for sediment reduction and water quality improvement,
2. enhance the water quality and aesthetics of the Big Sioux River, Lake Kampeska and Pelican Lake through the reduction of sediments and nutrients,
3. increase economic and environmental stability through improved conservation application, and
4. improve economic development of the area by enhancing wildlife and fish habitat, improving recreational use, and increasing productivity of depleted agricultural lands (USDA 2000, 3).

The report quantifies those items in their defined "purposes," listed above. It is not clear who would pay for the practices and treatments recommended or how one would go about obtaining the cooperation of farmers (who are indirectly and directly blamed for most of the problems), except perhaps through incentives. It is admirable that the report makes specific recommendations and assigns costs and benefits both onsite and offsite. Clearly, at least this report has a plan of action, whether or not it can be implemented fully. It provides expectations if there is no compliance, low compliance, or high compliance concerning their specific recommendations (USDA 2000, 38-40). Most of the changes recommended fall to farmers, and it leaves the reader wondering if farmers are expected to willingly comply after noting the assumed logic of the report, or if they are expected to comply through payments or withheld government payments, or if they are expected to comply through laws which will force their hand. Those who prepared the report cannot be faulted for that, because it was not part of the purpose or scope of the study to determine how to obtain compliance with their recommendations.

2002, Sediment *Accumulation and Distribution in Lake Kampeska*

Bryan D. Schaap and Steen K. Sando prepared a report entitled *Sediment Accumulation and Distribution in Lake Kampeska, Watertown, South Dakota* in 2002 for the United States Geological Survey, Department of the Interior, in cooperation with the Lake Kampeska Water Project District. It is known as Water-Resources Investigations Report 02-4171. Its purpose was to determine the rate and distribution of sedimentation in Lake Kampeska. In short, the study showed the following.

> Analysis of cesium-137 concentrations in sediment cores and changes in lake-bottom elevation over time led to the conclusion that during about the last 50 years, the sediment has been accumulating at a rate on the order of 0.01 foot per year or less. Changes in lake-bottom elevation during this time period indicate that the only significant deposition occurred in the area near the connection of Lake Kampeska to the Big Sioux River. Direct physical measurements and marine seismic surveys indicate that the flat-bottom interior part of the lake has 10 feet or more of sediment over a relatively irregular subbottom (Schaap and Sando 2002, 1).

APPENDIX C

Photos

1. September 1976, looking north at inlet-outlet in one of the driest years on record (Kant et al. 1987, 110).

2. Same view, 12 October 2007 in a relatively normal year. The bank has been stabilized with rock fill (see Appendix A, Maps, Figure 1, "a" for location).

3. Flood at City Park in spring 1986. Over the years, flooding drowned many trees.

4. Same view, 12 October 2007. After the "hundred year" flood of 1997, local government workers brought more fill and trees (see Appendix A, Maps, Figure 1, "b").

5. Locals contributed rocks for a future 1933 monument at City Park in memory of the village of Kampeska, marking the spot where Watertown was first established (Kant et al. 1983, 153).

6. Same site, 12 October 2007, with monument in place. Note the fill, young trees, pavement, and the housing development in the background (see Appendix A, Figure 1, “b”).

7. City Park, about 1920s. Note the bath houses and large crowds (Kant et al. 1983, 149).

8. Same site, 12 October 2007. The scene looks much the same with new restrooms and bath houses. There are many camping sites, today, in the background. City Park drawn large crowds in the summer (Appendix A, Figure 1,“b”).

9. Pumping station for Watertown's municipal water, about 1889 (Kant et al. 1983, 144).

10. Same building, 1901-1902 (Kant, et al 1983, 146).

11. In 1889 erosion and bank stabilization were problems. Notice the young trees (Kant et al. 1983, 149).

12. and 13. Pumping station, same views, 12 October 2007. Note the altered shoreline in comparison to photos 9, 10, and 11 (Appendix A, Figure 1,“c”).

14. Williams Family at Stony Point, about 1895 (Kant et al 1983, 147).

15. Williams Family and guests, Stony Point, about 1889 (Kant et al. 1983, 144)

16. Same site, 12 October 2007 (Appendix A, Figure 1, “d”). This spot looks remarkably the same. Many of the rocks are still in place, and the sandy beach looks much the same.

