Appendix B
Soil Series Descriptions
Lilleskogen Park

SANTIAGO SERIES

The Santiago series consists of well drained soils which are deep to a densic contact. They formed in loess or silty lacustrine deposits and in the underlying dense sandy loam till on ground moraines, disintegration moraines, and end moraines. Permeability is moderate in the silty mantle, slow or moderately slow in the lower part of the solum, and very slow in the substratum. Slope ranges from 1 to 45 percent. Mean annual precipitation is about 30 inches. Mean annual air temperature is about 42 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Haplic Glossudalfs

TYPICAL PEDON: Santiago silt loam, on a convex, northeast-facing slope of 8 percent, in a cultivated field, at an elevation of about 1,180 feet. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 10 inches; dark brown (10YR 3/3) silt loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many fine and few medium roots; 4 percent gravel; slightly acid; abrupt smooth boundary. (6 to 12 inches thick)

E/B--10 to 15 inches; about 60 percent brown (10YR 5/3) silt loam (E), very pale brown (10YR 7/3) dry; weak medium platy structure parting to moderate very fine subangular blocky; friable; extends as tongues into or surrounds remnants of dark yellowish brown (10YR 4/4) silt loam (Bt); moderate very fine subangular blocky structure; friable; common faint dark yellowish brown (10YR 3/4) clay films on faces of peds; common fine and medium roots; 1 percent gravel; moderately acid; clear smooth boundary.

B/E--15 to 23 inches; about 70 percent dark yellowish brown (10YR 4/4) silt loam (Bt); moderate very fine subangular blocky structure; friable; common faint dark yellowish brown (10YR 3/4) clay films on faces of peds; penetrated by tongues of brown (10YR 5/3) silt loam (E), very pale brown (10YR 7/3) dry; weak medium platy structure parting moderate very fine subangular blocky; friable; common fine and few medium roots; 1 percent gravel; very strongly acid; abrupt wavy boundary. (Glossic horizon ranges from 5 to 20 inches thick.)

2Bt1--23 to 36 inches; dark brown (7.5YR 3/4) gravelly sandy loam; moderate fine prismatic structure tending to part along horizontal cleavage planes to weak medium plates inherited from the parent material; firm; common fine roots; common faint dark brown (7.5YR 3/3) and few distinct reddish brown (5YR 4/4) clay films on all faces of peds; few prominent brown (10YR 5/3) silt coats on vertical faces of peds; 14 percent gravel and about 1 percent cobbles; slightly brittle; strongly acid; abrupt wavy boundary.

2Bt2--36 to 49 inches; dark brown (7.5YR 3/4) fine sandy loam; moderate fine prismatic structure tending to part along horizontal cleavage planes to weak medium plates inherited from the parent material; firm; few fine roots; many faint dark brown (7.5YR 3/3) clay films on

all faces of peds; very few prominent brown (10YR 5/3) silt coats on vertical faces of peds; 11 percent gravel and about 1 percent cobbles; slightly brittle; strongly acid; gradual wavy boundary. (Combined thickness of the 2Bt horizon ranges from 8 to 30 inches.)

2BCd1--49 to 69 inches; dark reddish brown (5YR 3/4) sandy loam; weak very coarse prismatic structure tending to part along horizontal cleavage planes to weak medium plates inherited from the parent material; firm; few fine roots; few faint dark reddish brown (5YR 3/3) clay films on top faces of peds; 9 percent gravel and about 1 percent cobbles; moderately acid; gradual wavy boundary.

2BCd2--69 to 87 inches; dark reddish brown (5YR 3/4) sandy loam; weak extremely coarse prismatic structure tending to part along horizontal cleavage planes to weak medium plates inherited from the parent material; firm; few fine roots; few distinct dark reddish brown (5YR 3/3) clay films on top faces of peds; 7 percent gravel and about 1 percent cobbles; few sandstone channers; moderately acid; gradual wavy boundary. (Combined thickness of the 2BCd horizon ranges from 0 to 70 inches.)

2Cd--87 to 102 inches; reddish brown (5YR 4/4) sandy loam; tending to part along horizontal cleavage planes to weak medium plates; firm; dense and compact; 9 percent gravel and about 1 percent cobbles; slightly acid.

TYPE LOCATION: Barron County, Wisconsin; about 2 miles east and 1.5 miles south of Reeve; located about 1,840 feet south and 2,040 feet east of the northwest corner of section 34, T. 32 N., R. 14 W.; USGS Connorsville topographic quadrangle; lat. 45 degrees 13 minutes 09 seconds N. and long. 92 degrees 05 minutes 12 seconds W., NAD 83.

RANGE IN CHARACTERISTICS: Thickness of the silty mantle ranges from 12 to 36 inches. Depth to the base of the argillic horizon and to densic contact ranges from 40 to 60 inches. Content of clay averages from 7 to 17 percent in the particle-size control section and the content of fine sand or coarser averages 15 to 70 percent. The base saturation (by sum of cations) is less than 60 percent in some part of the argillic horizon. Volume of gravel ranges from 0 to 10 percent in the silty mantle and from 5 to 35 percent in the till. Volume of cobbles ranges from 0 to 3 percent in the silty mantle and from 0 to 5 percent in the till. Volume of stones ranges from 0 to 1 percent in the silty mantle and from 0 to 3 percent in the till. Surface stones have coverage ranging from 0 to 3 percent. Reaction ranges from extremely acid to slightly acid in the solum, except it ranges to neutral in the Ap horizon where the soil is limed. Reaction ranges from strongly acid to neutral in the substratum.

The Ap horizon has hue of 7.5YR or 10YR, value of 3 or 4, and chroma of 1 to 3. Dry value is greater than 5.5. Uncultivated pedons have an A horizon, 1 to 4 inches thick, with hue of 7.5YR or 10YR, value of 2 or 3, and chroma of 1 or 2. Texture is silt loam.

Some pedons have an E horizon with hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. Colors of 4/3 or 5/3 have value dry of 7 or more. The E horizon is silt loam or silt.

Some pedons have a Bw horizon with hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4. It is silt loam. Bw horizons with spodic color have less than 0.6 percent organic carbon.

Santiago soils have a glossic horizon. Horizonation has a wide range depending on the thickness of the silty mantle and the degree to which eluviation has occurred. Therefore, there can be E/B, B/E, 2E/B, or 2B/E horizons singly or in combination.

