Appendix A

Acronyms

This appendix contains a list of the acronyms used in the report and their definitions.

Appendix A: Acronyms

Definition of Terms

1987 Manual	1987 Corps of Engineers Wetland Delineation Manual
2008 Supplement	United States Army Corps of Engineers Interim Regional Supplement to the Corps Of Engineers Wetland Delineation Manual: Midwest Region
Act	Illinois Interagency Wetland Policy Act of 1989
ALP	Airport Layout Plan
C Value	Coefficient of Conservatism
CWA	Clean Water Act of 1977
EA	IDOT South Suburban Airport Environmental Assessment dated February 27, 1998
EIS	Environmental Impact Statement
ESA	Endangered Species Act of 1973
FQA	Floristic Quality Assessment
FQI	Floristic Quality Index
FW	Farmed Wetland
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
IDNR	Illinois Department of Natural Resources
IDOT	Illinois Department of Transportation
IESPA	Illinois Endangered Species Protection Act of 1972
IESPB	Illinois Endangered Species Protection Board
INHS	Illinois Natural History Survey
IRAP	Indiana Regional Airport Study
INAI	Illinois Natural Area Inventory Sites
NFSAM	National Food Security Act Manual
NRCS	National Resource Conservation Service
NTCHS	National Technical Committee on Hydric Soils
NWI	National Wetland Inventory
PDOP	Position Dilution of Precision
PEM	Palustrine Emergent
PFO	Palustrine Forested
POW	Palustrine Open Water
PSS	Palustrine Scrub-Shrub
R20WH	Riverine Wetland
RPW	Relatively Permanent Waters
Tier 1-EIS	Tier 1 Environmental Impact Statement
Tier 1-ROD	Tier 1 Record of Decision
TNW	Traditional Navigable Waters
USACE	United States Army Corps of Engineers
USACE Chicago District	United States Army Corps of Engineers Chicago District
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WETS	Wetness Evaluation Tables

Appendix B

Historical Wetland Studies

This appendix contains mapping results from past wetland studies showing wetland delineation results from 1996, NRCS review results from 2002, and a comparison of 1996 and 2002 results with the current 2008/2009 study results.

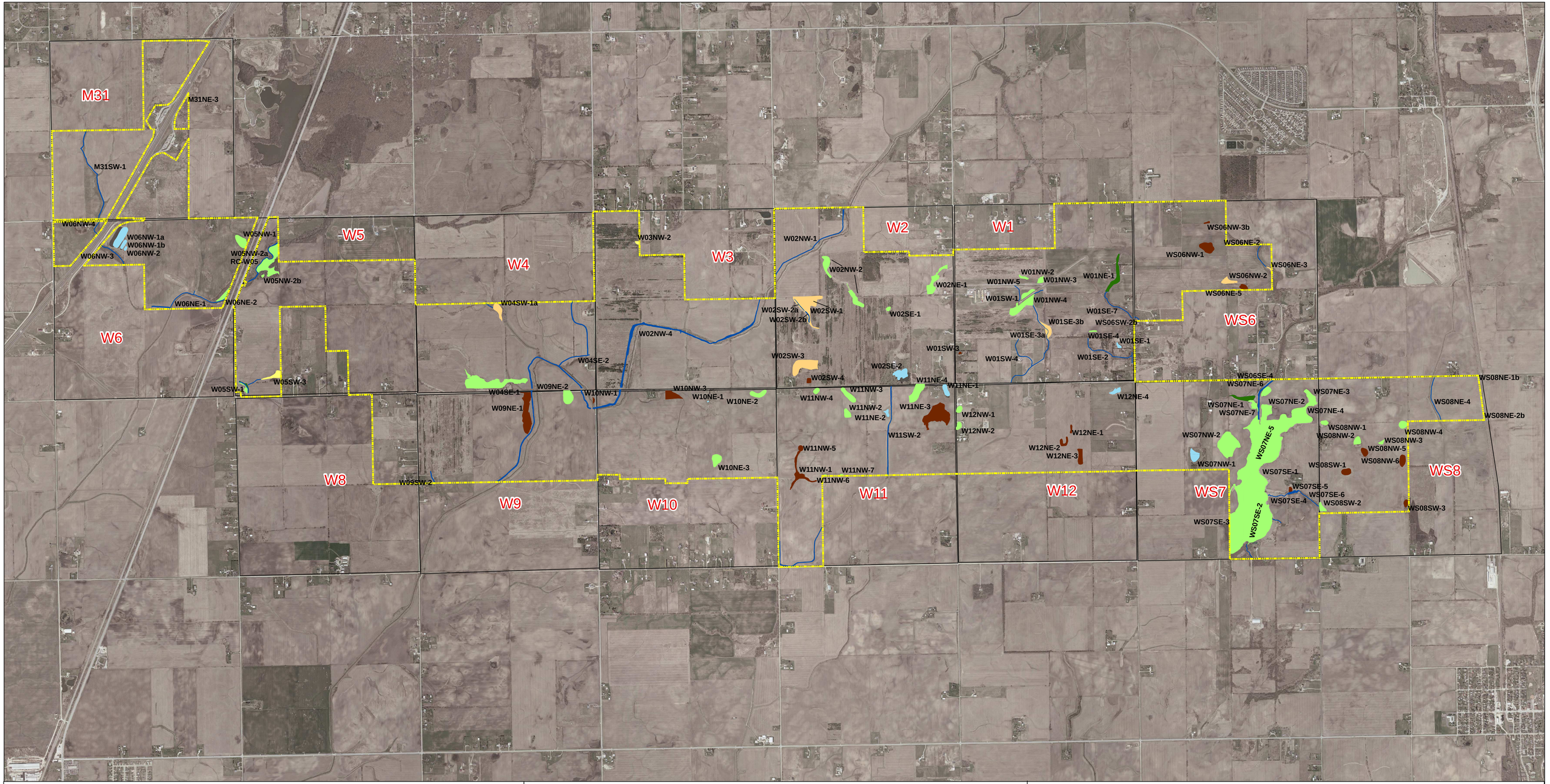
Exhibit B-1: 1996 Wetland Investigation Map—All Investigated Areas

Exhibit B-2: 1996 Wetland Delineation Map—Wetland Areas Only

Exhibit B-3: 2002 NRCS Review Results

Exhibit B-4: Identified Wetland Areas 1996, 2002 and 2008

Exhibits B-4 A-D: Same map as Exhibit B-4, divided into four quarters, A through D.



Legend

Wetland Types

- PEM
- PSS
- PFO
- POW
- PSS/PEM
- Stream
- Wetland Complex
- Upland
- 2008 Study Boundary
- Sections

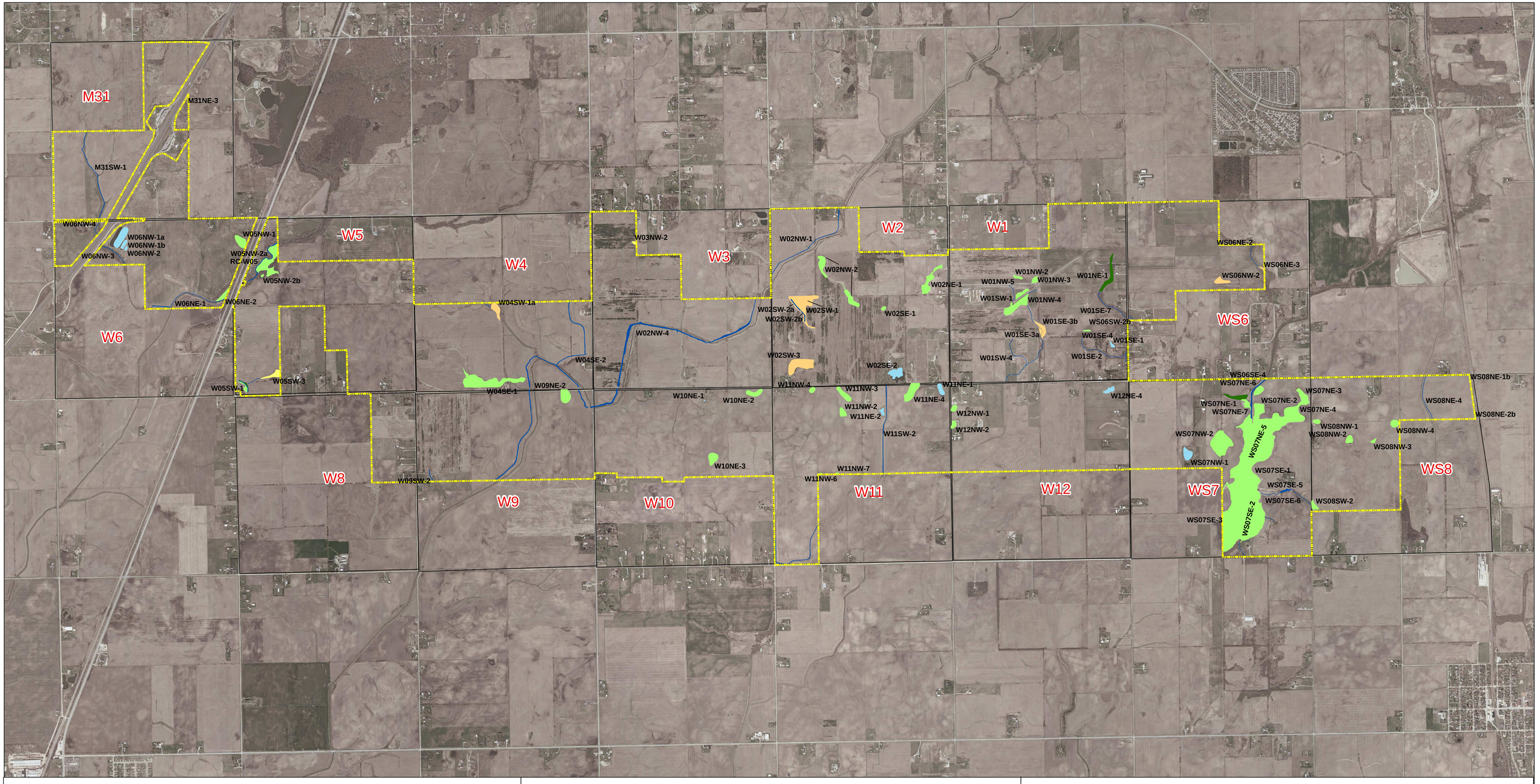
N

EXHIBIT B-1
1996 WETLAND DELINEATION MAP - ALL INVESTIGATED AREAS
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 2,000 4,000 8,000 12,000 Feet



Legend

Wetland Type

- PEM
- PSS
- PFO
- POW
- PSS/PEM
- Stream
- Wetland Complex
- 2008 Study Boundary
- Sections

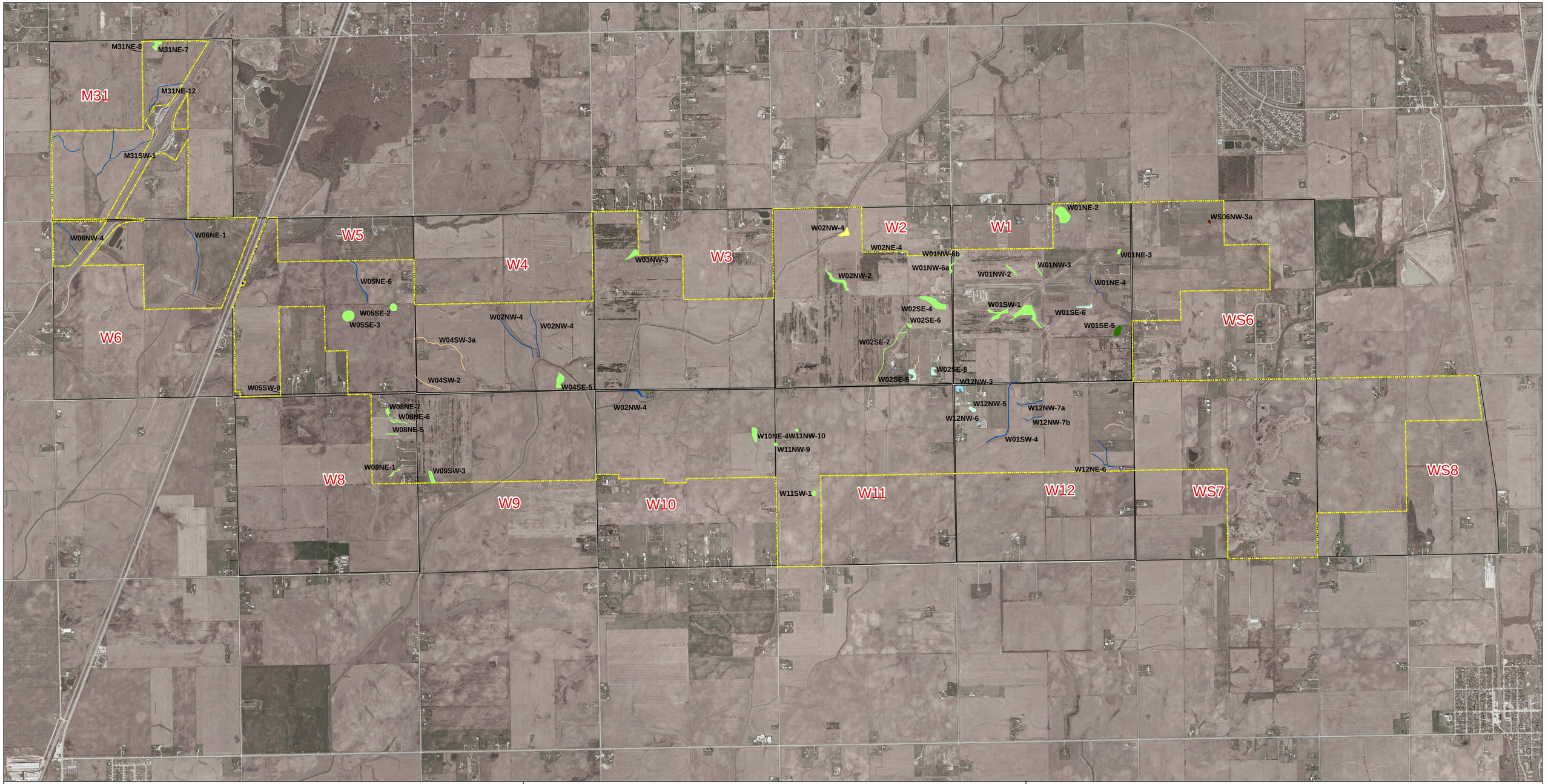
N

EXHIBIT B-2
1996 WETLAND DELINEATION MAP - WETLAND AREAS ONLY
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 2,000 4,000 8,000 12,000 Feet



