GEOLOGICAL AND SOILS DESCRIPTION OF DRAINAGE BASIN

Geological Description.

Lake Campbell and surrounding watershed is located on the Coteau des Prairie. This prairie coteau area is an erosion remnant, irregularly covered with glacial drift. This drift is the parent material of the soils and shallow aquifers in the Lake Campbell watershed.

The drift material consists of till and outwash laid down during the Wisconsin age. The till is composed of a heterogeneous mixture of material deposited directly by the glacier. It has a loamy texture consisting of about 40% sand, 34% silt and 26% clay (Soil Survey Moody County 1989).

Lake Campbell is a glacial outwash lake on a broad drift sheet that trends north and south, parallel with the Big Sioux River. There are no closed basins in this sheet, water flows in an integral pattern to the Big Sioux River.

Eastern South Dakota was glaciated at least four times during the Pleistocene Epoch. Deposits left by these four ice sheets are from youngest to oldest: the Wisconsin, Illinoian, Kansen and Nebrasken. The Wisconsin age has been sub-divided into four sub-stages listed in ascending order: the Iowan, Tazewell, Cary, and Mankato (Figure B-1).

No deposits older than the Wisconsin glacier are preserved in the Lake Campbell area. Little is know about pre-Wisconsin ice sheets; accepted theory is that the glaciers entered from the northeast (Baldwin 1951).

Much more is know about the Wisconsin age ice sheets because the till remained on the surface. Of the four Wisconsin glacial sub-stages in eastern South Dakota, the predominant remnants on the surface in the Lake Campbell area are from the Iowan and Cary age.

Iowan deposits are generally referred to as any till or boulder clay that is older then Tazewell deposits. Iowan deposits are characterized by level to slightly sloping topography, upon which an intricate pattern of dendritic drainage is developed. The smooth till surface is partly due to mantling of the former rough topography of the earliest Wisconsin age.

Cary deposits are comprised of till, outwash and glacial lake sediments. The Cary till is similar to Iowan but differentiated by topography, absence of loess and absence of well defined drainage. Cary till is characterized by knob and kettle topography which contains many filled depressions. The local relief varies greatly from ground to end moraine. In end moraine areas the terrain is rugged with maximum slopes ranging from six to greater than ten percent. The ground moraine is also rugged but slopes are usually less than six percent. Cary till varies from ten to seventy feet thick. Soil is normally poorly developed and often only six inches thick although in some instances reaches a few feet in thickness.

Cary outwash sediments are expressed as three topographical types: valley train deposits, terrace remnants and collapsed material (Steece,, 1958). The more common valley trains are characterized by level to nearly level, gently undulating

topography. They occupy low areas and are confined to stream valleys. The material consists primarily of poorly sorted sands and gravels with carbonate rocks predominating.

The terraces are thin deposits of sand and gravel, ranging from eight to twenty feet in thickness (Tipton 1958). The collapsed Cary outwash is difficult to distinguish from Cary till because the surface is rough and undrained. The outwash surface is closely underlain by sands and gravels, where as the till is mostly a mixture of clay.

No bedrock is exposed in the Lake Campbell watershed and surrounding area. However, data obtained from well logs in the vicinity reveal precambrian rocks beneath the surface deposits, unconformably overlain by rocks of Creteceous age. Since the bedrock is beneath the unconfined aquifers in the Lake Campbell drainage area, they have little or no effect on the lake.

Groundwater Hydrology.

Lake Campbell lies where two shallow unconfined aquifers merge, the Battle Creek and Big Sioux (Figure B-2). Both aquifers are glacial in origin. Glacial aquifers as a rule are unconsolidated sand and gravel outwash, deposited by melt water from receding glaciers.

The Battle Creek aquifer is composed of fine to medium sand with some fine gravel and is under lain by till. The aquifer is located only on the Battle Creek flood plain.

The aquifer is recharged by precipitation and snow melt. Reported water levels indicate that the groundwater flow follows Battle Creek through Lake Campbell into the Big Sioux Aquifer (figure B-2). The Battle Creek Aquifer discharges approximately 0.3 acre-ft/day through private wells, evapotranspiration and flow to the Big Sioux aquifer at (Water Resources of Lake and Moody County 1986).

Water chemistry analysis within the aquifer shows the two main components are calcium bicarbonate and sulfate. Concentrations range from 440 to 1,300 mg/l. and average 680 mg/l (USGS Water resource Investigations Report 1986).

Battle Creek Aquifer Characteristics: areal extent - 19.45 hectors; maximum thickness - 8 m.; average thickness - 4.25 m.; depth below surface - 0-1 m.; ground water level below land surface - 0-3 m.; estimated water storage volume - 34,000 acre-ft.; well discharge - 1-3 gallons per minute; suitability for irrigation is poor (Water Resource of Lake and Moody Counties S.D. 1986).