The E part of the E/B or B/E horizon has color and texture like the E horizon described above. The Bt part has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6.

Some pedons have a Bt horizon with color and texture like the Bt part described above.

The 2E part of the 2E/B or 2B/E horizon has hue of 5YR, 7.5YR, or 10YR, value of 4 to 6 and chroma of 2 or 3. Colors of 4/3 or 5/3 have value dry of 7 or more. The 2E part is typically sandy loam, fine sandy loam, loam, or their gravelly analogs, but in some pedons it is loamy sand or gravelly loamy sand. The 2Bt part has color and texture like the 2Bt horizon described below.

The 2Bt horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 3 to 5 and chroma of 4 to 6. It is typically sandy loam, fine sandy loam, loam, or their gravelly analogs. The bulk density ranges from 1.65 to 1.90 gm/cc. Some pedons have pockets or strata of loamy sand or gravelly loamy sand.

The 2BCd horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 3 to 5 and chroma of 4 to 6. It is typically sandy loam, fine sandy loam, or their gravelly analogs. Bulk density ranges from 1.8 to 2.0 gm/cc. Some pedons have pockets or strata of loamy sand or gravelly loamy sand.

The 2Cd horizon has hue of 2.5YR, 5YR, or 7.5YR, value of 3 to 5 and chroma of 4 to 6. It is typically sandy loam, fine sandy loam, or their gravelly analogs. Bulk density ranges from 1.8 to 2.0 gm/cc. Some pedons have pockets or strata of loamy sand or gravelly loamy sand.

COMPETING SERIES: These are the Amery, Arland, Automba, Goodland, Itasca, Kennan, Langlade, Marathon, Pemene, Rosholt, Scoba, and Steamboat series.
Amery and Automba soils do not have a 12 to 36 inch thick mantle that is more than 50 percent silt. In addition, Automba soils have base saturation of more than 60 percent in all parts of the argillic horizon.
Arland soils have a paralithic contact of sandstone at a depth of 20 to 40 inches.
Goodland, Itasca, Kennan, Langlade, Marathon, Pemene, Rosholt, Scoba, and Steamboat soils do not have a densic contact within the series control section.

GEOGRAPHIC SETTING:
Parent material--loess or silty lacustrine and in the underlying dense sandy loam till of Late Wisconsinan Age
Landform--ground moraines, disintegration moraines, and end moraines
Slope--1 to 45 percent

Elevation--800 to 1950 feet
Mean annual air temperature--39 to 45 degrees F
Mean annual precipitation--28 to 33 inches
Frost-free period--120 to 135 days

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Amery, Freeon, Haugen, Magnor, Newood, Newot, Otterholt, and Spencer soils.
The moderately well drained Freeon and somewhat poorly drained Magnor soils are in a drainage sequence with Santiago soils. They are on slightly lower or less sloping landscape positions.
The well drained Amery and Newot soils are on similar landscape positions and the moderately well drained Haugen and Newood soils are on less sloping landscape positions to those of Santiago soils where the silty mantle is less than 12 inches thick, or is absent.
The well drained Otterholt soils and moderately well drained Spencer soils are on landscape positions similar to those of Santiago soils where the silty mantle is more than 36 inches thick.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is medium to very high. Permeability is moderate in the silty mantle, slow or moderately slow in the lower solum, and very slow in the substratum.

USE AND VEGETATION: Many areas of this soil are used for cropland. Corn, small grains, and hay are common crops. Some areas remain in woodland. Native vegetation is mixed hardwood forest with a few conifers. Common trees are sugar maple, American basswood, northern red oak, white ash, American elm, and quaking aspen with some white pine and red pine.

DISTRIBUTION AND EXTENT: Northwestern Wisconsin and east-central Minnesota. LRR K, MLRA 90A and MLRA 90B. This soil is extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Mille Lacs County, Minnesota, 1927. Type location moved to Barron County, Wisconsin with the correlation of the soil survey in 1992.

REMARKS:
Particle size control section - the zone from 15 to 35 inches

Diagnostic horizons and features recognized in this pedon are:
Ochric epipedon - the zone from 0 to 15 inches (Ap, E/B);
Albic horizon - the zone from 10 to 15 inches (E part of the E/B);
Glossic horizon - the zone from 10 to 23 inches (E/B, B/E);
Argillic horizon - the zone from 15 to 49 inches (B/E, 2Bt1, 2Bt2);
Densic contact - the contact with dense till (2BCd1, 2BCd2, 2Cd) at 49 inches;
Lithologic discontinuity - at the upper boundary of the 2Bt1 horizon at 23 inches.

The bulk density and platyness of the argillic horizon is considered to be relict of the till, but studies are needed to determine whether or not these horizons meet criteria for fragipans or fragic soil properties.

The 2BCd1 and 2BCd2 horizons were originally described as 2Bt horizons, but were redesignated because they are transitional to the substratum and exhibit densic characteristics.

ADDITIONAL DATA: Former Soil Interpretation Records - WI0137 and WI0346. Refer to soil survey sample number S90WI-005-008 for NSSL data on the typical pedon.

RONNEBY SERIES

The Ronneby series consists of very deep, somewhat poorly drained soils that formed in loamy glacial till on drumlins and moraines. These soils have a densic contact at depths of 40 to 60 inches. The saturated hydraulic conductivity is moderate or moderately rapid in the upper part and very slow in the dense till. Slopes range from 0 to 2 percent. Mean annual precipitation is about 28 inches. Mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Aeric Glossaqualfs

TYPICAL PEDON: Ronneby loam on a plane slope of 1 percent in a cultivated field. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 8 inches; very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; very friable; about 2 percent gravel; moderately acid; abrupt smooth boundary. (6 to 10 inches thick)

E--8 to 11 inches; brown (10YR 5/3) fine sandy loam, gray (10YR 6/1) dry; moderate thin and medium platy structure; very friable; common fine prominant strong brown (7.5YR 4/6) Fe concentrations and common medium faint dark grayish brown (10YR 4/2) Fe depletions; about 2 percent gravel; slightly acid; clear smooth boundary. (4 to 12 inches thick)

B/E--11 to 17 inches; 60 percent brown (10YR 4/3) fine sandy loam (Bt); 40 percent brown (10YR5/3) fine sandy loam (E), gray (10YR 6/1) dry; weak fine subangular block structure; friable; common fine prominent strong brown (7.5YR 4/6) Fe concentrations and common medium faint dark grayish brown (10YR 4/2) Fe depletions; thin stone line with about 11 percent gravel; moderately acid; clear smooth boundary. (2 to 8 inches thick)