Legend

Wetland Type

- PEM
- PSS
- PFO
- POW
- PSS/PEM
- Stream
- Wetland Complex
- Upland
- 2008 Study Boundary
- Sections

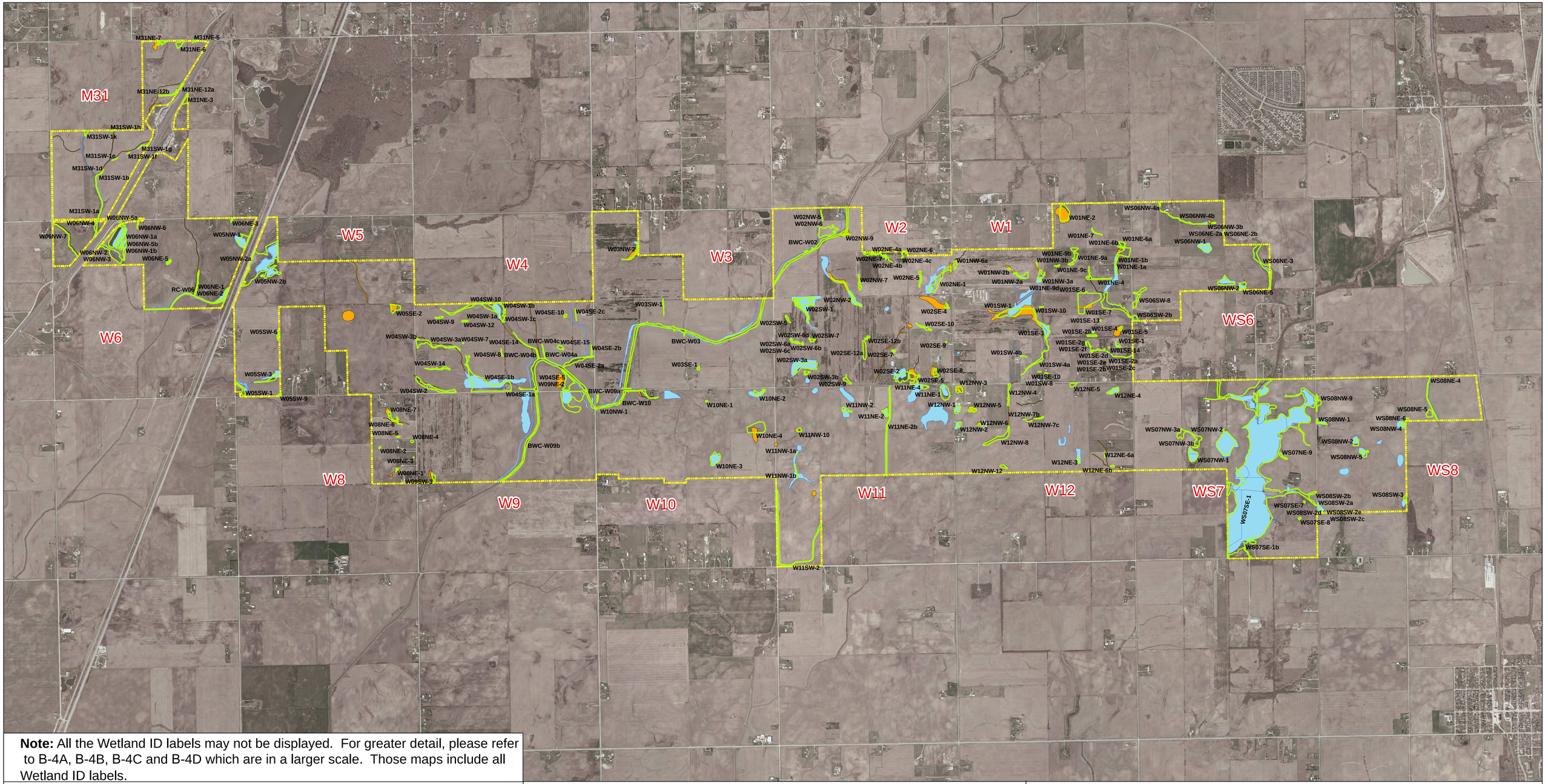
N

EXHIBIT B-3
2002 NRCS AERIAL REVIEW RESULTS
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 2,000 4,000 8,000 12,000 Feet



Note: All the Wetland ID labels may not be displayed. For greater detail, please refer to B-4A, B-4B, B-4C and B-4D which are in a larger scale. Those maps include all Wetland ID labels.

Legend

Investigation Results

- 1996 Wetland Areas
- 2002 Wetland Areas
- 2008-09 Wetland Areas
- 2008 Study Boundary
- Sections

N

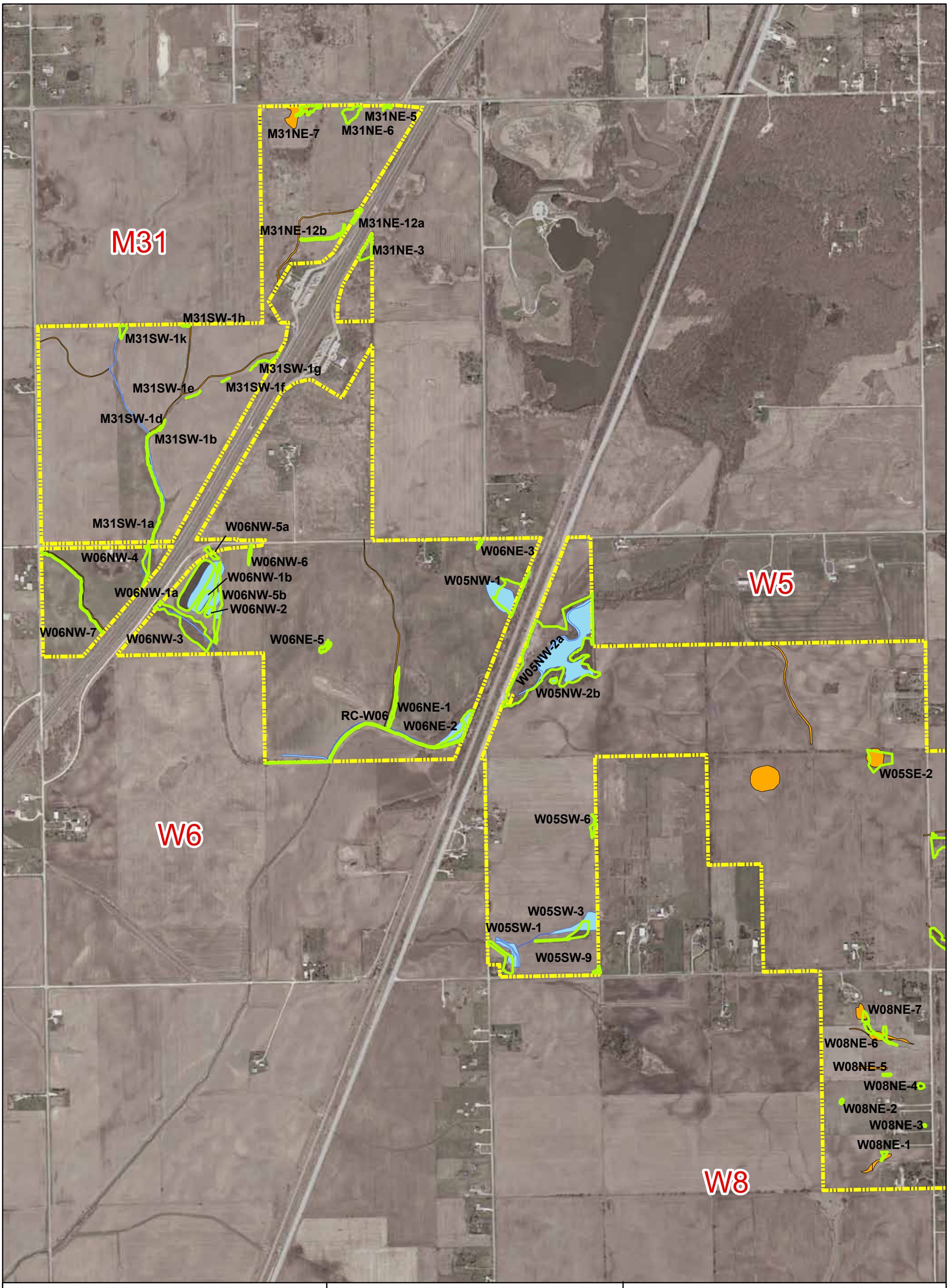
Only Wetland ID labels for the current study results are displayed on this map.

EXHIBIT B-4
IDENTIFIED WETLAND AREAS - 1996, 2002 and 2008-09
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 2,000 4,000 8,000 12,000 Feet



Legend

Investigation Results

- 1996 Wetland Areas
- 2002 Wetland Areas
- 2008 Wetland Areas
- 2008 Study Boundary
- Sections

N

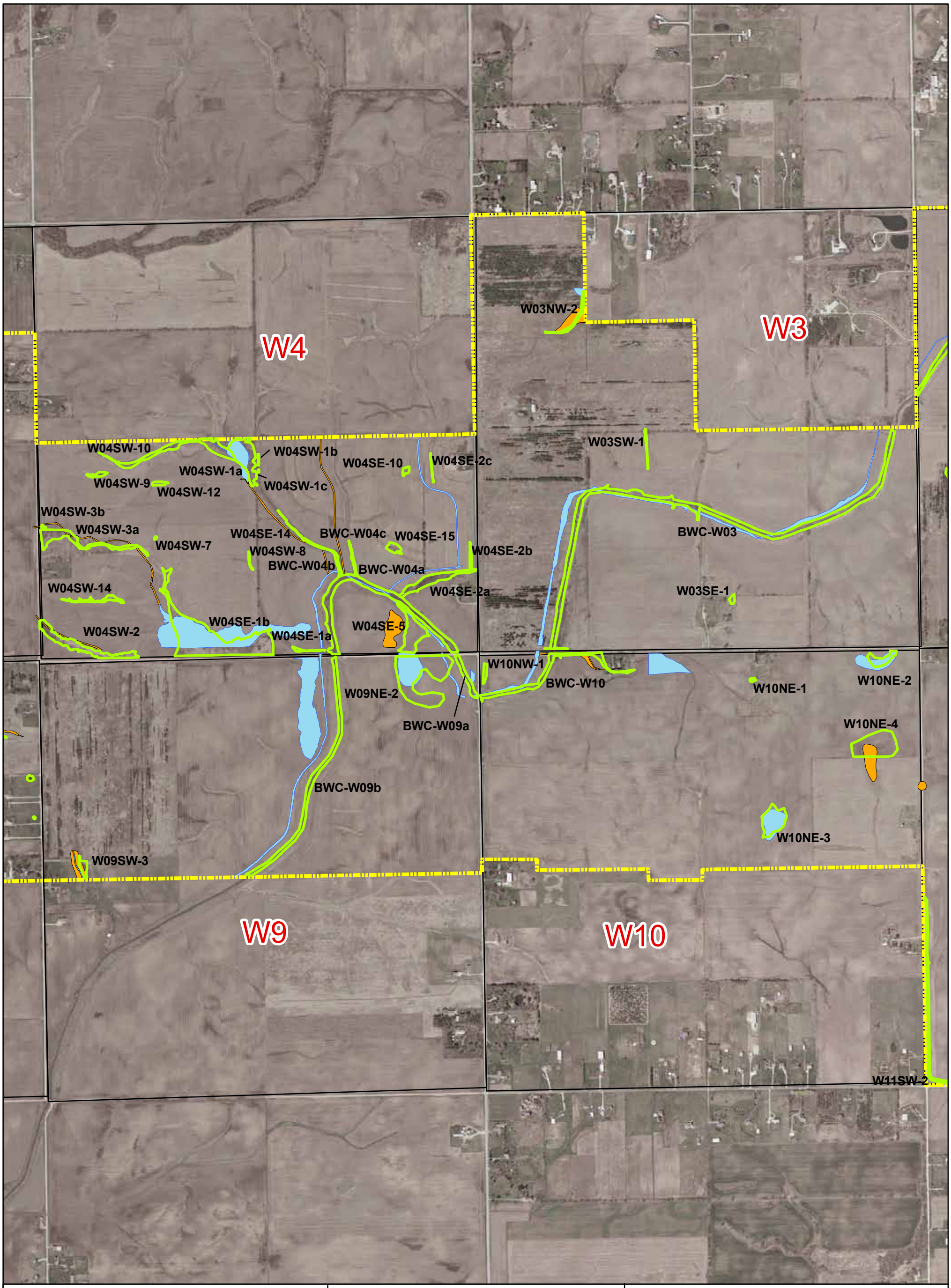
Only Wetland ID labels for the current study results are displayed on this map.