17. Stony Point beach, about mid-1900s (Kant et al. 1983, 154).

18. Same site, 12 October 2007 with the beach looking much the same (Appendix A, Figure 1, “d”).

19. Stony Point resort and amusement park, about 1901-1902 (Kant et al. 1983, 147). Most of these buildings are gone today. They have been replaced by a residence, a campground, and a store.

20. Same site, 12 October 2007. Note the foundation ruins for the circular building (Spider Web roller skating rink) above (Appendix A, Figure 1, “d”).

21. Green Gables tourist camp, about 1933 (Kant et al. 1983, 152).

22. Same site on 12 October 2007. After the demolition of Green Gables, Sunnyside Inn supper club occupied the site, until recent years when it was also torn down. Today, the site is an example of a "zerolandscape," nearly devoid of riparian habitat. These are some of the last vacant lots for sale on the lake (Appendix A, Figure 1, "e").

23. Sunset Beach, before 1889, probably on the east side of the lake. These were some of the first buildings at Lake Kampeska. Settlers cut down nearly all of the trees around the lake by the 1870s and 1880s according to Dr. Ward Williams (Kant et al. 1983, 145).

References

Asner, Gregory P., Ruth S. DeFries, and Richard Houghton. 2004. Typological responses of ecosystems to land use change. *Ecosystems and land use change*, ed. by Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, DC: American Geophysical Union, Geophysical Monograph Series 153, A: 337-44.
While land use change can result in intended responses, also to be considered are "unintended direct ecosystem responses" and "unintended indirect ecosystem responses." Using the summary chart on page 339 was particularly helpful in taking these into consideration in studying Lake Kampeska. For example, urbanization at the lake may have many unforeseen ramifications.

Barari, Assad. 1971. *Hydrology of Lake Kampeska.* Vermillion: University of South Dakota, Science Center.
Financed by South Dakota Game, Fish and Parks, and under the direction of the State Geologist, the purpose of this study was to determine the amount and quality of water recharging and discharging from the lake, along with fluctuation levels, water use, and possible methods of stabilization of water levels. It is one of four major studies of this lake summarized for this article.
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Baron, J. S., S. Del Grosso, D. S. Ojima, D. M. Theobald, and W. J. Parton. 2004. Nitrogen emissions among the Colorado Front Range: Response to population growth, land and water use change, and agriculture. *Ecosystems and land use change*, ed. Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, DC: American Geophysical Union, Geophysical Monograph Series 153, Q: 117-26.
While it cannot be proven that increased nitrogen emissions cause eutrophication, the link seems likely. Increases in nitrogen within an ecosystem are often byproducts of agricultural applications, as well as processes associated with increased urbanization. Nitrogen levels at Lake Kampeska are a key problem, and the concept needs to be part of public education in lake restoration.

Carpenter, Stephen R., Barbara J. Benson, Reinette Biggs, Jonathan W. Chipman, Jonathan A. Foley, Shaun A. Golding, Roger B. Hammer, Paul C. Hanson, Pieter T. J. Johnson, Amy M. Kamarainen, Timothy K. Kratz, Richard C. Lathrop, Katherine D. McMahon, Bill Provencher, James A. Rusak, Christopher T. Solomon, Emily H. Stanley, Monica G. Turner, M. Jake Vander Zanden, Chin-Hsien Wu, and Hengliang Yuan. Understanding regional change: A comparison of two lake districts. *Bioscience* 57(4): 323-35**.**
The authors study long term change in two lake district landscapes, one urban and one rural, for which they encourage an interdisciplinary approach to regional research. There are useful lists and charts showing common lake problems and causes, as well as the linkages within the ecosystem which impact lakes. It may be worth considering at Lake Kampeska when looking to the future.

Census of South Dakota, 1895. Codington County, South Dakota. Pierre: State of South Dakota.
This document provides information concerning the number of people in the county at that date.

Chittick, Douglas. 1961. A recipe for nationality stew. *Dakota panorama*, ed. J. Leonard Jennewein and Jane Boorman. Freeman, SD: Pine Hill Press, 1961: 89-146.
This book is South Dakota's contribution as a Dakota Territory centennial history.
Its chart showing population distribution of country of origin throughout South Dakota was helpful in determining who settled the state and where they settled.