Bt--17 to 33 inches; brown (7.5YR 4/4) fine sandy loam; weak medium platy structure parting to weak fine subangular blocky; friable; common distinct dark reddish brown (5YR 3/2) clay films on faces of peds; common fine distinct strong brown (7.5YR 4/6) Fe concentrations and common medium distinct brown (7.5YR 5/2) Fe depletions; few thin coatings of clean sand and silt on vertical cleavage faces; about 6 percent gravel; moderately acid; gradual wavy boundary. (5 to 18 inches thick)

BC--33 to 45 inches; reddish brown (5YR 4/3) fine sandy loam; weak medium platy structure; firm; few faint dark reddish brown (5YR 3/2) clay films on faces of plates and around pebble pockets; common fine prominent strong brown (7.5YR 4/6) Fe concentrations and common fine faint dark reddish gray (5YR 4/2) Fe depletions; about 10 percent gravel; slightly acid; gradual wavy boundary. (0 to 16 inches thick)

BCd--45 to 80 inches; reddish brown (5YR 4/3) fine sandy loam; very coarse and extremely coarse prismatic structure parting to moderate fine and medium platy, few 2 to 3 millimeter

oblique fractures 0.5 to 3.0 feet apart; very firm; few medium faint dark reddish brown (5YR 3/4) Fe concentrations and few medium dark reddish gray (5YR 4/2) Fe depletions along fracture faces in the upper part; about 9 percent gravel; neutral.

TYPE LOCATION: Benton County, Minnesota; about 1.5 miles south and 1.5 miles east of Foley; 1210 feet south and 180 feet east of the northwest corner of sec. 6, T. 36 N., R. 28 W.; USGS Quadrangle Foley, Minn.; Latitude 45 degrees 38 minutes 41 seconds N., and Longitude 93 degrees 52 minutes 59 seconds W., NAD 83.

RANGE IN CHARACTERISTICS: Depth to a densic contact is 40 to 60 inches. The content of rock fragments is 1 to 15 percent by volume throughout the profile. Stony and very stony phases are recognized. The argillic horizon has 8 to 18 percent clay.

The Ap or A horizon has hue of 10YR or 7.5YR, value of 2 or 3, chroma of 1 or 2. The A horizon is loam, fine sandy loam, sandy loam, very fine sandy loam or silt loam. Some pedons have an O horizon less than 3 inches thick. Reaction is strongly acid to slightly acid.

The E horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 1 to 3. The E horizon is fine sandy loam, loam, sandy loam or very fine sandy loam. Reaction is strongly acid to slightly acid.

The B/E or E/B horizon has hue of 10YR or 7.5YR, value of 4 or 5 and chroma of 2 to 4. It is fine sandy loam, sandy loam or loam. Reaction is strongly acid to slightly acid.

The Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 3 or 4. The Bt horizon is fine sandy loam, sandy loam or loam. The base status is greater than 60 percent. Bulk density ranges from 1.45 to 1.65 gm/cc. Reaction is strongly acid to slightly acid.

The BC horizon has hue of 5YR or less commonly 7.5YR, value of 3 to 5 and chroma of 3 or 4. It is fine sandy loam or sandy loam. Moist bulk density ranges from 1.65 to 1.80gm/cc. Reaction is moderately acid to neutral.

The BCd horizon has hue of 5YR or less commonly7.5YR, value of 3 to 5 and chroma of 3 or 4. Texture is fine sandy loam or sandy loam. Moist bulk density ranges from 1.85 to 2.0 gm/cc. It is moderately acid to neutral.

COMPETING SERIES: There are no competing series

GEOGRAPHIC SETTING: These soils have plane or slightly concave slopes on drumlins or moraines. Slope gradients range from 0 to 2 percent. Ronneby soils formed in noncalcareous, Superior lobe dense loamy glacial till of Late Wisconsinan Age. Mean annual air temperature is about 37 to 45 degrees F. Mean annual precipitation is about 24 to 33 inches. Frost-free days range from 90 to 145. Elevation above sea level ranges from 800 to 1450 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Milaca, Mora, and Parent soils, which form a drainage sequence with the Ronneby soils. Milaca soils are moderately well drained and are on more sloping terrain. The somewhat poorly drained Mora soils are on higher lying positions. The poorly and very poorly drained Parent soils are on lower positions on the landscape occupying flats, swales or depressions.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat poorly drained. Runoff is very low or low. Saturated hydraulic conductivity is moderate or moderately rapid in the upper part and very slow in the dense till. This soil has perched seasonal high saturation at a depth of 0.5 feet during April to June in years of normal precipitation.

USE AND VEGETATION: Approximately half of this soil is cultivated. Crops commonly grown are corn, soybeans, oats, and hay. The remaining areas are pastured or forested. Native vegetation is mixed deciduous forest or mixed deciduous-coniferous forest.

DISTRIBUTION AND EXTENT: MLRA-90, mostly in East-central Minnesota and northwestern Wisconsin. This soil is moderately extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Sherburne County, Minnesota, 1965.

REMARKS: Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface to 11 inches (Ap and E horizon); albic horizon - the zone from 8 to 11 inches (E horizon); argillic horizon - the zone from 11 to 33 inches (B/E and Bt horizons); glossic horizon-zone from 11 to 17 inches (B/E horizon); base saturation is above 60 percent in some part of the argillic horizon; aquic conditions- based on presumed positive reaction with alpha alpha dipyridyl at sometime during the year in most years. This parent material does not reduce soil colors typical of other parent material; densic contact- the zone beginning at 45 inches (BCd horizon). This soil was formerly classified as coarse-loamy, mixed, superactive, frigid, Udollic Epiaqualfs. Classification changed to reflect predomenance of a glossic horizon.

ADDITIONAL DATA: See National Soil Survey Lab 563MN-5-5 for data on the typical pedon. Soil Interpretation Record Number is MN0247.