EXHIBIT B-4A
IDENTIFIED WETLAND AREAS - 1996, 2002 and 2008-09 (Western Section)
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 500 1,000 2,000 3,000 Feet



Legend

Investigation Results

- 1996 Wetland Areas
- 2002 Wetland Areas
- 2008-09 Wetland Areas
- 2008 Study Boundary
- Sections

N

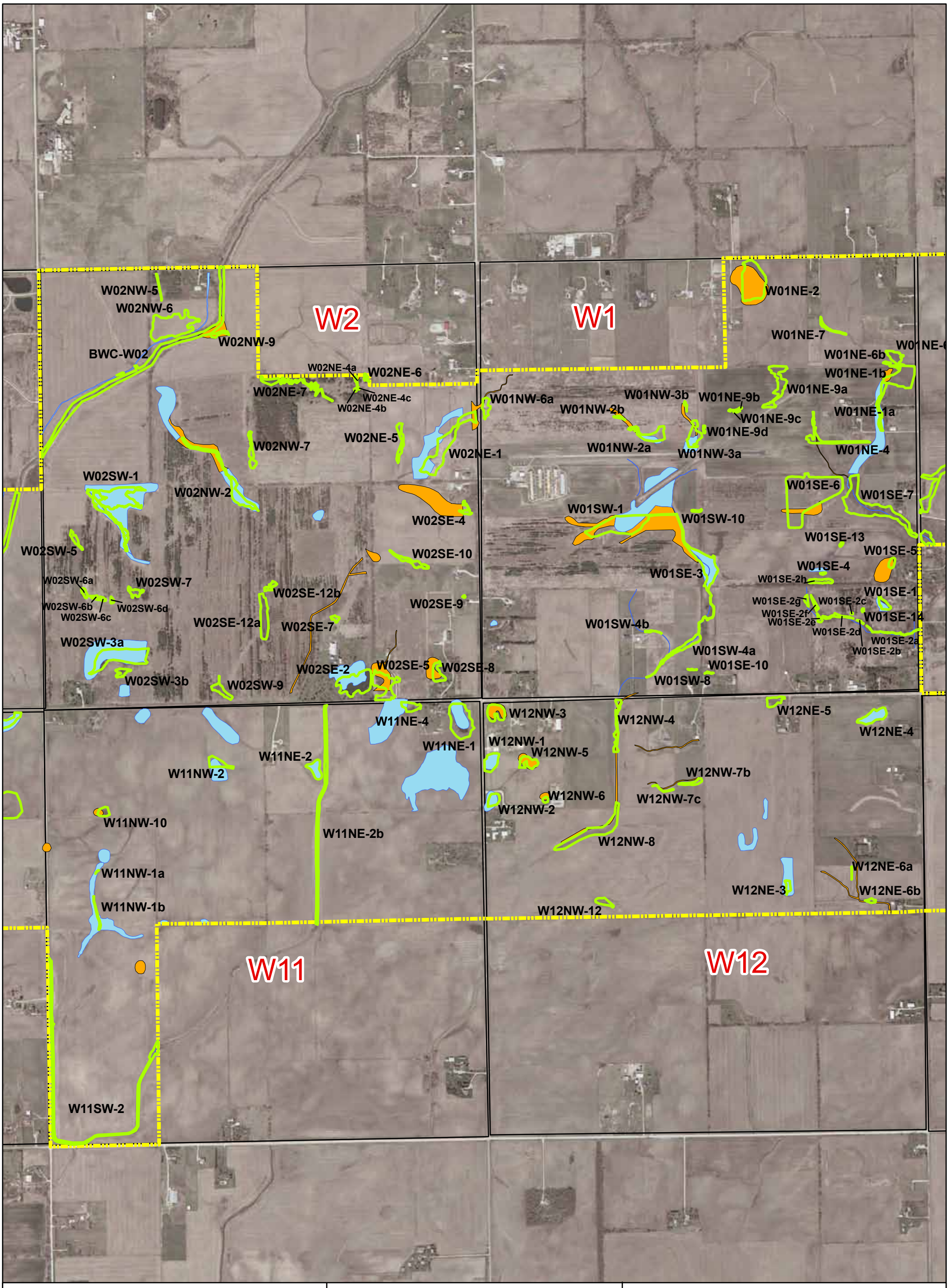
Only Wetland ID labels for the current study results are displayed on this map.

EXHIBIT B-4B
IDENTIFIED WETLAND AREAS - 1996, 2002 and 2008-09
(West-Central Section)
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 500 1,000 2,000 3,000 Feet



Legend

Investigation Results

- 1996 Wetland Areas
- 2002 Wetland Areas
- 2008-09 Wetland Areas
- 2008 Study Boundary
- Sections

N

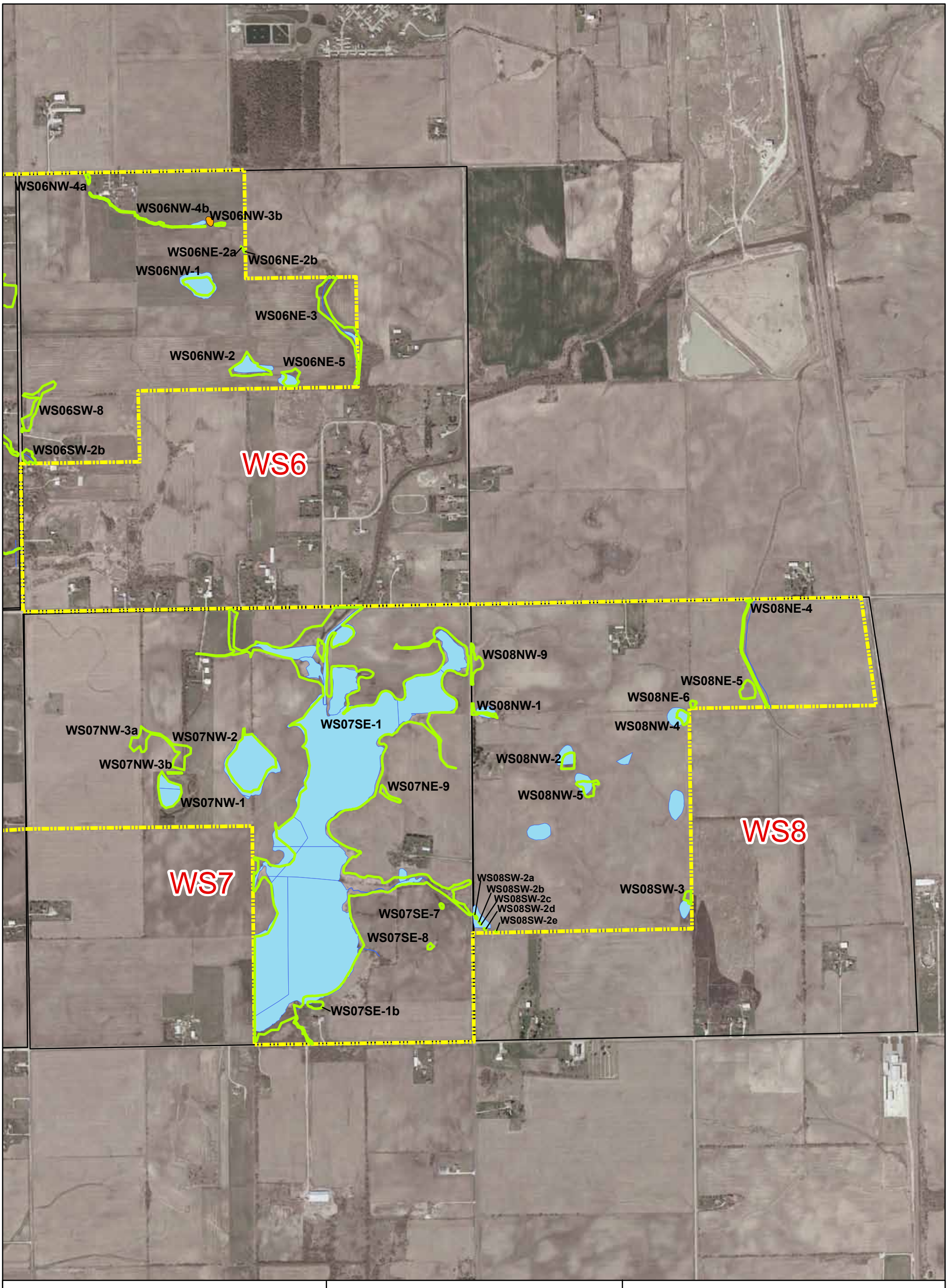
Only Wetland ID labels for the current study results are displayed on this map.

EXHIBIT B-4C
IDENTIFIED WETLAND AREAS - 1996, 2002 and 2008-09
(East-Central Section)
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 500 1,000 2,000 3,000 Feet



Legend

Investigation Results

- 1996 Wetland Areas
- 2002 Wetland Areas
- 2008-09 Wetland Areas
- 2008 Study Boundary
- Sections

N

Only Wetland ID labels for the current study results are displayed on this map.

EXHIBIT B-4D
IDENTIFIED WETLAND AREAS - 1996, 2002 and 2008-09
(Eastern Section)
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 500 1,000 2,000 3,000 Feet

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix C

Soils Information

This appendix contains a list of soils found in the study area; the official NRCS soil series descriptions of each soil listed; and a map showing the distribution of soils within the study area.

1) **Table C-1: Soils Mapped within the 2008/2009 Study Area**

2) **Eighteen NRCS Soil Series Descriptions from the National Cooperative Soil Survey**

3) **Exhibit C-1: Soil Units Map**

Table C-1
Soils Mapped within 2008/2009 Study Area
South Suburban Airport

Map Unit Symbol	Map Unit Name	Acres in Study Area	Percent of Study Area	Landforms	Hydric Component
23B	Blount silt loam, 2 to 4 percent slopes	31.0	0.59%	Till Plains	Ashkum
146B	Elliott silt loam, 2 to 4 percent slopes	136.8	2.60%	Till Plains	Ashkum
149A	Brenton silt loam, 0 to 2 percent slopes	59.6	1.13%	Outwash plains, Stream terraces	Pella, Drummer
152A*	Drummer silty clay loam, 0 to 2 percent slopes	428.0	8.14%	Depressions in Outwash plains, Till plains, Stream terraces	Drummer, Harpster
153A*	Pella silty clay loam, 0 to 2 percent slopes	93.0	1.77%	Outwash plains, Till plains	Pella, Houghton, Harpster
219A	Millbrook silt loam, 0 to 2 percent slopes	1.7	0.03%	Outwash plains, Stream terraces	Drummer
223C2	Varna silt loam, 4 to 6 percent slopes	4.4	0.08%	Till plains	Ashkum
232A*	Ashkum silty clay loam, 0 to 2 percent slopes	1089.4	20.71%	Depressions and drainageways in Till plains	Ashkum, Houghton
293B	Andres silt loam, 2 to 5 percent slopes	20.9	0.40%	Till plains and Lake plains	Ashkum
294B	Symerton silt loam, 2 to 5 percent slopes	8.3	0.16%	Till plains and Lake plains	Ashkum
294C2	Symerton silt loam, 5 to 10 percent slopes, eroded	38.6	0.73%	Till plains and Lake plains	Ashkum
298A	Beecher silt loam, 0 to 2 percent slopes	4.9	0.09%	Till plains	Ashkum
298B	Beecher silt loam, 2 to 4 percent slopes	1231.5	23.41%	Till plains	Ashkum
298B2	Beecher silt loam, 2 to 4 percent slopes, eroded	54.5	1.04%	Till plains	Ashkum
330A*	Peotone silty clay loam, 0 to 2 percent slopes	48.1	0.91%	Potholes and depressions on Till plains	Peotone, Houghton
440B	Jasper loam, 2 to 5 percent slopes	59.9	1.14%	Outwash plains	Selma
440C2	Jasper loam, 5 to 10 percent slopes, eroded	64.7	1.23%	Outwash plains	Selma
530C2	Ozaukee silt loam, 4 to 6 percent slopes, eroded	400.5	7.61%	Ground moraines	Ashkum
530C3	Ozaukee silt loam, 4 to 6 percent slopes, severely eroded	24.1	0.46%	Ground moraines	Ashkum
530D2	Ozaukee silt loam, 6 to 12 percent slopes, eroded	61.2	1.16%	Ground moraines	Ashkum
530D3	Ozaukee silt loam, 6 to 12 percent slopes, severely eroded	101.6	1.93%	Ground moraines	Ashkum

Map Unit Symbol	Map Unit Name	Acres in Study Area	Percent of Study Area	Landforms	Hydric Component
530E2	Ozaukee silt loam, 12 to 20 percent slopes, eroded	7.4	0.14%	Ground moraines	Ashkum
530F	Ozaukee silt loam, 20 to 30 percent slopes	4.1	0.08%	Ground moraines	Ashkum
531B	Markham silt loam, 2 to 4 percent slopes	59.7	1.14%	Till plains	Ashkum
531C2	Markham silt loam, 4 to 6 percent slopes, eroded	1218.4	23.16%	Till plains	Ashkum
531D2	Markham silt loam, 6 to 12 percent slopes, eroded	4.8	0.09%	Till plains	Ashkum
1103A*	Houghton muck, undrained, 0 to 2 percent slopes	72.2	1.37%	Closed depressions in lake and outwash plains; Ground and end moraines; floodplains	Houghton
W	Water	13.3	0.25%		

*Hydric soil

LOCATION ANDRES IL+IN

Established Series
Rev. SKH-LJB-MWB
07/2008

ANDRES SERIES

The Andres series consists of very deep, somewhat poorly drained soils formed in loamy outwash and the underlying silty till on ground moraines and lake plains. A mantle of loess or other silty material, as much as 61 cm (24 inches), overlies the outwash in many pedons. Slope ranges from 0 to 5 percent. Mean annual precipitation is about 890 mm (35 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Aquic Argiudolls

TYPICAL PEDON: Andres silt loam - on a nearly level slope in a cultivated field at an elevation of 193 meters (633 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 28 cm (0 to 11 inches); black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; few very fine roots; neutral; abrupt smooth boundary. [25 to 51 cm (10 to 20 inches) thick]

BA--28 to 36 cm (11 to 14 inches); brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; few very fine roots; many distinct black (10YR 2/1) organic coatings on faces of peds; common fine faint grayish brown (10YR 5/2) iron depletions in the matrix; neutral; clear smooth boundary. [0 to 28 cm (0 to 11 inches) thick]

Bt1--36 to 48 cm (14 to 19 inches); brown (10YR 4/3) clay loam; moderate fine subangular blocky structure; friable; few very fine roots; common fine distinct dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black (7.5YR 2.5/1) weakly cemented iron-manganese concretions throughout; common fine faint grayish brown (10YR 5/2) iron depletions in the matrix; neutral; clear smooth boundary.