Codington County Historical Society. Archives at Watertown, South Dakota.
The archives include photos, documents and maps of Codington County, including all historical photos in Appendix C.

DeFries, Ruth S., Gregory P. Asner, Richard Houghton. 2004. Trade-Offs in Land-Use Decisions: Towards a Framework for Assessing Multiple Ecosystem Responses in Land-Use Change. *Ecosystems and land use change*, ed. Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, D. C.: American Geophysical Union, Geophysical Monograph Series 153, A: 1-12.
This introductory chapter sets the stage for understanding how land use changes cause ecosystems responses including "hydrological, climatic, biogeochemical, human health, and biological diversity." The information was helpful in grasping the concept of "unintended consequences" when land use is changed from grassland and wetlands to agricultural and urban, as in the case at Lake Kampeska.

Eleventh census of the United States. 1880. Codington County, South Dakota. Washington: United States Census Bureau.
This document provides information about the number of people in the county at that date.

Eshleman, Keith N. 2004. Hydrological consequences of land use change: A review of the state of the science. *Ecosystems and land use change*, ed. Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, D. C.: American Geophysical Union, Geophysical Monograph Series 153, A: 13-29.
As one consequence of human population growth there have been changed land use patterns and the resulting impact on hydrological processes. The potential to involve input from social scientists in identifying "dominant economic and/ or social drivers" concerning land use is an innovative concept and potentially helpful in solving the complicated issues facing Lake Kampeska in the future.

Goudie, Andrew. 2006. *The human impact on the natural environment*. Carlton, Victoria, Australia: Blackwell Publishing: 146-48.
This is a comprehensive overview of how humans impacted earth's ecosystem through time, including an emphasis on the future. It is worth noting that agriculture may be the number one source of water pollution, but fertilizer application does not have to be the cause in all cases. High nitrate levels may also be caused by organic wastes leaching in the soil.

Graf, William L. 2001. Damage control: Restoring the physical integrity of America's rivers. *Annals of the Association of American Geographers* 91 (1):1-27.
A presidential address at the annual AAG conference, this paper is a passionate plea that physical integrity of rivers is imperative in systems management which emphasizes "hydrodiversity, geodiversity, and biodiversity." This approach makes sense for long-range planning for the Big Sioux River and one of its tributaries, Lake Kampeska.

Graf, William L. and Patricia Gober. 1992. Movements, cycles, and systems, Chapter 11. *Geography's inner worlds: Pervasive themes in contemporary American geography*, ed. Ronald F. Abler, Melvin G. Marcus, and Judy M. Olson. Rutgers University Press: New Brunswick, NJ: 234-54.
Geographers analyze processes as systems and patterns of interacting elements which change over time. Processes as systems and patterns at Lake Kampeska include the elements of the physical environment, as well as the elements of people, business, and government, all of which interact through time. Thus, culture impacts the built environment and the physical landscape.

Hammond, Patricia D. 1994. *Water quality monitoring and evaluation of nonpoint-source*

contamination in the Big Sioux Aquifer, South Dakota, 1989 through 1992. Vermillion: Science Center, University of South Dakota.
This Open-file Report 67-UR was conducted for the State of South Dakota, Department of Environment and Natural Resources, Division of Geological Survey. This survey was for the stated purpose in its title. Since the aquifer provides water for about one-third of the state's population, its quality is of utmost importance. The project set up a permanent monitoring network for nitrate, ammonia, and pesticides and found that the quality of the water is "generally good." Since 1989, water has been tested with "emphasis on nitrates and pesticides." The Big Sioux Aquifer is of major importance for Lake Kampeska, although other aquifers interact in the system.

Hem, John D., Adrian Demayo, and Richard A. Smith. 1990. Hydrogeochemistry of rivers and lakes: Surface water hydrology. *The geology of North America,* Vol. 0-1: 189-232.
This is a summary of the chemical composition, principles, and processes concerning North American surface water, as well as procedures for to those collecting surface water samples. Concerning Lake Kampeska, the information about algae bloom was of interest as a basic process which needs to be the focus of public education in lake restoration. **"**Water quality of eutrophic lakes with algae blooms reflect altered water chemistry because of altered levels of nitrogen, phosphorus, dissolved oxygen, and siltation."