FREEON SERIES

The Freeon series consists of very deep, moderately well drained soils which are deep to a densic contact. They formed in loess or silty lacustrine deposits and in the underlying dense sandy loam till on ground moraines, end moraines, disintegration moraines, drumlins, and ice-walled glacial lake plains. Permeability is moderate in the silty mantle, slow or moderately slow in the till subsoil, and very slow in the substratum. Slopes range from 0 to 20 percent. Mean annual precipitation is about 30 inches. Mean annual air temperature is about 42 degrees F. TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, frigid Oxyaquic Glossudalfs

TYPICAL PEDON: Freeon silt loam - on a convex 2 percent slope in a cultivated field at an elevation of about 1,200 feet. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine subangular blocky structure; friable; common fine roots; about 2 percent gravel; moderately acid; abrupt smooth boundary. (6 to 9 inches thick)

E/B--7 to 19 inches; about 60 percent brown (10YR 5/3) silt loam (E), very pale brown (10YR 7/3) dry; weak medium platy structure; friable; extends as tongues into or surrounds remnants of dark yellowish brown (10YR 4/4) silt loam (Bt); moderate fine subangular blocky structure; friable; few distinct dark brown (7.5YR 3/4) clay films on faces of peds; common fine and very fine roots; many very fine and few medium tubular pores; common coarse prominent strong brown (7.5YR 4/6) masses of iron accumulation; about 5 percent gravel and 1 percent cobbles; slightly acid; clear smooth boundary. (0 to 15 inches thick)

2B/E--19 to 39 inches; about 70 percent dark brown (7.5YR 3/4) sandy loam (Bt); moderate medium subangular blocky structure; friable; common faint dark brown (7.5YR 3/4) clay films on faces of peds; penetrated by tongues of brown (10YR 5/3) sandy loam (E), very pale brown (10YR 7/3) dry; weak thick platy structure; friable; few fine roots; many fine tubular pores; common coarse prominent strong brown (7.5YR 5/8) masses of iron accumulation; about 12 percent gravel and 1 percent cobbles; strongly acid; clear smooth boundary. (The glossic horizon ranges from 5 to 40 inches thick.)

2Bt--39 to 53 inches; dark reddish brown (5YR 3/4) sandy loam; moderate fine and medium prismatic structure tending to part along horizontal cleavage planes to weak thin plates inherited from the parent material; firm; few fine roots; common fine tubular pores; common fine and medium vesicular pores; common faint dark reddish brown (5YR 3/4) clay films on all faces of peds; very few prominent brown (10YR 5/3) silt coats on vertical faces of peds; few coarse prominent strong brown (7.5YR 5/8) masses of iron accumulation; about 5 percent gravel and 1 percent cobbles; strongly acid; clear smooth boundary. (5 to 30 inches thick)

2BCd1--53 to 69 inches; dark reddish brown (5YR 3/4) sandy loam; weak very coarse prismatic structure tending to part along horizontal cleavage planes to weak thin plates inherited from

the parent material; firm; many fine tubular pores; few medium vesicular pores; common faint dark reddish brown (5YR 3/4) clay films on top faces of peds; few medium prominent strong brown (7.5YR 5/8) masses of iron accumulation on vertical ped faces; about 5 percent gravel and 1 percent cobbles; moderately acid; clear wavy boundary.

2BCd2--69 to 85 inches; dark reddish brown (5YR 3/4) sandy loam; weak extremely coarse prismatic structure tending to part along horizontal cleavage planes to weak thin plates inherited from the parent material; many fine tubular pores; few medium vesicular pores; common faint dark reddish brown (5YR 3/4) clay films on top faces of peds; about 5 percent gravel and 1 percent cobbles; moderately acid; clear wavy boundary. (Combined thickness of the 2BCd horizons ranges from 0 to 70 inches.)

2Cd--85 to 100 inches; reddish brown (5YR 4/4) sandy loam; massive tending to part along horizontal cleavage planes to weak thin plates; firm; dense and compact; about 5 percent gravel and 1 percent cobbles; moderately acid.

TYPE LOCATION: Barron County, Wisconsin; about 3 1/2 miles south of Barron; 1100 feet north and 200 feet west of the southeast corner, sec. 16, T. 33 N., R. 12 W. Dallas USGS quadrangle; lat. 45 degrees 20 minutes 30 seconds N. and long. 91 degrees 51 minutes 35 seconds W.; NAD27.

RANGE IN CHARACTERISTICS: Thickness of silty mantle ranges from 12 to 36 inches. Depth to the base of the argillic horizon and to densic contact ranges from 40 to 60 inches. Content of clay averages from 7 to 17 percent in the particle-size control section and content of fine sand or coarser averages 15 to 70 percent. The base saturation (by sum of cations) is less than 60 percent in some part of the argillic horizon. Volume of gravel ranges from 0 to 10 percent in the silty mantle and from 5 to 35 percent in the till. Volume of cobbles ranges from 0 to 3 percent in the silty mantle and from 0 to 5 percent in the till. Volume of stones ranges from 0 to 1 percent in the silty mantle and from 0 to 3 percent in the till. Surface stones have coverage ranging from 0 to 3 percent. Reaction ranges from extremely acid to slightly acid in the solum, except that it ranges to neutral in the Ap horizon where the soil is limed. Reaction ranges from strongly acid to neutral in the substratum. Redox concentrations are within 40 inches and occur as high in the profile as the E horizon in some pedons. Redox depletions are below the upper 10 inches of the argillic in some pedons. Saturation occurs below the upper 10 inches of the argillic, but within a depth of 40 inches at some time in most years.

The Ap horizon has value of 3 or 4 and chroma of 2 or 3. Uncultivated areas have A horizons,1 to 4 inches thick, with hue of 10YR, value of 2 or 3, and chroma of 1 to 3.

Some pedons have an E horizon with hue of 7.5YR or 10YR, value of 4 or 5, and a chroma of 2 or 3. Colors of 4/3 and 5/3 have value dry of 7 or more. The E horizon is silt loam or silt.

Some pedons have a Bw horizon with hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4. It is silt loam. Bw horizons with spodic color have less than 0.6 percent organic carbon.

Freeon soils have a glossic horizon. Horizonation has a wide range depending on the thickness of the silty mantle and the degree to which eluviation has occurred. Therefore, there can be E/B, B/E, 2E/B, or 2B/E horizons singly or in combination.

The E part of the E/B or B/E horizon has color and texture like the E horizon described above. The Bt part has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6.

Some pedons have a Bt horizon with color and texture like the Bt part described above.