Bt2--48 to 66 cm (19 to 26 inches); grayish brown (10YR 5/2) clay loam; moderate fine prismatic structure parting to moderate fine angular blocky; friable; few very fine roots; common faint dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black (7.5YR 2.5/1) weakly cemented iron-manganese concretions throughout; common fine faint gray (10YR 5/1) iron depletions and common fine distinct yellowish brown (10YR 5/4) masses of oxidized iron in the matrix; neutral; clear smooth boundary.

Bt3--66 to 91 cm (26 to 36 inches); grayish brown (10YR 5/2) silty clay loam; moderate fine prismatic structure parting to moderate medium angular blocky; friable; few very fine roots; common faint dark gray (10YR 4/1) clay films on faces of peds; few fine black (7.5YR 2.5/1) weakly cemented iron-manganese concretions throughout; common fine faint gray (10YR 5/1)

iron depletions and common fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; neutral; clear smooth boundary. [Combined thickness of the Bt horizon is 30 to 102 cm (12 to 40 inches).]

2Bt4--91 to 127 cm (36 to 50 inches); light olive brown (2.5Y 5/4) silty clay loam; weak medium prismatic structure; firm; few very fine roots; common faint grayish brown (2.5Y 5/2) clay films on faces of peds; few fine black (7.5YR 2.5/1) weakly cemented iron-manganese concretions throughout; many medium prominent gray (N 5/) iron depletions in the matrix; 3 percent gravel; very slightly effervescent; slightly alkaline; clear smooth boundary. [8 to 38 cm (3 to 15 inches) thick]

2C--127 to 152 cm (50 to 60 inches); light olive brown (2.5Y 5/4) silty clay loam; massive; firm; few fine black (7.5YR 2.5/1) weakly cemented iron-manganese concretions throughout; many medium prominent gray (N 5/) iron depletions in the matrix; 5 percent gravel; slightly effervescent; slightly alkaline.

TYPE LOCATION: Livingston County, Illinois, about 2.8 kilometers (1.75 miles) north of Campus; 465 meters (1,525 feet) south and 155 meters (510 feet) east of the northwest corner of sec. 27, T. 30 N., R. 8 E.; USGS Campus topographic quadrangle; lat. 41 degrees 02 minutes 52 seconds N., and long. 88 degrees 18 minutes 17 seconds W., NAD 27; UTM Zone 16T, 0390341 easting and 4544894 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of soil development ranges from 91 to 152 cm (36 to 60 inches). The mollic epipedon ranges from 25 to 51 cm (10 to 20 inches) in thickness. It includes the upper part of the B horizon in some pedons. Depth to carbonates is 61 to 140 cm (24 to 55 inches). Depth to the till is 56 to 127 cm (22 to 50 inches). Some pedons have as much as 61 cm (24 inches) of loess or silty material overlying the outwash. The particle-size control section ranges from 27 to 35 percent clay and from 15 to 40 percent fine and coarser sand. Content of gravel ranges from 0 to 10 percent.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam, loam, or silty clay loam. Reaction is moderately acid to neutral.

The BA, Bt, or 2Bt horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. It typically is clay loam, loam, or sandy clay loam. If a mantle of loess is present, it is silt loam or silty clay loam. Reaction ranges from moderately acid to slightly alkaline. In some pedons it contains carbonates.

The 2Bt or 3Bt horizon, the part formed in weathered till, has hue of 10YR, 2.5Y, or 5Y, value of 3 to 6, and chroma of 2 to 4. It is silty clay loam or silt loam with more than 22 percent clay. Reaction ranges from slightly acid to moderately alkaline. It typically contains carbonates, but in some pedons it is noneffervescent.

The 2C or 3C horizon, the unweathered till, has hue of 10YR, 2.5Y, or 5Y, value of 4 to 6, and chroma of 1 to 8. It is silty clay loam or silt loam with more than 22 percent clay and less than 20 percent sand. It is slightly alkaline or moderately alkaline and is calcareous. Some pedons have thin strata of loam or silty clay.

COMPETING SERIES: These are the Aztalan, Darroch, Francesville, Gilboa, Houstenader, La Hogue, Lahoguess, Le Sueur, Marcellon, Newhaven, Odell, Protivin, and Vigar series. Aztalan and Marcellon soils average less than 27 percent clay in the particle-size control section. Darroch, Gilboa, La Hogue, Lahoguess, Le Sueur, Newhaven, and Odell soils average more than 20 percent sand and less than 22 percent clay in the lower part of the series control section. Francesville soils contain a densic layer between 51 to 102 cm (20 and 40 inches). Houstenader soils contain more than 40 percent clay in the lower part of the series control section. Protivin soils contain more than 20 percent sand in the lower part of the series control section. Vigar soils have a mollic epipedon more than 51 cm (20 inches) thick.

GEOGRAPHIC SETTING: Andres soils are on nearly level to slightly undulating till plains and lake plains. They formed in loamy outwash and silty till that contain more than 22 percent clay. A mantle of loess or other silty material, as much as 61 cm (24 inches) thick, overlies the outwash in many pedons. Slope ranges from 0 to 5 percent. Mean annual air temperature ranges from 8 to 12 degrees C (46 to 54 degrees F), mean annual precipitation ranges from 740 to 890 mm (29 to 35 inches), frost-free period ranges from 160 to 180 days, and elevation ranges from 183 to 311 meters (600 to 1,020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Elliott, Martinton, Milford, and Symerton soils. Ashkum and Milford soils are on lower positions on the landform, are poorly drained, and contain more clay in the particle-size control section. Elliott and Martinton soils are on similar positions and have more clay in the particle-size control section. Symerton soils are on slightly higher positions and are better drained.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat poorly drained. These soils have a perched seasonal high water table at a depth of 30 to 61 cm (1 to 2 feet) at some time between January and May in most years. The potential for surface runoff is low. Saturated hydraulic conductivity is moderately high (1.41 to 4.23 micrometers/s). Permeability is moderately slow.

USE AND VEGETATION: Most areas of the soil are cultivated. Corn, soybeans, small grain, and meadow are the principal crops. A few areas are used for pasture. Native vegetation is tall prairie grasses.

DISTRIBUTION AND EXTENT: Northeastern Illinois and northwestern Indiana. Extent is moderate; about 36,423 hectares (90,000 acres) have been mapped in MLRAs 95B, 108A, 110, 111C, and 111D.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Will County, Illinois, 1951.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon 0 to 28 cm (0 to 11 inches) (Ap horizon); argillic horizon 36 to 127 cm (14 to 50 inches) (Bt1, Bt2, Bt3, and 2Bt4 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION ASHKUM IL+IN WI MI

Established Series
Rev. GOW-JWS-DEC
04/2008

ASHKUM SERIES

The Ashkum series consists of very deep, poorly drained soils on till plains. They formed in colluvial sediments and in the underlying silty clay loam till. Slope ranges from 0 to 3 percent. Mean annual precipitation is about 890 mm (35 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine, mixed, superactive, mesic Typic Endoaquolls

TYPICAL PEDON: Ashkum silty clay loam, on a concave slope with less than a 1 percent gradient in a cultivated field at an elevation of 215 meters (705 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 18 cm (0 to 7 inches); black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; many very fine roots; neutral; clear smooth boundary.

A-- 18 to 30 cm (7 to 12 inches); black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine and medium granular structure; friable; common very fine roots; neutral; clear smooth boundary. [Combined thickness of the A horizon is 25 to 51 cm (10 to 20 inches)].

BAg-- 30 to 46 cm (12 to 18 inches); dark gray (2.5Y 4/1) silty clay loam; moderate very fine and fine subangular blocky structure; firm; common very fine roots; many distinct continuous black (10YR 2/1) organic coatings on faces of peds; common fine very dark gray (7.5YR 3/1) very weakly cemented iron-manganese concretions throughout; neutral; clear smooth boundary. [0 to 18 cm (0 to 7 inches) thick]

Bg1--46 to 74 cm (18 to 29 inches); grayish brown (2.5Y 5/2) silty clay; moderate medium prismatic structure parting to moderate medium angular blocky; firm; common very fine roots; few distinct very dark gray (10YR 3/1) organic coatings on faces of peds; common fine very dark gray (7.5YR 3/1) very weakly cemented iron-manganese concretions throughout; common fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; common fine faint gray (2.5Y 5/1) iron depletions in the matrix; neutral; clear wavy boundary. [0 to 56 cm (0 to 22 inches) thick]

2Bg2--74 to 124 cm (29 to 49 inches); grayish brown (2.5Y 5/2) silty clay loam; weak medium prismatic structure parting to moderate medium angular blocky; firm; few very fine roots; few distinct very dark gray (10YR 3/1) organic coatings on faces of peds; common fine very dark gray (10YR 3/1) very weakly cemented iron-manganese concretions throughout; common fine and medium prominent yellowish brown (10YR 5/8) and faint brown (10YR 5/3) masses of oxidized iron in the matrix; common fine and medium faint gray (5Y 5/1) iron depletions in the

matrix; about 8 percent gravel; neutral; gradual wavy boundary. [0 to 51 cm (0 to 20 inches) thick]

2BCg--124 to 137 cm (49 to 54 inches); grayish brown (2.5Y 5/2) silty clay loam; weak medium prismatic structure parting to weak coarse angular blocky; firm; few very fine roots; common fine very dark gray (10YR 3/1) very weakly cemented iron-manganese concretions throughout; common fine and medium prominent yellowish brown (10YR 5/6) and faint brown (10YR 5/3) masses of oxidized iron in the matrix; common fine and medium faint gray (2.5Y 5/1) iron depletions in the matrix; about 8 percent gravel; slightly effervescent; slightly alkaline; gradual wavy boundary. [0 to 36 cm (0 to 14 inches) thick]

2Cg--137 to 152 cm (54 to 60 inches); grayish brown (2.5Y 5/2) silty clay loam; massive; firm; common fine prominent yellowish brown (10YR 5/6) and common fine and medium faint brown (10YR 5/3) masses of oxidized iron in the matrix; common fine faint gray (2.5Y 5/1) iron depletions in the matrix; about 8 percent gravel; strongly effervescent; slightly alkaline.

TYPE LOCATION: Will County, Illinois, about 1.5 miles (2.4 kilometers) east of Manhattan; 96 feet south and 2,030 feet east of the northwest corner of sec. 22, T. 34 N., R. 11 E.; Will County, Illinois; USGS Manhattan topographic quadrangle; lat. 41 degrees 25 minutes 30 seconds N. and long. 87 degrees 57 minutes 19 seconds W., NAD 27; UTM Zone 16, 420168 easting and 4586370 northing, NAD 83:

RANGE IN CHARACTERISTICS: The depth to the base of soil development ranges from 76 to 152 cm (30 to 60 inches). Thickness of the colluvial sediments ranges from 38 to 102 cm (15 to 40 inches). Depth to carbonates ranges from 61 to 122 cm (24 to 48 inches), but can be as deep as 152 cm (60 inches) in some pedons. The mollic epipedon ranges from 25 to 61 cm (10 to 24 inches) in thickness. It includes the upper part of the Bg horizon in some pedons. The particle-size control section averages between 35 and 42 percent clay. Rock fragment content is less than 15 percent throughout the series control section.

The Ap or A horizon has hue of 10YR, 2.5Y, or is neutral; value of 2 to 3; and chroma of 0 or 1. It is silt loam, silty clay loam, or silty clay. Reaction is moderately acid to slightly alkaline.

Some pedons have an AB horizon rather than a BA horizon.

The BA, Bg, 2Bg, or 2BCg horizon has hue of 10YR, 2.5Y, 5Y, 5GY, or is neutral; value of 3 to 6; and chroma of 2 or less or may have a chroma of 3 in pedons with hue of 5Y. Redoximorphic features commonly are present with chroma of 2 to 8. It is silty clay loam or silty clay. Reaction ranges from slightly acid to moderately alkaline.

The 2Cg horizon commonly has hue of 2.5Y, 5Y, 5GY, or is neutral, but includes 10YR in some pedons; value of 4 to 6, and chroma of 0 to 8. It is silty clay loam. Reaction ranges from slightly acid to moderately alkaline.

COMPETING SERIES: These are the Milford, Secondcreek, and Woldale series. Milford soils have subhorizons (thin strata or varves) in the lower part of the series control section that have poorly graded soil separates. Secondcreek soils are greater than 152 cm (60 inches) to the base of soil development. Woldale soils contain more than 15 percent rock fragments in the lower part of

the series control section.