Hogan, Edward Patrick and Erin Hogan Fouberg. 1998. *The geography of South Dakota*. Sioux Falls: The Center for Western Studies.
This is a comprehensive geography of the state. It provided basic information.

Kant, Joanita, ed. 1983. *Maggie: The Civil War diary of Margaret Wylie Mellette.* Watertown, SD: Codington County Historical Society, Inc.
This is a Civil War diary with biographical information about the Mellette Family when they lived at Watertown, including at Lake Kampeska.

Kant, Joanita; Virginia Allen; and Dr. Stanley W. Allen, Jr., ed. 1987. *Pictorial history of Codington County, South Dakota*. Dallas: Taylor Publishing Company. This book contains a short history of Codington County from its founding in the 1870s until 1987, along with 1,000 photos, including many of Lake Kampeska scenes before 1900. Especially see these chapters: Disasters, and Lakes and Rivers.

L'Vovich, Mark, and Gilbert White. In collaboration with A. V. Belyaev, J. Kindler, N. I. Koronkevic, T. R. Lee, and G. V. Voropaev. 1990. Use and transformation of terrestrial water systems. *The Earth as transformed by human action: Global and regional changes in the biosphere over the past 300 years,* ed. B. L. Turner II, W. C. Clark, R. W. Kates, J. F. Richards, J. T. Mathews, W. B. Meyers. Cambridge: Press Syndicate of the University of Cambridge: 235-52.
This research attempts to quantify humankind's present use and the transformation of the world's freshwater resources. Of help concerning Lake Kampeska were there comments on the interrelationship of "population, social organization, technology, and environmental conditions" which may help to explain the past and provide clues for the future.

Loveland, Thomas R. and Ruth S. DeFries. 2004. Observing and monitoring land use and land cover change. *Ecosystems and land use change,* ed. Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, DC: American Geophysical Union, Geophysical Monograph Series 153, A: 231-48.

Remote sensing approaches to land-use change might be combined with direct field observation and corroborating data concerning social, economic, and distribution of types of land cover in order to provide better information about land-use change. Thus, collecting field data is essential for a more complete picture, including such settings as the following: social, economic, land cover as vegetation, and the built environment.

Madison, Ken R. *Diagnostic/feasibility study, Lake Kampeska, Codington County, South Dakota*. 1994. Pierre: South Dakota Department of Environment and Natural Resources. This major study of Lake Kampeska is a diagnostic and feasibility study commenting on hard data from samples, since there was reason to believe that the lake might face problems. It was one of four research summaries used for this article.

McPherson, Gregory E. and Renee A. Haip. 1989. Emerging desert landscape in Tucson. *Geographical review* 79(4): 435-49.The authors address land and water use, degradation, and adaptation in arid lands. When only water conservation is promoted, it can result in a "zerolandscape." It raises the possibility of "appropriate plants" as a landscape around Lake Kampeska when considering the future of the lake.

Mellette House archives. Mellette Memorial Association, Inc., Watertown, South Dakota. These archives from Mellette House, a house museum, contain various documents telling the story of the Mellette Family and their impact on Codington County's early development, including the lake.

Meyer, Gerald. 1989. Fresh water of the North American continent: A profile. *The geology of North America, Vol. A: The geology of North America—an overview* (Chapter 18), ed. Albert Bally and Allison R. Palmer. The Geological Society of America: 537-554.
The hydrogeology of North America is explored as naturally occurring ground and surface water with less about practical issues of distribution and use patterns. It contains useful graphics concerning acid rain (sulfuric and nitric acids) distribution in North America, showing that South Dakota (Lake Kampeska) has a relatively unaffected level of from 5.13 to 5.07, unlike much of the eastern one-third of the United States and Canada.

Micklin, Philip P. 1996. Man and the water cycle: Challenges for the 21st century. *Geojournal* 39(3): 285-98. River, lake, and groundwater pollution needs to be addressed in the future using an ecosystems approach, a widened knowledge base, and national and international cooperation. Since lakes have "suffered most seriously from anthropogenic caused pollution," this article was particularly relevant to the study of Lake Kampeska. The model describing the genesis for ecosystems and the concept of self-sustaining circular ecosystems are valuable tools for public education concerning lake restoration and the future.