The 2E part of the 2E/B or 2B/E horizons has hue of 5YR, 7.5YR, or 10YR; value of 4 to 6, and chroma of 2 or 3. Colors of 4/3 or 5/3 have value dry of 7 or more. The 2E part is typically sandy loam, fine sandy loam, loam, or their gravelly analogs, but in some pedons it is loamy sand or gravelly loamy sand. The 2Bt part has color and texture like the 2Bt horizon described below.

The 2Bt horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 to 5; and chroma of 4 to 6. It is typically sandy loam, fine sandy loam, loam, or their gravelly analogs. Bulk density ranges from 1.65 to 1.90. Some pedons have pockets or strata of loamy sand or gravelly loamy sand.

The 2BCd horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 to 5; and chroma of 4 to 6. It is typically sandy loam, fine sandy loam, or their gravelly analogs. Clay content averages more than 7 percent. Bulk density ranges from 1.8 to 2.0 gm/cc. Some pedons have pockets or strata of loamy sand or gravelly loamy sand.

The 2Cd horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 3 to 5; and chroma of 4 to 6. It is typically sandy loam, fine sandy loam, or their gravelly analogs. Clay content averages more than 7 percent. Bulk density ranges from 1.8 to 2.0 gm/cc. Some pedons have pockets or strata of loamy sand or gravelly loamy sand.

COMPETING SERIES: These are the Aftad, Blowers, Frogcreek, Haugen, Neopit, and Scott Lake series. A similar soil is the Brennyville series.

Aftad, Neopit and Scott Lake soils do not have a densic contact within the series control section.

Blowers and Haugen soils do not have a 12 to 36 inch mantle that is more than 50 percent silt.

Brennyville soils have base saturation greater than 60 percent in all parts of the argillic horizon.

Frogcreek soils average less than 7 percent clay in the dense till.

GEOGRAPHIC SETTING:
Parent material: Formed in loess or silty lacustrine and in the underlying dense sandy loam till of Late Wisconsinan Age.
Landform: Ground moraines, disintegration moraines, end moraines, drumlins, and ice-walled glacial lake plains.

Slope: 0 to 20 percent.
Elevation: 800 to 1950 feet.
Mean annual air temperature: 39 to 45 degrees F.
Mean annual precipitation: 28 to 33 inches.
Frost-free days: 120 to 135 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Adolph, Almena, Amery, Auburndale, Capitola, Cebana, Haugen, Magnor, Newood, Newot, Santiago, and Spencer soils.

The well drained Santiago, the somewhat poorly drained Magnor, the poorly drained Cebana, and the very poorly and poorly drained Adolph and Capitola soils are in a drainage sequence with Freeon soils. Santiago soils are on steeper sloping landforms. Magnor soils are in lower or less sloping areas. Cebana, Adolph, and Capitola soils are in depressions and drainageways.

The moderately well drained Spencer soils are on similar landscape positions as Freeon soils, the somewhat poorly drained Almena soils are in lower or less sloping areas, and the poorly drained Auburndale soils are in depressions and drainageways. These soils have a silty mantle greater than 36 inches thick.

The well drained Amery and Newot soils, and the moderately well drained Haugen and Newood soils are on landscape positions that are similar to, higher than, or more sloping than those of Freeon soils where the silty mantle is less than 12 inches thick, or is absent.

DRAINAGE AND PERMEABILITY: Moderately well drained. Surface runoff low to high. Permeability is moderate in the silty mantle, moderately slow or slow in the till subsoil, and very slow in the substratum. This soil has a perched seasonal high water table at a depth of 2 to 3.5 feet for 1 month or more at some time during the period of September to June in most years.

USE AND VEGETATION: Much of this soil is cleared and used for pastureland or cropland. Corn, small grain, and hay are the major crops. The remainder is in woodland or wooded pasture. Native vegetation is deciduous forest. Common trees are sugar maple, black cherry, American basswood, white ash, yellow birch, American elm, bigtooth aspen, quaking aspen, balsam fir, northern red oak, and eastern hophornbeam.

DISTRIBUTION AND EXTENT: North-central and northwestern Wisconsin and east-central Minnesota. LRR K, MLRA 90A, and MLRA 90B. This soil is extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Barron County, Wisconsin, 1949. The original type location was changed in Barron County with the correlation of the updated soil survey in 1992.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
Particle size control section - the zone from 19 to 39 inches.
Ochric epipedon - the zone from 0 to 19 inches (Ap, E/B).
Albic horizon - the zone from 7 to 19 inches (E part of the E/B).
Glossic horizon - the zone from 7 to 39 inches (E/B, 2B/E).
Argillic horizon - the zone from 19 to 53 inches (2B/E, 2Bt).
Densic contact - the contact with dense till (2BCd1, 2BCd2, 2Cd) at 53 inches.
Redoximorphic concentrations - oxidized color features in the zone from 7 to 69 inches.
Lithologic discontinuity - at the upper boundary of the 2Bt/E horizon at 19 inches.

The bulk density and platyness of the argillic horizon is considered to be relict of the till, but studies are needed to determine whether or not these horizons meet criteria for fragipans or fragic soil properties.

The 2BCd1 and 2BCd2 horizons were originally described as 2Bt horizons, but were re-designated because they are transitional to the substratum and exhibit densic characteristics.

ADDITIONAL DATA: Former Soil Interpretation Record - WI0030. Refer to soil survey sample number S90WI-005-7 for NSSL data on the typical pedon.

KINGSLEY SERIES

The Kingsley series consists of very deep, well drained soils that formed in loamy glacial till on glacial moraines. These soils have moderate over moderately slow permeability. Slopes range from 2 to 40 percent. Mean annual precipitation is about 27 inches. Mean annual temperature is about 46 degrees F.

TAXONOMIC CLASS: Coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs

TYPICAL PEDON: Kingsley sandy loam with a convex slope of 20 percent in a terminal moraine in a mixed deciduous forest. (Colors are for moist soil unless otherwise stated.)