GEOGRAPHIC SETTING: Ashkum soils are on nearly level and gently sloping till plains of Wisconsinan Age in colluvial positions on the low parts of the topography and along upland drainageways. The soils formed in colluvial sediments consisting of erosional sediments from till and loess or shallow lacustrine materials less than 40 inches (102 cm) thick and in the underlying silty clay loam till. Slope gradients commonly are less than 1 percent and range from 0 to 3 percent. Mean annual air temperature ranges from 48 to 54 degrees F (9 to 12 degrees C), mean annual precipitation ranges from 29 to 40 inches (740 to 1020 mm), frost-free period ranges from 140 to 180 days, and elevation ranges from 540 to 1020 feet (165 to 311 meters) above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These include the Andres, Elliott, Symerton, and Varna soils. The Symerton and Varna soils are moderately well drained and the Andres and Elliott soils are somewhat poorly drained. All of these soils generally are on higher elevations.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. The potential for surface runoff is low. Permeability is moderately slow. Saturated hydraulic conductivity is moderately high (1.41 to 4.23 micrometers/s). Where drained, an intermittent apparent seasonal high water table is 0.5 foot (15 cm) above the surface to 1.0 foot (30 cm) below the surface at some time between January and May in normal years.

USE AND VEGETATION: Most areas are used for cropland. Principal crops are corn and soybeans and other crops include small grain and meadow. Native vegetation is marsh grasses and sedges.

DISTRIBUTION AND EXTENT: Northeastern Illinois, southeastern Wisconsin, and west-central Indiana. These soils are extensive in MLRAs 95B, 108A, and 110.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Iroquois County, Illinois, 1940.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 30 cm (12 inches) (Ap and A horizons); cambic horizon - the zone from a depth of 30 to 137 cm (12 to 54 inches) (BAg, Bg1, 2Bg2, and 2BCg horizons); aquic moisture regime - chroma of 2 or less in the matrix and redoximorphic features present in the zone from 30 to 152 cm (12 to 60 inches) (BAg, Bg1, 2Bg2, 2BCg, and 2Cg horizons).

ADDITIONAL DATA: Refer to pedon number S57ILL-99-2 and University of Illinois laboratory numbers 6918-6925, published in SSIR No. 19, which is near the type location.

National Cooperative Soil Survey
U.S.A.

LOCATION BEECHER IL+IN WI

Established Series
Rev. GOW-HLW-DCH-DEC
07/2007

BEECHER SERIES

The Beecher series consists of very deep, somewhat poorly drained soils on moraines and till plains. They formed in up to 46 cm (18 inches) of silty material and silty clay loam or clay loam glacial till. They are moderately deep or deep to dense till. Slope ranges from 0 to 6 percent. Mean annual precipitation is about 910 mm (36 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine, illitic, mesic Udollic Epiaqualfs

TYPICAL PEDON: Beecher silt loam - on a south-facing slope with a gradient of less than 1 percent in a cultivated field at an elevation of about 200 meters (655 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 23 cm (0 to 9 inches); very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak very fine granular structure; friable; neutral; abrupt smooth boundary. [15 to 25 cm (6 to 10 inches) thick]

BE--23 to 33 cm (9 to 13 inches); dark grayish brown (10YR 4/2) silty clay loam; moderate very fine granular structure; friable; common distinct very dark gray (10YR 3/1) organic coatings on faces of peds; few fine faint brown (10YR 5/3) masses of iron accumulation in the matrix; slightly acid; clear smooth boundary. [0 to 20 cm (0 to 8 inches) thick]

2Bt1--33 to 41 cm (13 to 16 inches); brown (10YR 5/3) silty clay loam; moderate very fine subangular blocky structure; firm; few distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; few fine black (10YR 2/1) iron-manganese oxide concretions throughout; many fine distinct yellowish brown (10YR 5/6) masses of iron accumulation in the matrix; 1 percent gravel; moderately acid; clear smooth boundary.

2Bt2--41 to 53 cm (16 to 21 inches); grayish brown (10YR 5/2) silty clay loam; moderate very fine and fine subangular blocky structure; firm; few distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; common distinct dark gray (10YR 4/1) clay films on faces of peds; many fine prominent yellowish brown (10YR 5/6) masses of iron accumulation in the matrix; 2 percent gravel; moderately acid; clear smooth boundary.

2Bt3--53 to 69 cm (21 to 27 inches); grayish brown (10YR 5/2) silty clay loam; moderate medium prismatic structure parting to moderate fine subangular blocky; firm; few distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; common distinct dark gray (10YR 4/1) clay films on faces of peds; few fine dark brown (7.5YR 3/3) and black (10YR 2/1) iron-

manganese oxide concretions throughout; few fine prominent yellowish brown (10YR 5/6 and 10YR 5/8) masses of iron accumulation in the matrix; 2 percent gravel; slightly alkaline; clear smooth boundary.

2Bt4--69 to 81 cm (27 to 32 inches); yellowish brown (10YR 5/4) silty clay loam; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; common distinct grayish brown (10YR 5/2) clay films on faces of peds; few fine black (10YR 2/1) iron-manganese oxide concretions throughout; common fine distinct yellowish brown (10YR 5/6) and prominent yellowish brown (10YR 5/8) masses of iron accumulation in the matrix; many medium prominent gray (5Y 5/1) iron depletions in the matrix; 2 percent gravel; slightly alkaline; clear smooth boundary. [Combined thickness of the 2Bt horizons is 25 to 71 cm (10 to 28 inches).]

2BCt--81 to 94 cm (32 to 37 inches); yellowish brown (10YR 5/6) silty clay loam; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; few distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; few fine black (10YR 2/1) iron-manganese oxide concretions throughout; many coarse prominent gray (5Y 5/1) iron depletions in the matrix; 2 percent gravel; slightly effervescent; moderately alkaline; clear smooth boundary. [0 to 20 cm (0 to 8 inches) thick]

2Cd--94 to 152 cm (37 to 60 inches); yellowish brown (10YR 5/4) silty clay loam; massive; very firm; few fine black (10YR 2/1) iron-manganese oxide concretions throughout; common fine distinct yellowish brown (10YR 5/6) and prominent yellowish brown (10YR 5/8) masses of iron accumulation in the matrix; common fine prominent greenish gray (5GY 5/1) iron depletions in the matrix; common medium prominent greenish gray (5G 6/1) iron depletions on cleavage planes; 5 percent gravel; strongly effervescent; moderately alkaline.

TYPE LOCATION: Kankakee County, Illinois; about 4 kilometers (2.5 miles) northeast of Bourbonnais; 104 meters (340 feet) south and 20 meters (65 feet) west of the northeast corner of sec. 14, T. 31 N., R. 12 E.; USGS Bradley, Illinois, topographic quadrangle; lat. 41 degrees 10 minutes 36 seconds N. and long. 87 degrees 47 minutes 56 seconds W., NAD 27; UTM Zone 16, 432988 easting and 4558680 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of soil development is commonly 74 to 102 cm (29 to 40 inches) but ranges from 61 to 114 cm (24 to 45 inches). The depth to carbonates ranges from 51 to 107 cm (20 to 42 inches). The particle-size control section averages 35 to 50 percent clay.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is silt loam. Reaction ranges from very strongly acid to neutral.

The E horizon, where present, has hue of 10YR or 2.5Y, value of 4 or 5, and chroma or 1 or 2. Reaction ranges from very strongly acid to neutral.

The BE, 2Bt, or Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. Either the matrix or ped faces have dominant chroma of 2 or less with at least one horizon between the Ap or A horizon and 30 inches (76 cm) which has chroma of 3 or more in the matrix. Texture is silty clay loam or silty clay. Reaction ranges from very strongly acid to

slightly alkaline.

The 2BCt or 2Cd horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6. Texture is silty clay loam or clay loam. Reaction is slightly alkaline or moderately alkaline. Carbonates are present.

COMPETING SERIES: This is the Frankfort series. Frankfort soils average more than 50 percent clay in the particle-size control section.

GEOGRAPHIC SETTING: Beecher soils are typically on convex slopes in the relatively undissected till plains of Wisconsinan Age. Slopes commonly have gradients of 1 to 4 percent but range from 0 to 6 percent. They formed in silty clay loam or clay loam glacial till that in many places has a mantle of loess or silty material up to 46 cm (18 inches) thick. Mean annual air temperature ranges from 7 to 13 degrees C (45 to 55 degrees F), mean annual precipitation ranges from 740 to 1020 mm (29 to 40 inches), frost-free period ranges from 140 to 180 days, and the elevation ranges from 165 to 311 meters (540 to 1020 feet) above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Blount, Elliott, and Markham soils. The poorly drained Ashkum soils are in depressions and drainageways. The somewhat poorly drained Elliott and Blount soils form a biosequence and are on similar landform positions. The moderately well drained Markham soils are on higher landform positions.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat poorly drained. An intermittent perched high water table is at a depth of 15 to 61 cm (0.5 foot to 2.0 feet) at some time between January and May in normal years. The potential for surface runoff is low to high. Saturated hydraulic conductivity is moderately low to moderately high (0.42 to 1.41 micrometers/s). Permeability is slow.

USE AND VEGETATION: Mostly used as cropland. Main crops grown are corn, soybeans, small grains, and hay. Some areas are used as pasture. Native vegetation is a mixture of hardwood trees and prairie grasses.

DISTRIBUTION AND EXTENT: Northeastern Illinois, southeastern Wisconsin, and northwestern Indiana. Extent is moderate in MLRAs 95B, 108A, and 110.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Will County, Illinois, 1948.

REMARKS: Diagnostic horizons recognized in this pedon are: ochric epipedon (mollic intergrade) - the zone from the surface to 23 cm (9 inches) (Ap horizon); argillic horizon - the zone from 33 to 81 cm (13 to 32 inches) (2Bt1, 2Bt2, 2Bt3, and 2Bt4 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION BLOUNT OH+IL IN MI WI

Established Series
Rev. RAR
04/2008

BLOUNT SERIES

The Blount series consists of very deep soils that are moderately deep or deep to dense till. They are somewhat poorly drained, slowly permeable soils. They formed in till. These soils are on till plains and have slopes ranging from 0 to 6 percent. Mean annual temperature is 51 degrees F, and mean annual precipitation is 33 inches.

TAXONOMIC CLASS: Fine, illitic, mesic Aeric Epiaqualfs

TYPICAL PEDON: Blount silt loam - on a northwest-facing, concave, 1 percent slope in a cultivated field at an elevation of 867 feet. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 7 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate fine and medium granular structure; friable; common roots; 3 percent pebbles; slightly acid; abrupt smooth boundary. (5 to 10 inches thick)

Btg--7 to 12 inches; grayish brown (10YR 5/2) silty clay; moderate medium subangular blocky structure; firm; common roots; common distinct dark grayish brown (10YR 4/2) clay films on surfaces of peds; common distinct light gray (10YR 7/1) (dry) clay depletions on vertical surfaces of peds; many distinct yellowish brown (10YR 5/4) masses of iron accumulation with clear boundaries in the matrix; 3 percent pebbles; strongly acid; clear wavy boundary.

Bt--12 to 23 inches; dark yellowish brown (10YR 4/4) clay; weak fine and medium prismatic structure parting to moderate medium subangular blocky; firm; few roots; many distinct grayish brown (10YR 5/2) clay films on faces of peds; many distinct dark grayish brown (10YR 4/2) iron depletions with clear boundaries in the matrix; common prominent gray (10YR 5/1) iron depletions with clear boundaries and distinct yellowish brown (10YR 5/6) masses of iron accumulation with diffuse boundaries in the matrix; 4 percent pebbles; slightly acid; clear wavy boundary. (Combined thickness of the Btg and/or Bt horizons is 12 to 35 inches.)

BCtg--23 to 30 inches; grayish brown (10YR 5/2) silty clay loam; weak medium subangular blocky structure; firm; few faint dark grayish brown (10YR 4/2) clay films on vertical surfaces of peds; few distinct light gray (10YR 7/2) calcium carbonate coatings on vertical surfaces of peds; many distinct dark yellowish brown (10YR 4/4) and common prominent yellowish brown (10YR 5/6) masses of iron accumulation with clear boundaries in the matrix; 8 percent pebbles; slightly effervescent; slightly alkaline; clear wavy boundary. (0 to 18 inches thick)

CBd--30 to 42 inches; brown (10YR 4/3) clay loam; weak medium platy structure; very firm; common distinct white (10YR 8/1) calcium carbonate coatings on surfaces; common faint grayish brown (10YR 5/2) iron depletions with diffuse boundaries in the matrix; 10 percent

pebbles; strongly effervescent; moderately alkaline; gradual wavy boundary. (0 to 16 inches thick)

Cd1--42 to 54 inches; brown (10YR 5/3) clay loam; massive; very firm; common distinct light gray (10YR 7/1) calcium carbonate coatings on surfaces; few distinct dark gray (10YR 4/1) iron depletions with diffuse boundaries in the matrix; 10 percent pebbles; strongly effervescent; moderately alkaline; gradual wavy boundary.

Cd2--54 to 80 inches; brown (10YR 4/3) clay loam; massive; very firm; 10 percent pebbles; strongly effervescent; moderately alkaline.

TYPE LOCATION: Mercer County, Ohio; approximately 1.25 miles east of Wabash; in Washington Township; 130 feet west and 1880 feet south of the northeast corner of sec. 3, T. 6 S., R. 1 E.; Erastus Quadrangle; lat. 84 degrees 46 minutes 45 seconds N. and long. 40 degrees 33 minutes 35 seconds W., NAD 1927.

RANGE IN CHARACTERISTICS: The depth to the base of the argillic horizon ranges from 20 to 45 inches. The depth to carbonates ranges from 19 to 40 inches. Depth to the densic horizon is greater than 30 inches. The particle-size control section averages between 35 and 45 percent clay. Rock fragments are predominantly igneous, limestone, and dolomite pebbles.