Moglen, Glenn E. and Karen C. Nelson, Margaret A. Palmer, James E. Pizzuto, Catriona E. Rogers, and Mohamad I. Hejazi. 2004. Hydro-ecologic responses to lake use in small urbanizing watersheds within the Chesapeake Bay Watershed. *Ecosystems and land use change,* ed. Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, DC: American Geophysical Union, Geophysical Monograph Series 153, A: 41-60.
This is a study of the Chesapeake Bay watershed and the stress of urbanization, particularly including food availability for fish and temperature changes which can impact spawning. Although studies from other regions may not be applicable to Lake Kampeska, this article raises interesting questions for the future concerning potential impacts from urban stresses.

Potter, Kenneth W., Jamie C. Douglas, and Edmund M. Brick. 2004. Impacts of agriculture on aquatic ecosystems in the humid United States. *Ecosystems and land use change*, ed. Ruth DeFries, Gregory Asner, and Richard Houghton. Washington, DC: American Geophysical Union, Geophysical Monograph Series 153, A: 31-40. Hydrologic processes have been radically altered by modern agriculture, particularly the use of fertilizer which has left a "lasting legacy" of damage which may be somewhat repairable, but other damages to the ecosystem may be more difficult to change. An overall plan for ecosystem restoration for Lake Kampeska needs an assessment of what is feasible as a point of beginning.

Schaap, Bryan D. and Steven K. Sando. 2004. *Sediment accumulation and distribution in Lake Kampeska, Watertown, South Dakota*. Water-resources investigations report 02-4171. Rapid City, South Dakota: U. S. Geological Survey. This major study examined sediment levels in Lake Kampeska. It was one of four summaries which were used for this article.

Schell, Herbert S. *History of South Dakota*. 1968. Lincoln: University of Nebraska Press. Until recently, this was the only widely used general history of the state. It provided historical context for the geography Lake Kampeska in Codington County.

Tarbell, Wright. Early history of Codington County. 1949. *South Dakota historical collections report*, XIV. Pierre: State Historical Society: 276-469. An amateur historian from Watertown, this author assembled a comprehensive history of the county's early days. It was useful in that context.

United States Department of Agriculture. 2000. *Upper Big Sioux River: River basin study final report*. USDA: Natural Resources Conservation Service, South Dakota; in cooperation with Codington Conservation District; Day County Conservation District; Grant County Conservation District; Roberts Conservation District; SD Department of Agriculture, Division of Resource Conservation & Forestry; SD Department of Environment and Natural Resources; and Upper Big Sioux River Watershed Advisory Board. May. (Their map source on page 14: US Bureau of the Census 1995 TIGER Line Data and information from NRCS field personnel. UTM Projection, Zone 14, NAD27. June 1999, 1008506.)This comprehensive report was developed by a wide range of interests to find cost-effective and feasible ways to improve the quality of the Upper Big Sioux River Basin and to improve its quality through a conservation plan which could enhance economic development and agricultural enhancement, while benefiting wildlife and fish habitat. It was of use for this research paper because it offers alternatives and tries to quantify their implementation and cost effectiveness. It constitutes the master plan for what might be done.

Williams, Mike, ed. Lake Kampeska Water Project District webpage. 18:32:12 September 24, 2007, E1-E2. < http://www.lakekampeska.org/history.htm> (last accessed 24 September 2007). The editor is Coordinator of Upper Big Sioux River Watershed Project, City of Watertown, South Dakota. One of the most knowledgeable people in Watertown about the lake's history, Mike Williams' name is synonymous with efforts to restore Lake Kampeska. It is a cause to which he has dedicated his life. As a private individual, he worked for many years to improve the quality of the lake. Now, he is a city employee dedicated to that work. Through e-mails, he provided general information and map sources.

Wohl, Ellen E. 2004. *Disconnected rivers: Linking rivers to landscapes*. New Haven: Yale University Press. This is a sensitive look at why we should be concerned about rivers, including a general overview of North American river systems, human impact through time, pollution, governmental impact, endangerment, and rehabilitation. Handling groundwater runoff and their sediment loads

will be one of the main problems for those who manage Lake Kampeska and the Big Sioux River in the future.

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