A1--0 to 3 inches; black (10YR 2/1) sandy loam, very dark gray (l0YR 3/l) dry; weak very fine granular structure; very friable; about 10 percent gravel; slightly acid; clear irregular boundary. (2 to 5 inches thick)

A2--3 to 7 inches; very dark grayish brown (10YR 3/2) sandy loam, grayish brown (l0YR 5/2) dry; weak very fine subangular blocky structure; very friable; about 10 percent gravel; slightly acid; clear wavy boundary. (0 to 5 inches thick)

E--7 to 14 inches; brown (7.5YR 4/2) loamy sand, pinkish gray (7.5YR 6/2) dry; weak medium subangular blocky structure; very friable; about 10 percent gravel; moderately acid; clear wavy boundary. (4 to 12 inches thick)

Bt1--14 to 25 inches; reddish brown (5YR 4/4) sandy loam; moderate medium and coarse subangular blocky structure; friable; few thin clay films and thin nearly continuous coatings of clean sand particles on faces of peds; about 10 percent gravel; moderately acid; clear smooth boundary.

Bt2--25 to 34 inches; reddish brown (5YR 4/4) sandy loam; moderate medium and coarse platy structure parting to moderate very fine subangular blocky; friable, hard and brittle; few thin clay films and coatings of clean sand and silt particles on faces of peds; about 10 percent gravel; strongly acid; gradual smooth boundary. (Bt horizon is 12 to 28 inches thick)

C--34 to 48 inches; reddish brown (5YR 4/4) sandy loam; moderate fine and medium platy structure; friable; few thin coatings of clean sand and silt particles on faces of peds in upper part; about 10 percent gravel; moderately acid.

TYPE LOCATION: Hennepin County, Minnesota; suburbs of the city of Bloomington; 2,640 feet north of the southwest corner of Sec. 16, T. 116 N., R. 21 W.; USGS Bloomington quadrangle; lat. 44 degrees 51 minutes 17 seconds N. and long. 93 degrees 21 minutes 29 seconds W., NAD27

RANGE IN CHARACTERISTICS: The depth to free carbonates ranges from 30 to 100 inches or more. The profile contains 2 to 15 percent by volume of rock fragments, most of which are igneous rocks.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The E horizon has hue of 10YR or 7.5YR, value of 4 or 5 and chroma of 2 through 4. The A and E horizons are fine sandy loam, sandy loam, coarse sandy loam, loam, loamy sand, or loamy coarse sand with the coarser textures commonly in the E horizon. They are slightly or moderately acid.

The Bt horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 3 to 6. Some pedons have 10YR hue in the upper part, value of 4 or 5 and chroma of 4 to 6. It mostly is sandy loam or coarse sandy loam, but thin sandy clay loam, loamy sand, or loamy coarse sand subhorizons are in some pedons. It typically averages between 10 to 15 percent clay but ranges from 8 to 18 percent. It ranges from 55 to 70 percent fine sand and coarser material. B/A clay ratios are 1.5 to 2.0. It commonly is strongly or moderately acid and less commonly slightly acid to slightly alkaline in the lower part of some pedons. Some pedons have a thin BC horizon.

The C horizon typically has hue of 5YR or 7.5YR, and value and chroma of 3 or 4, but thin strata with yellower hues are common. It is sandy loam or coarse sandy loam but thin, finer- or coarser-textured strata are common. It is friable or firm. It is moderately acid through slightly alkaline. It has less than 5 percent calcium carbonate equivalent.

COMPETING SERIES: These are the Backbone, Bainter(T), Desker, Forkhorn(T), Billett, Oronoco, Pardeeville, Rusktown(T) and Ulster series. Backbone soils have bedrock beginning at a depth of 20 to 40 inches. Bainter(T), Desker, Forkhorn(T) and Rusktown(T) soils have sandy textures in the lower third of the series control section. Billett soils have formed in outwash and have loamy sand or sand C horizons. Oronoco soils formed in aeolian sediments and lack coarse fragments. Ulster soils have a lithologic discontinuity and stratified textures(eolian) in the lower third of the series control section. Pardeeville soils are not clearly separated at this time. Will need further study.

GEOGRAPHIC SETTING: These soils are on convex slopes on complex undulating to steep moraines of Late Wisconsin age. Slopes range from 2 to 40 percent. The Kingsley soils formed in nonacid, reddish brown sandy loam till. Mean annual temperature ranges from 45 to 48 degrees F. Mean annual precipitation ranges from 26 to 30 inches. Frost free days range from 130 to 160. Elevations above sea level range from 1000 to 1300 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: Burnsville, Chetek, Hayden, Salida, and Nymore soils are the main ones. Burnsville and Chetek soils are somewhat excessively drained, and Salida and Nymore soils are excessively drained. Hayden soils are fine-loamy and formed in calcareous till.

DRAINAGE AND PERMEABILITY: Well drained. Surface runoff is medium or rapid. Permeability is moderate or moderately slow.

USE AND VEGETATION: This soil is cropped to small grains, corn, soybeans, hay, and vegetable and fruit crops. The remainder is in pasture or forest, or developed for homesites. The native vegetation was mixed deciduous forest. Present day vegetation is mainly oaks.

DISTRIBUTION AND EXTENT: East-central Minnesota. This series is moderately extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Dakota County, Minnesota, 1942.

REMARKS: Diagnostic horizons and features recognized in this pedon are: orchric epipedon-the zone from 0 to 14 inches (A1,A2,E horizons) argillic horizon-the zone from 14 to 34 inches (Bt1,Bt2 horizons) mollic subgroup- the zone from 0 to 7 inches (A1,A2 horizons) udic moisture regime.

ADDITIONAL DATA: Refer to MN. Agr. Exp. Sta. Central File Code No. 759 for results of some laboratory analysis of the typical pedon, and to S74MN-163-3 for data on an additional pedon.

DEMONTREVILLE SERIES

The DeMontreville series consists of very deep, well drained and moderately well drained soils formed in a moderately thick sandy mantle of aeolian or glacial lacustrine or outwash sediments and the underlying loamy glacial till on glacial moraines. Permeability is rapid in the sandy mantle and moderately slow in the rest of the soil. These upland soils have slopes ranging from 1 to 45 percent. Mean annual temperature is about 41 degrees F. Mean annual precipitation is about 29 inches.

TAXONOMIC CLASS: Loamy, mixed, superactive, frigid Arenic Hapludalfs

TYPICAL PEDON: DeMontreville loamy fine sand with a 2 percent plane south-facing slope on a glacial moraine in an alfalfa field. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 7 inches; dark grayish brown (10YR 4/2) loamy fine sand; light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; 2 to 5 percent gravel; slightly acid; abrupt smooth boundary. (5 to 8 inches thick)

E1--7 to 11 inches; brown (10YR 4/3) loamy fine sand, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; very friable; about 5 percent gravel; moderately acid; clear irregular boundary.