The Ap horizon has a hue of 10YR, value of 3 or 4 (6 or more dry), and chroma of 1 to 3. Some pedons have an A horizon less than 5 inches in thickness that has color value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. The Ap or A horizon typically is silt loam but includes loam texture in some pedons. Some eroded pedons are silty clay loam. Rock fragment content ranges from 0 to 5 percent. Reaction ranges from strongly acid to neutral.

Some pedons have an E, BE or an EB horizon 3 to 6 inches thick. The E horizon has a hue of 10YR or 2.5Y, value of 4 or 5, and chroma 1 to 3.

The BE or EB horizon has color in the same range as the Bt horizon. It typically is silty clay loam but includes silt loam. Rock fragment content ranges from 0 to 10 percent. It ranges from strongly acid to neutral.

The Bt and Btg horizons have hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4. They are silty clay loam, clay loam, clay, or silty clay. The clay content ranges from 35 to 48 percent in individual subhorizons. The sand content averages 10 to 25 percent. Rock fragment content ranges from 3 to 10 percent. They range from slightly acid to very strongly acid in the upper part and from moderately acid to slightly alkaline in the lower part.

The BCtg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. It is silty clay loam, clay loam, or silty clay. Rock fragment content ranges from 3 to 15 percent. Reaction ranges from slightly acid to slightly alkaline and contains carbonates in some pedons. Some pedons have secondary carbonates (Bk horizon) as masses or as coatings on the underside of rock fragments in the lower B horizons. Some pedons do not have a BCtg horizon

The CBd and Cd horizons have hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 2 to 4. They are silty clay loam or clay loam. Clay content ranges from 27 to 40 percent. Rock fragment

content ranges from 5 to 15 percent. They are slightly alkaline or moderately alkaline. They have 22 to 35 percent calcium carbonate equivalent. Some pedons do not have a CBd horizon.

COMPETING SERIES: These are the Bennington, Brockport, Caneadea, Churchville, Del Rey, Fulton, Lockport, Kimmell, Mahoning, Nappanee, Odessa, Remsen, and Rhinebeck soils. Bennington and Mahoning soils have a calcium carbonate equivalent less than 22 percent and rock fragments that are dominantly shale, siltstone, or sandstone. Brockport and Lockport soils have a lithic or paralithic contact within 40 inches. Caneadea, Del Rey, Fulton, Odessa, and Rhinebeck soils contain less than 10 percent sand and generally less than 5 percent rock fragments in the lower part of the series control section. Churchville soils are formed in lacustrine deposits in the upper part of the series control section and have more rock fragments in the lower part of the series control section than Blount soils. Kimmell soils contain less than 5 percent rock fragments in the lower part of the series control section. Nappanee soils average more than 45 percent clay in the particle-size control section. Remsen soils contain more than 40 percent clay in the lower part of the series control section.

GEOGRAPHIC SETTING: Blount soils are on till plains of Wisconsinan Age. Slopes commonly are 1 to 3 percent and range from 0 to 6 percent. The soils formed in silty clay loam or clay loam till. Some areas have a mantle of loess or other silty material as much as 18 inches thick. Elevation ranges from 600 to 1500 feet. Mean annual temperature ranges from 45 to 55 degrees F, and mean annual precipitation ranges from 29 to 42 inches. The frost-free period is 130 to 180 days.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Beecher, Glynwood, Lybrand, Morley, and Pewamo soils. The poorly drained Ashkum and Pewamo soils are in depressions and drainageways. The Beecher soils have a darker colored surface layer and are on similar nearby landforms. The moderately well drained Glynwood soils and well drained Lybrand and Morley soils are nearby on slightly higher or more sloping parts of the landform.

DRAINAGE AND PERMEABILITY: Somewhat poorly drained. The potential for surface runoff is low to medium. Permeability is slow. An intermittent perched seasonal high water table is at a depth of 0.5 to 2.0 feet in most years.

USE AND VEGETATION: Almost all areas of Blount soils are cultivated. Corn, soybeans, small grain, and meadow are the principal crops. Native vegetation is hardwood forest.

DISTRIBUTION AND EXTENT: Blount soils are in northern Illinois, Indiana, Michigan, Ohio, and Wisconsin. Dominant acreage is in MLRA 111, with lesser acreages in MLRA's 95B, 97, 98, 108, and 110. The extent of Blount soils is large; the acreage more than 2,500,000.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Vermilion County, Illinois, 1931.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
ochric epipedon - the zone from the surface of the soil to a depth of 7 inches (Ap horizon);
argillic horizon - the zone from approximately 7 to 30 inches (Btg, Bt, and BCtg horizons);
aquic conditions - 7 to 54 inches (Btg, Bt, BCtg, CBd, Cd1 horizons);

densic contact - 30 inches.

Supporting laboratory data is needed to confirm the presence of densic materials in the CBd and Cd horizons. Densic horizon is defined with this revision as being at depths of greater than 30 inches. Blount series is in major land region M and Churchville series is entirely in major land region R. There is some overlap in rock fragments in the lower part of the series control section but Churchville series is usually greater 15 percent and Blount series is less than 10 percent in most cases.

ADDITIONAL DATA: Laboratory characterization data is available for MC-20, the typical pedon. Other data are given in SSSA proc. 28: 674-679, Morley and Blount soils: A Statistical Summary of Certain Physical and Chemical Properties of some Selected Profiles in Ohio.

National Cooperative Soil Survey
U.S.A.

LOCATION BRENTON IL+IN OH

Established Series
Rev. SEW-CCC-AAC
04/2008

BRENTON SERIES

The Brenton series consists of very deep, somewhat poorly drained soils formed in loess or other silty material and in the underlying loamy stratified outwash. These soils are on outwash plains and stream terraces. Permeability is moderate. Slope gradient ranges from 0 to 5 percent. Mean annual precipitation is about 864 mm (34 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Aquic Argiudolls

TYPICAL PEDON: Brenton silt loam - on a nearly level slope, in a cultivated field, at an elevation of 232 meters (768 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap1--0 to 20 cm (0 to 8 inches); black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate medium granular structure; friable; many very fine roots throughout; moderately acid; abrupt smooth boundary.

Ap2--20 to 36 cm (8 to 14 inches); very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to moderate medium granular; friable; common very fine roots throughout; few very fine tubular pores; moderately acid; abrupt smooth boundary. [Combined thickness of the Ap or A horizon(s) is 25 to 58 cm (10 to 23 inches)]

Bt1--36 to 43 cm (14 to 17 inches); brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; friable; common very fine roots along faces of peds; few very fine tubular pores; few distinct very dark grayish brown (10YR 3/2) organo-clay films on faces of peds; few fine distinct yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; few fine prominent iron-manganese concretions and stains throughout; moderately acid; clear smooth boundary.

Bt2--43 to 56 cm (17 to 22 inches); olive brown (2.5Y 4/4) silty clay loam; weak fine prismatic structure parting to moderate medium angular blocky; friable; common very fine and few fine roots along faces of peds; few very fine and fine tubular pores; common distinct dark brown (10YR 3/3) organo-clay films on faces of peds; few fine prominent dark grayish brown (10YR 4/2) iron depletions in the matrix; few fine prominent iron-manganese concretions and stains throughout; moderately acid; clear smooth boundary.

Bt3--56 to 71 cm (22 to 28 inches); olive brown (2.5Y 4/4) silty clay loam; moderate medium prismatic structure parting to moderate fine and medium angular blocky; friable; common very fine and few fine roots along faces of peds; few very fine and fine tubular pores; common

distinct dark brown (10YR 3/3) organo-clay films on faces of peds; few fine prominent grayish brown (10YR 5/2) iron depletions and distinct yellowish brown (10YR 5/4) iron-manganese accumulations in the matrix; few fine prominent iron-manganese concretions and stains throughout; moderately acid; clear smooth boundary.

Bt4--71 to 84 cm (28 to 33 inches); light olive brown (2.5Y 5/4) silty clay loam; moderate medium prismatic structure parting to strong medium subangular blocky; friable; common very fine and few fine roots along faces of peds; few very fine tubular pores; few distinct grayish brown (10YR 5/2) clay films on faces of peds; common fine and medium distinct grayish brown (2.5Y 5/2) iron depletions in the matrix; few fine prominent iron-manganese concretions and stains throughout; moderately acid; clear smooth boundary. [Combined thickness of the Bt horizons is 25 to 74 cm (10 to 29 inches).]

2Bt5--84 to 114 cm (33 to 45 inches); olive brown (2.5Y 4/4) stratified loam and fine sandy loam; moderate medium and coarse subangular blocky structure; friable; few very fine roots along faces of peds; few very fine tubular pores; many distinct very dark grayish brown (2.5Y 3/2) organo-clay films lining root channels and common distinct grayish brown (2.5Y 5/2) clay films on faces of peds; few fine distinct grayish brown (2.5Y 5/2) iron depletions and common fine and medium prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; common fine prominent iron-manganese concretions and stains throughout; slightly acid; clear smooth boundary. [8 to 53 cm (3 to 21 inches) thick]

2BC--114 to 137 cm (45 to 54 inches); light olive brown (2.5Y 5/6) and light brownish gray (2.5Y 6/2) loam; weak medium subangular blocky structure; friable; few very fine roots along faces of peds; few very fine tubular pores; many distinct very dark grayish brown (2.5Y 3/2) organo-clay films on surfaces along root channels and pores; common fine prominent iron-manganese concretions and stains throughout; neutral; clear smooth boundary. [0 to 38 cm (0 to 15 inches) thick]

2Cg1--137 to 175 cm (54 to 69 inches); gray (2.5Y 6/1) silt loam; weak thick and very thick platy rock structure; very friable; few very fine roots throughout; many very fine horizontal tubular pores between plates and few very fine vertical tubular pores through plates; many very dark grayish brown (2.5Y 3/2) organo-clay films on surfaces along root channels and pores; common fine and medium prominent light olive brown (2.5Y 5/6) masses of oxidized iron in the matrix; common very fine and fine prominent black (10YR 2/1) iron-manganese accumulations in the matrix; slightly effervescent; neutral; clear smooth boundary.

2Cg2--175 to 203 cm (69 to 80 inches); gray (2.5Y 6/1) silt; massive; very friable; few very fine roots throughout; few very fine tubular pores; common fine and medium prominent yellowish brown (10YR 5/6 and 10YR 5/8) masses of oxidized iron in the matrix; strongly effervescent; slightly alkaline.

TYPE LOCATION: McLean County, IL, 160 meters (525 feet) east and 493 meters (1,620 feet) south of the northwest corner of sec. 15, T. 22 N., R. 6 E.; USGS Bellflower, IL topographic quadrangle; latitude 40 degrees 21 minutes 52.8 seconds N., longitude 88 degrees 30 minutes 54.8 seconds W; NAD 27., UTM Zone 16T 0371340 easting 4469120 northing; NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of argillic horizon ranges from 102 to 152 cm (40 to 60 inches). Carbonates are below a depth of 102 cm (40 inches). The depth to the horizons with greater than 15 percent sand ranges from 61 to 102 cm (24 to 40 inches). The particle-size control section averages between 27 and 35 percent clay.

The A, Ap, and/or AB horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 or 2. Texture is silt loam however some Ap2 horizons where deep occasional plowing has mixed in some subsoil or some AB horizons may be silty clay loam. It ranges from moderately acid to slightly alkaline depending upon liming practices.

The Bt horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. Redoximorphic features have chroma of 2 to 8. Texture is silty clay loam, but includes silt loam in the lower part of some pedons. The average sand content is less than 15 percent. Reaction ranges from moderately acid to neutral.

The 2Bt and 2BC horizons have hue of 7.5YR, 10YR, 2.5Y, or 5Y; value of 4 to 7; and chroma of 1 to 8. It is typically stratified clay loam, loam or fine sandy loam, but may include subhorizons that are sandy loam, silty clay loam, silt loam, or sandy clay loam. Rock fragment content is less than 5 percent. Reaction ranges from moderately acid to slightly alkaline.

The 2Cg or 2C horizon has hue of 7.5YR, 10YR, 2.5Y, or 5Y; value of 4 to 7; and chroma of 1 to 8. It typically is stratified; textures include loam, sandy loam, sandy clay loam, , silt, or silt loam, and thin strata of sand or loamy sand. Clay content averages less than 27 percent. Rock fragment content is less than 15 percent. Reaction ranges from neutral to moderately alkaline with effervescence ranging from very slightly to strongly effervescent.

COMPETING SERIES: These are the Arrowsmith, Bearpen, Edwardsville, Elburn, Frankenmuth, Grundelein, Hacreek, Harco, Higginsville, Keller, Lafayette, Lawndale, Lisbon, Lismod, Loran, Mundelein, Muscatune, Nevin, Raub, Rooks, Rowley, and Shannondale series. Arrowsmith, Harco, Lisbon, Lismod, and Mundelein soils contain carbonates within a depth of 40 inches. Bearpen soils average less than 27 percent clay in the control section. Edwardsville, Elburn, Hacreek, Higginsville, Lawndale, Muscatune, Nevin, Rowley, and Shannondale soils are greater than 40 inches to horizons that average more than 15 percent sand. Frankenmuth soils have an E horizon and have the base of the argillic horizon within a depth of 22 inches. Grundelein and Lafayette soils average more than 15 percent gravel in the lower part of the series control section. Raub soils do not have stratification in the lower part of the series control section . Keller, Loran, and Rooks soils average more than 27 percent clay in the lower part of the series control section.