The Big Sioux Aquifer runs in a southerly direction through the Big Sioux flood plain. Aquifer material is composed of fine to medium, poorly sorted sand to well sorted medium gravel. Aquifer recharge is by infiltration of rain water and snow melt through the 0.3 to 6 m. of top soil (Water Resources of Brooking county 1989).

Water quality in the Big Sioux Aquifer is similar to the Battle Creek Aquifer with calcium bicarbonate and sulfate predominating. Average calcium concentration is 100 mg/l., average bicarbonate concentration is 260 mg/l. and average dissolved sulfate concentration is 180 mg/l..

As stated earlier Lake Campbell is on the merge point of the Battle Creek Aquifer and the Big Sioux Aquifer with the flow going towards the Big Sioux. Aquifer recharge by Lake Campbell usually only occurs during spring run off and extreme high water periods. The remainder of the year the aquifer is recharging Lake Campbell. The ground/surface water connection is moderate between Lake Campbell and the aquifers (Classification Preservation Restoration of Lakes in Northeastern S.D 1977.)

Topography.

Lake Campbell watershed is on undulating and gently rolling glacial plain with many small depressions. It is drained by Battle Creek which flows the Big Sioux River. The drainage pattern is poorly defined in most areas, but is well defined along Battle Creek.

Slopes in the watershed vary between 0 and 6 percent as a general rule, although two small areas less than 10 acres have slopes between 8 and 9 percent and a few areas less than 5 acres have slopes above 10 percent (Figure B-3). Slopes were measured from U.S. Geological Survey topographical maps. The steepest slopes were searched out to determine the maximum slope. Average slope was calculated by taking random slope measurements perpendicular to the drainage approximately every mile across the entire watershed. Slopes ranged from 0 to 8,76 percent and average 1.01 percent.

Soils.

Soils that predominate the Lake Campbell water shed consist of deep, well drained, nearly level to sloping soils, formed over glacial till and are found on the uplands and valleys of the watershed. The three primary soil types found in Lake Campbell watershed are: Egan Series, Wentworth-Sinai and Dempster.

Egan Series soil have a dark grayish-brown silty clay and loam surface layer approximately 7 inches thick. The subsoil is brown, grayish-brown, and light brownish gray silty clay loam about 24 inches thick. It is slightly hard and hard when dry and friable when moist. The under material is calcareous, light brownish gray clay loam glacial till.

Egan soils have moderate organic matter content and medium to high fertility. Surface run off is slow to medium. Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high. The slopes very between 2 to 6 percent (Soil Survey of Moody County, S.D. 1989.).

Wentworth-Sinai soils are found on slightly higher ground and closer to the west end of the watershed than Egan soils (Figure B-4). These soils consist of deep, well drained, nearly level to

gently sloping silty glacial drift and are closely associated with the Egan soils. The surface layer is dark grayish-brown silty clay loam about 7 inches thick. The subsoil is silty clay loam about 27 inches thick. The upper part is brown, and the lower part is light brownish gray and is calcareous. It is slightly hard to hard when dry and friable when moist. The under lying material is calcareous, light brownish-gray silty clay loam. It is mottled and yellowish brown and dark brown stained (Soil Survey of Lake County S.D., 1973).

Dempster soils are found along Battle Creek and its flood plain on nearly level to slightly sloping surfaces. These soils have silty texture and are moderately deep over sand and gravel (Figure B-4).

Dempster soils have moderate organic content and medium fertility. Surface runoff is slow to medium and permeability is moderate above the underlying sand and gravel. Available water capacity is moderate. Water erosion is a hazard in sloping areas. Slopes range from 0-2 percent (Soil survey of Lake County S.D. 1973).

Using U.S. Geological Survey topographical maps to define the watershed, approximately 112080 acres contribute runoff into Lake Campbell. The contributing area is often smaller for most precipitation events because numerous small lakes and lowlands store runoff in the watershed. Farmland accounts for approximately 90 percent of the watershed while marsh and lakes make up the remainder.

In 1986 and 1987, sediment and nutrient load data was collected for Lake Campbell and the watershed. Sediment loading data was calculated using an AGNPS model which incorporated the universal soil loss equation (Ullery et.al. 1987). Below are sediment yields for two significant rainfall event in 1986 and 1987.

DISCHARGE PARAMETERS	WATERSHED CONDITION 1886	1987
Runoff, inches	2.49	2.36
Sediments, Tons	4,723	4,657
Nitrogen, lb/ac.		
Sediment	.29	.29
Soluble	2.78	1.35
Total	3.07	1.64
Phosphorous, lb/ac.		
Sediment	.15	.15
Soluble	.56	.23
Total	.71	.38