E2--11 to 15 inches; brown (10YR 4/3) loamy sand, pale brown (10YR 6/3) dry; weak medium subangular blocky structure; friable; about 10 percent gravel; moderately acid; clear wavy boundary. (0 to 22 inches thick, combined thickness)

BE--15 to 24 inches; brown (10YR 5/3) loamy sand; moderate medium subangular blocky structure; friable; about 8 percent gravel; moderately acid; clear irregular boundary. (0 to 15 inches thick)

2Bt1--24 to 29 inches; dark reddish brown (5YR 3/4) sandy loam; moderate medium subangular blocky structure; firm; few faint clay films along vertical cleavages; about 10 percent gravel; moderately acid; clear wavy boundary.

2Bt2--29 to 41 inches; dark reddish brown (5YR 3/4) sandy loam; moderate medium subangular blocky structure; firm; few faint clay films along vertical cleavages; about 10 percent gravel; slightly acid; clear wavy boundary. (9 to 22 inches, combined thickness)

2C--41 to 60 inches; dark reddish brown (5YR 3/4) sandy loam; massive; firm; about 15 percent gravel; slightly acid.

TYPE LOCATION: Washington County, Minnesota. About one mile east northeast of Willernie; 750 feet south and 2,010 feet west of the northeast corner, sec. 28, T. 30 N., R. 21 W.

RANGE IN CHARACTERISTICS: The thickness of the solum ranges from 30 to 50 inches and depth to the glacial till ranges from 20 to 40 inches. Free carbonates are absent to depths of 60 inches or more. The A and B horizons contain 0 to 10 percent gravel by volume and the 2B and 2C horizons contain from 8 to 20 percent gravel and cobbles of mixed lithology. The 2B and 2C horizons have moist bulk density ranging from 1.65 to 1.75 gm/cc. The soil moisture control section is not dry in all parts for 20 to 35 consecutive days during the 120 days following the summer solstice.

The A or Ap horizons have hue of 10YR, value of 2 to 4, and chroma of 1 to 3. The E horizon has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 2 to 4. The A and E horizons typically are loamy fine sand or loamy sand but sand or fine sand are in the range. They are strongly acid through neutral.

Some pedons have a Bw horizon in the upper sediment instead of an E horizon. It has hue of 10YR or 7.5YR, value of 3 to 5, and chroma of 3 to 6. It is loamy sand or loamy coarse sand but coarse sand, sand, fine sand, and loamy fine sand are in the range. It is strongly acid through neutral.

Some pedons have B/E or 2 B/E horizons, but the E part comprises less than 15 percent of the horizon.

The 2Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 3 to 6. In some pedons mottles with chroma of 2 are below the upper 10 inches of the argillic horizon. It is sandy loam, sandy clay loam, loam, or fine sandy loam. It averages between 6 to 18 percent clay, but parts may range up to 22 percent. It is moderately acid or slightly acid. It has few through many clay films.

The 2C horizon has hue of 7.5YR or 5YR, value of 3 or 4, and chroma of 4 to 6. It is sandy loam, coarse sandy loam, loamy coarse sand or their gravelly analogues. It is moderately acid through neutral.

COMPETING SERIES: These are the Andrusia (T), Braham, Captom (T), Cutaway, Escanaba, Haskill Pomroy and Redeye soils. Andrusia soils have friable argillic horizons and are formed in glacial outwash sediments. Braham soils have hue of 10YR and have more than 18 percent clay in the argillic horizon. Captom soils are dry in the soil moisture control section for more than 35 consecutive days during the 120 days following the summer solstice. Cutaway soils have 18 to 35 percent clay in the argillic horizon, hues yellower than 7.5YR and also have bisequum development. Escanaba soils have Bs horizons and are dominated by fine sands throughout. Haskill soils have sand in the lower part of the series control section and below the argillic horizon. Pomroy and Redeye soils have argillic horizons that formed in dense till which have bulk densities greater than 1.8. Redby soils also have hue of 10YR or yellower and free carbonates within 60 inches.

GEOGRAPHIC SETTING: DeMontreville soils are on summits and upper side slopes of knolls on glacial moraines. Slopes are plane or convex and slope gradients range from 1 to 45 percent. These soils formed in a moderately thick sandy mantle of aeolian or lacustrine or outwash sediments and loamy glacial till of the Late Wisconsinan Age. Mean annual temperature ranges from 37 to 45 degrees F. Mean annual precipitation ranges from about 24 to 33 inches. Frost-free days range from 90 to 150. Elevation above sea level ranges from 670 to 1450 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: DeMontreville soils are commonly adjacent to the Cushing, Kingsley, and Mahtomedi soils. The well drained Cushing and Kingsley soils occupy similar landscape positions and formed entirely from loamy glacial till. The excessively drained Mahtomedi soils formed in sandy sediments and are on similar landscapes.

DRAINAGE AND PERMEABILITY: Well drained and moderately well drained. Medium or slow runoff. Rapid permeability in the upper sandy mantle and moderately slow permeability in the underlying horizons. These soils have a perched water table above the horizons in glacial till for short periods during wet seasons.

USE AND VEGETATION: About one-half of this soil is cleared and used for pasture or cropped to corn, small grains, or hay. The remainder is in forest or wooded pasture. Native vegetation was deciduous forest, mainly oaks.

DISTRIBUTION AND EXTENT: Central and east-central Minnesota. Moderately extensive.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota

SERIES ESTABLISHED: Washington and Ramsey Counties, Minnesota, 1978.

REMARKS: Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface to a depth of 15 inches (Ap, E1, and E2 horizons); argillic horizons - the zone from 24 to 41 inches (2Bt1 and 2Bt2 horizons); arenic subgroup - sandy textures in upper 24 inches.

CATHRO SERIES

The Cathro series consists of very deep, very poorly drained organic soils moderately deep to loamy materials. They formed in organic material 16 to 51 inches thick overlying loamy glacial deposits on ground moraines, end moraines, outwash plains, lake plains, stream terraces, and flood plains. Permeability is moderately slow to moderately rapid in the organic material and moderately slow or moderate in the loamy material. Slopes range from 0 to 2 percent. Mean annual precipitation is about 32 inches. Mean annual air temperature is about 43 degrees F.