GEOGRAPHIC SETTING: Brenton soils are on outwash plains and stream terraces of Wisconsinan Age. Topography is relatively smooth and uniform, and slope gradient ranges from 0 to 5 percent. Brenton soils formed in 24 to 40 inches of loess or other silty material and in the underlying loamy stratified outwash. Mean annual air temperature ranges from 45 to 54 degrees F., mean annual precipitation ranges from 32 to 40 inches, frost free days range from 150 to 180 days, and the elevation ranges from 400 to 1020 feet above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Darroch, Drummer, Elburn, La Hogue, Mundelein, and Proctor soils. The somewhat poorly drained Darroch, Elburn, La Hogue,

and Mundelein soils are on similar landforms. Brenton soils are in a drainage sequence with the well drained Proctor soils and the poorly drained Drummer soils. Proctor soils are on nearby higher elevations and Drummer soils are on lower parts of the landform.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat poorly drained. The potential for surface runoff is negligible to medium. The saturated hydraulic conductivity is moderately high to high (4.23 to 14.11 micrometer per second). Permeability is moderate. An intermittent apparent seasonal high water table is at a depth of 31 to 61 cm (1.00 to 2.0 feet) at some time between January and May in normal years.

USE AND VEGETATION: Most areas are cropped. Corn and soybeans are the principal crops. Some areas are used for growing small grain and meadow. Native vegetation is tall prairie grass.

DISTRIBUTION AND EXTENT: Central and northern Illinois, Indiana, and Ohio. The series is of moderate extent in MLRAs 115, 95B, 108, 110, and 114.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana

SERIES ESTABLISHED: Ford County, Illinois, 1929.

REMARKS: A till substratum phase is recognized. It will be investigated during MLRA update activities and possibly a new soil series will be established.

Diagnostic horizons and features recognized in this pedon are:
mollic epipedon - the zone from the surface of the soil to a depth of 14 inches (Ap and AB horizons);
argillic horizon - the zone from approximately 14 to 45 inches (Bt1, Bt2, Bt3, Bt4, and 2Bt5 horizons);
udic moisture regime.

With this update the OSD is relocated to a site which better fits the classification. Refer to pedon 01IL-113-003.

National Cooperative Soil Survey
U.S.A.

LOCATION DRUMMER IL+IN OH WI

Established Series
Rev. JBF-JDA-TJE
05/2008

DRUMMER SERIES

The Drummer series consists of very deep, poorly drained soils formed in loess or other silty material and in the underlying loamy stratified outwash on nearly level or depressional parts of outwash plains, stream terraces, and till plains. Slope ranges from 0 to 2 percent. Mean annual precipitation is about 940 mm (37 inches), and mean annual air temperature is about 11 degrees C (52 degrees F).

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Typic Endoaquolls

TYPICAL PEDON: Drummer silty clay loam - on a south-facing concave slope with less than 1 percent gradient under grass at an elevation of about 218 meters (715 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 18 cm (0 to 7 inches); black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; firm; many fine roots; moderately acid; clear smooth boundary.

A--18 to 36 cm (7 to 14 inches); black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to weak fine granular; firm; many fine and medium roots throughout; slightly acid; clear smooth boundary. [Combined thickness of the A horizons is 25 to 56 cm (10 to 22 inches)].

BA--36 to 48 cm (14 to 19 inches); very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate fine and medium subangular blocky structure; firm; many fine and medium roots; few fine faint very dark grayish brown (2.5Y 3/2) extremely weakly cemented iron-manganese accumulations in the matrix; slightly acid; gradual smooth boundary. [0 to 20 cm (0 to 8 inches) thick]

Bg--48 to 64 cm (19 to 25 inches); dark gray (10YR 4/1) silty clay loam; moderate fine prismatic structure parting to moderate fine angular blocky; firm; many fine roots; common fine distinct and prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; many worm holes; neutral; gradual smooth boundary.

Btg1--64 to 81 cm (25 to 32 inches); grayish brown (2.5Y 5/2) silty clay loam; weak fine and medium prismatic structure parting to moderate fine angular blocky; firm; many fine roots; common distinct dark gray (N 4/0) clay films on faces of peds; many medium distinct yellowish brown (10YR 5/4) iron-manganese accumulations in the matrix; neutral; gradual wavy boundary.

Btg2--81 to 104 cm (32 to 41 inches); gray (N 5/0) silty clay loam; weak medium prismatic structure parting to weak medium angular blocky; firm; few fine roots; few distinct dark gray (N

4/0) clay films on faces of peds; many medium prominent yellowish brown (10YR 5/4) iron-manganese accumulations in the matrix; neutral; clear wavy boundary. [Combined thickness of the Bg horizon and Btg horizons is 51 to 119 cm (20 to 47 inches).]

2Btg3--104 to 119 cm (41 to 47 inches); gray (N 5/0) loam; weak coarse subangular blocky structure; friable; few fine roots; few distinct dark gray (10YR 4/1) clay films on faces of peds; common medium prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; 4 percent fine gravel; neutral; abrupt wavy boundary. [10 to 25 cm (4 to 10 inches) thick]

2Cg--119 to 152 cm (47 to 60 inches); dark gray (10YR 4/1) stratified loam and sandy loam; massive; friable; many medium prominent olive brown (2.5Y 4/4) iron-manganese accumulations in the matrix; many medium distinct gray (N 5/0) iron depletions in the matrix; slightly alkaline.

TYPE LOCATION: Champaign County, Illinois; on the University of Illinois south farm 1 mile south of Urbana; 1,600 feet east and 300 feet north of the southwest corner of sec. 19, T. 19 N., R. 9 E.; USGS Urbana topographic quadrangle; lat. 40 degrees 05 minutes 04 seconds N.,long. 88 degrees 13 minutes 58 seconds W.; UTM Zone 16T 0394896 easting 4437648 northing; NAD 27.

RANGE IN CHARACTERISTICS: The depth to the base of soil development ranges from 102 to 165 cm (40 to 65 inches). The depth to horizons with greater than 15 percent sand ranges from 102 to 152 cm (40 to 60 inches). The dominant clay mineral in the upper part of the series control section is smectite and in the lower part is illite. The particle-size control section averages between 20 and 35 percent clay and less than 15 percent fine sand or coarser. The mollic epipedon ranges from 25 to 61 cn (10 to 24 inches) in thickness and extends into the upper part of the B horizon in many pedons. Rock fragments are less than 15 percent in the lower part of the series control section. Depth to carbonates is greater than 102 cm (40 inches).

The Ap, A, and/or AB horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 2 to 3; and chroma of 0 to 2. It is silty clay loam and less commonly is silt loam. Clay content ranges from 20 to 35 percent. Reaction ranges from moderately acid to slightly alkaline.

Some pedons have an AB horizon rather than a BA horizon.

The Bg, Btg, and/or BA horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value dominantly of 4 or 5, but ranges to 3 in the upper part and to 6 in the lower part; and chroma dominantly of 1 or 2, but ranging from 0 to 4. Texture is silty clay loam in the upper part and silty clay loam or silt loam in the lower part. Clay content ranges from 20 to 35 percent. Reaction ranges from moderately acid to slightly alkaline.

The 2Bg, 2Btg, and/or 2BCg horizon has hue of 7.5YR, 10YR, 2.5Y, 5Y, or is neutral; value of 4 to 6; and chroma of 0 to 2. Some pedons have nearly equal proportions of low chroma and high chroma colors in the matrix. Texture is commonly loam or silt loam, and most pedons contain strata of sandy loam, clay loam, silty clay loam, sandy clay loam, or fine sandy loam. Clay content ranges from 15 to 33 percent and sand content ranges from 15 to 55 percent. Content of rock fragments is less than 7 percent. Reaction ranges from slightly acid to moderately alkaline.

The 2Cg and/or 2C horizon has hue of 7.5YR, 10YR, 2.5Y, 5Y, or is neutral; value of 4 to 7; and chroma of 0 to 8. It typically is stratified. Textures include loam, sandy loam, sandy clay loam, clay loam, silt loam, and silty clay loam. Some pedons have thin strata of loamy sand. Clay content ranges from 10 to 32 percent and sand content ranges from 15 to 80 percent. Content of rock fragments is less than 15 percent. Reaction ranges from neutral to moderately alkaline.

COMPETING SERIES: These are the Chalmers, Chetomba, Dolbee, Dunham, Elpaso, Elvira, Garwin, Gillet_Grove, Hartsburg, Madelia, Marcus, Mascoutah, Maxcreek, Maxfield, Ossian, Patton, Pella, Rushmore, Sable, and Wacousta series. Chalmers, Maxcreek and Maxfield soils are less than 40 inches to subhorizons that average more than 15 percent sand. Chetomba, Madelia, Pella, Rushmore, and Wacousta soils contain carbonates at depths less than 40 inches. Dolbee and Elvira soils formed in silty alluvial sediments on flood plains and river terraces and are subject to flooding. Dolbee soils do not have stratification and typically have less sand in the substratum than the Drummer soils. Elvira soils have high concentrations of iron and manganese oxides in the solum. Dunham soils average more than 15 percent gravel in the lower part of the series control section. Elpaso and Gillett_Grove soils have a well graded sand fraction in the lower part of the series control section. Garwin, Hartsburg, Marcus, Mascoutah, Ossian, and Sable soils average less than 15 percent sand in the lower part of the series control section. Patton soils average less than 25 percent sand in the lower part of the series control section, and the sand fraction is dominantly fine and very fine sand.

GEOGRAPHIC SETTING: Drummer soils are on nearly level or depressional parts of outwash plains, stream terraces, and till plains of Wisconsinan Age. Slope ranges from 0 to 2 percent. Drummer soils formed in 40 to 60 inches of loess or other silty material and in the underlying loamy stratified outwash. Mean annual air temperature ranges from 46 to 54 degrees F., mean annual precipitation is 29 to 40 inches, frost free days range from 140 to 180 days, and the elevation ranges from 500 to 1020 feet above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are Blackberry, Brenton, Catlin, Clare, Dana, Elburn, Flanagan, Lisbon, Plano, Proctor, Raub, Saybrook, and Sidell soils. The associated soils are on higher positions on the landform. The somewhat poorly drained Elburn, moderately well drained Blackberry, and well drained Plano soils form a drainage sequence with Drummer soils. The somewhat poorly drained Brenton, moderately well drained Clare and well drained Proctor soils have a thinner mantle of loess. The moderately well drained Catlin, Dana, and Saybrook soils, the somewhat poorly drained Flanagan, Lisbon, and Raub soils, and the well drained Sidell soils formed in loess and in the underlying loamy till.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. In drained conditions, an apparent seasonal high water table is 15 cm (0.5 foot) above the surface to 31 cm (1.0 foot) below the surface at some time between January and May in most years. In undrained conditions, an apparent seasonal high water table is 15 cm (0.5 foot) above the surface to 15 cm (0.5 foot) below the surface at some time between November and June in most years. The potential for surface runoff is negligible to low. Water ponds on these soils for brief periods during the spring. Saturated hydraulic conductivity is moderately high to high (4.23 to 14.11 micrometers per second). Permeability is moderate.

USE AND VEGETATION: Most areas are cropped. Corn and soybeans are the principal crops. Some areas are used for growing small grain or meadow. Native vegetation is hydrophytic

grasses, reeds, and sedges.

DISTRIBUTION AND EXTENT: Northern and central Illinois, northwestern Indiana, southwestern Ohio and southeastern Wisconsin. The extent is large in MLRAs 95B, 108, 110, 111, and 114; more than 500,000 acres have been correlated in Illinois to date.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Ford County, Illinois, 1929.

REMARKS: Diagnostic horizons and features recognized in this pedon are:
mollic epipedon - the zone from the surface to a depth of 48 cm (19 inches) (Ap, A, and BA horizons);
cambic horizon - the zone from approximately 48 to 119 cm (19 to 47 inches) (Bg, Btg1, Btg2, and 2Btg3 horizons);
aquic conditions - redoximorphic features present in the zone from approximately 36 to 152 cm (14 to 60 inches) (BA, Bg, Btg1, Btg2, 2Btg3, and 2Cg horizons).

ADDITIONAL DATA: SSIR No. 19, pp. 92-109. University of Illinois Agricultural Experiment Station Bulletin 665, Profile No. 29.

National Cooperative Soil Survey
U.S.A.

LOCATION ELLIOTT IL+IN OH WI

Established Series
Rev. JBF-JWS-EJE-DEC
05/2008

ELLIOTT SERIES

The Elliott series consists of very deep, somewhat poorly drained soils on till plains. They formed in up to 51 cm (20 inches) of loess or other silty material and in the underlying silty clay loam till. Slope ranges from 0 to 7 percent. Mean annual precipitation is about 914 mm (36 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine, illitic, mesic Aquic Argiudolls

TYPICAL PEDON: Elliott silt loam - on a west-facing slope with less than a 1 percent gradient in a cultivated field at an elevation of 704 feet (215 meters) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 15 cm (0 to 6 inches); black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common fine roots; moderately acid; abrupt smooth boundary.

A--15 to 28 cm (6 to 11 inches); black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; friable; common fine roots; slightly acid; clear smooth boundary. [Combined thickness of the A horizon is 25 to 51 cm (10 to 20 inches).]

Bt1--28 to 41 cm (11 to 16 inches); light olive brown (2.5Y 5/4) silty clay; moderate fine subangular blocky structure; friable; common fine roots; few distinct black (10YR 2/1) organic oatings on faces of peds; many distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds; neutral; clear smooth boundary. [0 to 25 cm (0 to 10 inches) thick]

2Bt2--41 to 58 cm (16 to 23 inches); light olive brown (2.5Y 5/4) silty clay loam; moderate fine prismatic structure parting to moderate fine angular blocky; friable; few fine roots; common distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds; few fine distinct yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; few fine distinct grayish brown (2.5Y 5/2) iron depletions in the matrix; 1 percent gravel; neutral; clear smooth boundary.