TAXONOMIC CLASS: Loamy, mixed, euic, frigid Terric Haplosaprists

TYPICAL PEDON: Cathro muck - on a slope of 1 percent in a forested area (Colors are for moist conditions unless otherwise stated.)

0a1--0 to 6 inches; black (5YR 2/1) rubbed and pressed muck (sapric material); about 40 percent fiber, about 15 percent rubbed; weak fine granular structure; nonsticky; primarily herbaceous fibers; neutral (pH 6.8 in water); clear wavy boundary.

0a2--6 to 11 inches; black (5YR 2/1) broken face and rubbed muck (sapric material), dark reddish brown (5YR 2/2) pressed; about 35 percent fiber, about 10 percent rubbed; weak medium granular structure; nonsticky; primarily herbaceous fibers; neutral (pH 6.8 in water); clear smooth boundary.

0a3--11 to 23 inches; black (5YR 2/1) on broken face and rubbed muck (sapric material); about 40 percent fibers, less than 10 percent rubbed; massive; nonsticky; primarily herbaceous fibers; neutral (pH 6.8 in water); abrupt smooth boundary. (Combined thickness of Oa horizons is 15 to 51 inches.)

Cg--23 to 60 inches; grayish brown (2.5Y 5/2) sandy loam; massive; slightly sticky; common coarse prominent reddish brown (5YR 5/3) and common coarse distinct brown (10YR 5/3) Fe concentrations; strongly effervescent; moderately alkaline.

TYPE LOCATION: Delta County, Michigan; about 4 miles south of Ensign; 1,620 feet north and 200 feet east of the southwest corner of sec. 23, T. 40 N., R. 21 W.

RANGE IN CHARACTERISTICS: The depth to the loamy C horizon ranges from 16 to 51 inches. Woody fragments over 2cm in size comprise less than 15 percent of the organic material. The organic portion of the control section has hue of 10YR, 7.5YR, or 5YR; value of 2 or 3; and chroma of 0 to 3 or are neutral. In some pedons the value or chroma or both increases 1 or 2 units when exposed to the air. The organic portion of the control section ranges from pH 4.5 to less than pH 7.8 in calcium chloride and does not have free carbonates.

The surface tier exclusive of loose surface litter or mosses, is comprised of mucky peat (hemic material) or muck (sapric material) material with an unrubbed fiber content that ranges from about 20 percent to 50 percent; rubbed is less than 20 percent. Up to 4 inches of peat is on the surface in some pedons. The surface tier is weak or moderate fine granular structure. Typically the structure grade becomes stronger as the amount of recognizable woody material increases.

The subsurface tier is muck (sapric material). The unrubbed fiber content ranges from 50 to less than 10 percent and is less than 16 percent after rubbing. Some pedons have thin layers of mucky peat (hemic material) in the control section. Ash content of the organic layer just above the loamy substratum is as much as 40 percent in some pedons.

A thin A horizon is present in some pedons. It has hue of 10YR, 2.5Y, 5Y or is neutral, value of 2 or 3 and chroma of 0 to 2. It is sandy loam, fine sandy loam, sandy clay loam, loam, silt loam or their mucky analogs. It ranges from moderately acid to slightly alkaline.

The C horizon has hue of 5YR, 7.5YR, 10YR, 2.5Y, 5GY, 5GB, or 5Y; value of 4 to 6; and chroma of 1 to 3. It is sandy loam, fine sandy loam, very fine sandy loam, sandy clay loam, loam, silt loam, clay loam or silty clay loam. Stratified substratums phases containing thin strata of fine sand or sand, less than 3 inches thick are recognized. It ranges from moderately acid to moderately alkaline. Coarse fragments range from 0 to 25 percent by volume. Some pedons do not contain free carbonates.

COMPETING SERIES: These are the Berner, Bullwinkle, Dingle, Nidaros, and Wonsqueak series. Berner soils have a sandy layer above the loamy sediment. Bullwinkle soils have greater than 15 percent woody fragments in the organic material. Dingle soils occur in areas with 14 to 16 inches of annual precipitation and in elevations from 5900 to 6000 feet. Nidaros soils have sandy underlying materials. Wonsqueak soils are substantially drier in the moisture control section during the 120 days following the summer solstice.

GEOGRAPHIC SETTING: Cathro soils commonly are in relatively small depressions mainly within ground moraines, end moraines, lake plains and outwash plains. A few areas are on narrow flood plains. Individual bodies range in size from about 10 to 100 acres. Slopes are 0 to 2 percent. The ground water carrying minerals from the surrounding upland, influences the composition of the organic deposit. Mean annual precipitation ranges from about 19 to 43 inches. Mean annual air temperature ranges from 36 to 45 degrees F. Frost-free days range from 70 to 145. Elevation above sea levl ranges from 600 to 2,000 feet.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Carbondale and Rifle soils that occupy similar landscape positions and the Angelica and Ensley soils. Angelica and Ensley soils are poorly drained mineral soils commonly located adjacent to the edges of Cathro soils. The Carbondale soils have hemic soil materials within 51 inches. Rifle soils formed in hemic materials 51 inches or greater.

DRAINAGE AND PERMEABILITY: Very poorly drained. Depth to the seasonal high saturation ranges from 1 foot above the surface to 0.5 foot below the surface at some time from October to June in most years. Ponded phases have a seasonal high saturation from 4 foot above the surface to 0.5 foot below the surface throughout the year. Surface runoff is neglible to low. Permeability is moderately rapid to moderately slow in the organic portion and moderately slow or moderate in the mineral substratum. Stratified substratum phases have saturated hydraulic conductivity ranging up to moderately rapid or rapid in the individual sand strata.

USE AND VEGETATION: Most of these soils are in woodland, however some are in sedge and cattails. Vegetation includes white cedar, alder, and balsam fir. A few areas are cleared and are used for pasture.

DISTRIBUTION AND EXTENT: Northern Lower Peninsula and Upper Peninsula of Michigan, northern Minnesota, northern Wisconsin and upper New England.

MLRA OFFICE RESPONSIBLE: St. Paul, Minnesota.

SERIES ESTABLISHED: Delta County, Michigan, 1969.

REMARKS: Diagnostic horizons and features recognized in this pedon are: sapric material from the surface to 23 inches (Oa1, Oa2, and Oa3 horizons); terric feature at 23 inches (Cg horizon); aquic moisture regime (low chroma in the soil moisture control section.)