2Bt3--58 to 71 cm (23 to 28 inches); grayish brown (2.5Y 5/2) silty clay loam; moderate fine prismatic structure parting to moderate fine angular blocky; friable; few fine roots; common distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds; common fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; 1 percent gravel; neutral; clear smooth boundary.

2Bt4--71 to 89 cm (28 to 35 inches); olive brown (2.5Y 4/4) silty clay loam; moderate fine prismatic structure parting to moderate fine angular blocky; firm; few fine roots; many distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds; few fine black (7.5YR 2.5/1) very

weakly cemented iron-manganese concretions throughout; few medium white (10YR 8/1) moderately cemented calcium carbonate concretions throughout; few fine distinct yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; 1 percent Gravel; slightly effervescent; slightly alkaline; clear smooth boundary.

2Bt5--89 to 104 cm (35 to 41 inches); olive brown (2.5Y 4/4) silty clay loam; weak fine prismatic structure parting to moderate medium angular blocky; firm; few fine roots; common distinct gray (5Y 6/1) clay films on faces of peds; few fine distinct yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; 2 percent gravel; strongly effervescent; slightly alkaline; clear smooth boundary. [Combined thickness of the 2Bt horizon is 89 to 104 cm (10 to 28 inches).]

2Cd--104 to 152 cm (41 to 60 inches); olive brown (2.5Y 4/4) silty clay loam; massive; very firm; common fine prominent gray (5Y 5/1) iron depletions in the matrix; 3 percent gravel; strongly effervescent; moderately alkaline.

TYPE LOCATION: Livingston County, Illinois; about 2 miles (3.2 kilometers) east of Emmington; 690 feet (210 meters) south and 2,436 feet (742 meters) west of the center of sec. 21, T. 29 N., R. 8 E.; USGS Cullom topographic quadrangle; lat. 40 degrees 58 minutes 12 seconds N. and long. 88 degrees 19 minutes 19 seconds W., NAD 83; UTM Zone 16, 388762 easting and 4536262 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of soil development ranges from 51 to 114 cm (20 to 45 inches). The depth to carbonates ranges from 43 to 102 cm (17 to 40 inches). The particle-size control section averages between 35 and 45 percent clay. The mollic epipedon is 25 to 51 cm (10 to 20 inches) thick.

The Ap, A, or AB horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It is silt loam, silty clay loam, or loam. Rock fragment content ranges from 0 to 5 percent. Reaction ranges from moderately acid to neutral.

The BA, Bt, 2Bt, or 2Btg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 4. Redoximorphic features have chroma of 1 to 8. Texture is silty clay loam or silty clay, and less commonly clay and clay loam. Subhorizons range from 35 to 50 percent clay, 4 to 25 percent sand, and from 0 to 10 percent rock fragments. Reaction typically ranges from moderately acid to neutral but is slightly alkaline in the lower part in some pedons.

The 2BC, 2BCg, 2Cd, or 2Cdg horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 to 6. Redoximorphic features are commonly present. Texture is silty clay loam or clay loam. Clay content ranges from 27 to 40 percent, sand content ranges from 5 to 30 percent, and rock fragment content
ranges from 1 to 15 percent. Reaction is slightly alkaline or moderately alkaline. Bulk density of the 2Cd or 2Cdg horizons ranges from 1.7 to 1.9 gm/cc.

COMPETING SERIES: These are the Chenoa, Clarence, Martinton, and Strole series. Chenoa soils average less than 8 percent fine sand and coarser in the upper part of the particle-size control section. Clarence and Strole soils average more than 45 percent clay in the particle-size control section. Martinton soils average less than 27 percent clay in some subhorizon in the

lower part of the series control section. In addition, the sand fraction of the Martinton soil is predominantly fine or very fine.

GEOGRAPHIC SETTING: Elliott soils are on relatively undissected parts of till plains of Wisconsinan Age. Slope gradients range from 0 to 7 percent. The soils typically formed in silty clay loam till with a surface mantle of loess or other silty material ranging from 0 to 51 cm (0 to 20 inches) thick. Mean annual
air temperature ranges from 7 to 11 degrees C (45 to 52 degrees F), mean annual precipitation ranges from 711 to 1016 mm (28 to 40 inches), frost-free period ranges from 140 to 180 days, and elevation ranges from 165 to 311 meters (541 to 1020 feet) above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Beecher, Blount, and Varna soils. The moderately well drained Varna soils and the poorly drained Ashkum soils form a hydro-sequence with Elliott soils. Ashkum soils are on lower landform positions and Varna soils are on higher landform positions. The somewhat poorly drained Beecher and Blount soils form a biosequence with Elliott soils and are on similar parts of landforms. Blount soils have a light colored surface layer, and Beecher soils lack the required surface layer thickness for a mollic epipedon.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat poorly drained. The potential for surface runoff is low to high. Permeability is slow. Saturated hydraulic conductivity is moderately low or moderately high (0.42 to 1.41 micrometers/s). An intermittent perched seasonal high water table is at a depth of 30 to 61 cm (1.0 to 2.0 feet) at some time between January and May in most years.

USE AND VEGETATION: Most areas are cultivated. Corn, soybeans, small grain, and meadow are the principal crops. Native vegetation is prairie grasses.

DISTRIBUTION AND EXTENT: Northeastern Illinois, southeastern Wisconsin, northern Indiana, and Ohio. The series is of large extent in MLRA's 95B, 108A, 110, 111B, and 111C. More than 300,000 acres (121,408 hectares) have been correlated in the four states named.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Ford County, Illinois, 1929.

REMARKS: A bedrock substratum phase is recognized with limestone bedrock at depths of 60 to 80 inches (152 to 203 cm). This phase will need to be evaluated during future MLRA update activities.
Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 28 cm (11 inches) (Ap and A horizons); argillic horizon - the zone from approximately 28 to 104 cm (11 to 41 inches) (Bt1, 2Bt2, 2Bt3, 2Bt4, and 2Bt5 horizons); udic moisture
regime.

ADDITIONAL DATA: Refer to pedon number 85IL105034 from the University of Illinois Pedology Laboratory. This data is on file at the Illinois NRCS State Office and Indianapolis MLRA Region 11 Office.

National Cooperative Soil Survey
U.S.A.

LOCATION HARPSTER IL+IA IN MN

Established Series
Rev. JBF-JWS-JCD
04/2008

HARPSTER SERIES

The Harpster series consists of very deep, poorly drained soils formed in calcareous loess or glacial drift. They are on nearly level or depressional parts of outwash plains, till plains, glacial lake plains, or stream terraces. Slope ranges from 0 to 2 percent. Mean annual precipitation is about 890 mm (35 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Typic Calciaquolls

TYPICAL PEDON: Harpster silty clay loam - in a cultivated field at an elevation of 220 meters (722 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Apk--0 to 23 cm (0 to 9 inches); black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common very fine roots; many snail shells; strongly effervescent (20 percent calcium carbonate); moderately alkaline; abrupt smooth boundary.

Ak--23 to 46 cm (9 to 18 inches); very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine and medium granular structure; firm; common very fine roots; many snail shells; strongly effervescent (18 percent calcium carbonate); moderately alkaline; clear smooth boundary. [(Combined thickness of the A horizon is 25 to 48 cm (10 to 19 inches).]

Bg1--46 to 64 cm (18 to 25 inches); dark grayish brown (2.5Y 4/2) silty clay loam; weak fine and medium angular blocky structure; firm; common very fine roots; many distinct very dark gray (10YR 3/1) organic coatings on faces of peds; common fine distinct light olive brown (2.5Y 5/4) masses of oxidized iron in the matrix; few snail shells; slightly effervescent (7 percent calcium carbonate); moderately alkaline; gradual smooth boundary.

Bg2--64 to 79 cm (5 to 31 inches); dark gray (5Y 4/1) silty clay loam; moderate medium prismatic structure parting to moderate fine and medium angular blocky; firm; few very fine roots; many distinct very dark gray (10YR 3/1) organic coatings on faces of peds; few fine prominent dark yellowish brown (10YR 4/4) and few fine distinct olive (5Y 4/4) extremely weakly cemented iron-manganese accumulations in the matrix; few snail shells; slightly effervescent (5 percent calcium carbonate); slightly alkaline; gradual smooth boundary.

Bg3--79 to 91 cm (31 to 36 inches); dark gray (5Y 4/1) silty clay loam; weak coarse prismatic structure parting to weak medium angular blocky; firm; few very fine roots; common distinct very dark gray (10YR 3/1) organic coatings on faces of peds; common medium distinct olive (5Y 4/4) extremely weakly cemented iron-manganese accumulations and few fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; 2 percent gravel; slightly effervescent (2 percent calcium carbonate); slightly alkaline; gradual smooth boundary.

Bg4--91 to 104 cm (36 to 41 inches); 40 percent olive brown (2.5Y 4/4), 35 percent olive yellow (2.5Y 6/6), and 25 percent gray (5Y 5/1) silty clay loam; weak coarse angular blocky structure; firm; few very fine roots; 2 percent gravel; slightly effervescent (2 percent calcium carbonate); slightly alkaline; gradual smooth boundary. [Combined thickness of the Bg horizon is 25 to 89 cm (10 to 35 inches).]

Cg1--104 to 142 cm (41 to 56 inches); 55 percent gray (5Y 5/1), 40 percent light olive brown (2.5Y 5/6),

and 5 percent dark yellowish brown (10YR 4/4) silt loam; massive; firm; 1 percent gravel; strongly effervescent (16 percent calcium carbonate); moderately alkaline; clear smooth boundary.

2Cg2--142 to 152 cm (56 to 60 inches); gray (10YR 5/1) loam; massive; friable; 5 percent gravel; strongly effervescent; moderately alkaline.

TYPE LOCATION: Ford County, Illinois; about 4.8 kilometers (3 miles) southwest of Gibson City; 261 meters (855 feet) south and 21 meters (70 feet) west of the northeast corner of sec. 20, T. 23 N., R. 7 E.; USGS Gibson City West topographic quadrangle; lat. 40 degrees 26 minutes 24 seconds N. and long. 88 degrees 25 minutes 23 seconds W., NAD 27; UTM Zone 16, 379305 easting and 4477570 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of soil development ranges from 56 to 117 cm (22 to 46 inches). The mollic epipedon ranges from 25 to 61 cm (10 to 24 inches) in thickness and includes the upper part of the B horizon in some pedons. A calcic horizon is typically at the surface or within a depth of 41 cm (16 inches) and has a calcium carbonate equivalent of 15 to 40 percent. These soils commonly contain small snail shells in part or all of the series control section. The depth to horizons with greater than 15 percent sand ranges from 91 to 152 cm (36 to 60 inches). The particle-size control section averages between 27 and 35 percent clay. Reaction is slightly alkaline or moderately alkaline. Gravel content is less than 10 percent.

The Apk or Ak horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 2 to 3; and chroma of 0 or 1. It typically is silty clay loam but is silt loam in some pedons.

The Bg horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 3 to 6; and chroma of 0 to 2. Redoximorphic features generally have higher chroma. Texture is typically silty clay loam, but includes silt loam, clay loam, and loam in the lower part. Clay content ranges from 22 to 35 percent.

The Cg or 2Cg horizon has hue of 7.5YR, 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 to 8. It commonly has redoximorphic features. Texture is typically silt loam or loam, but strata of sandy loam, very fine sandy loam, or clay loam is present in some pedons. Clay content ranges from 15 and 30 percent and sand content ranges from 5 to 55 percent.

COMPETING SERIES: These are the Chipman, Leen, Logan, Prophetstown, and Spaulding series. Chipman, Leen, and Logan soils are dry for more than 20 consecutive days in all parts of the soil moisture control section in at least 6 out of 10 years. Prophetstown soils contain 18 to 27 percent clay in the particle-size control section. Spaulding soils contain less than 7 percent sand in the lower part of the series control section.

GEOGRAPHIC SETTING: Harpster soils are on nearly level or slightly depressional parts of till plains, outwash plains, lake plains, or stream terraces. Slopes typically are less than 1 percent but range to as much as 2 percent. The soils formed in calcareous silty material derived from loess or glacial drift. Mean annual air temperature ranges from 7 to 11 degrees C (45 to 52 degrees F), mean annual precipitation ranges from 740 to 1020 mm (29 to 40 inches), frost-free period ranges from 140 to 180 days, and elevation ranges from 165 to 311 meters (540 to 1,020 feet) above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Brenton, Drummer, Elburn, Hartsburg and Pella soils. None of these soils have calcic horizons. The somewhat poorly drained Brenton and Elburn soils are on higher parts of the landform. The poorly drained Drummer soils generally are on slightly higher lying parts of till plains or outwash plains. The poorly drained Hartsburg and Pella soils are on similar depressional areas on outwash plains or till plains.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. Where drained, an apparent seasonal high water table is 15 cm (0.5 foot) above the surface to 31 cm (1.0 foot) below the surface at some time between January and May in most years. In undrained conditions, an apparent seasonal

high water table is 15 cm (0.5 foot) above the surface to 15 cm (0.5 foot) below the surface at some time between November and June in most years. The potential for surface runoff is negligible. Saturated hydraulic conductivity is moderately high or high (4.23 to 14.11 micrometers per second). Permeability is moderate.

USE AND VEGETATION: Most areas are cultivated. Corn and soybeans are the principal crops. Native vegetation is hydrophytic herbaceous vegetation.

DISTRIBUTION AND EXTENT: Central and northern Illinois, east and north-central Iowa, and south-central Minnesota and west-central Indiana. Harpster soils are of moderate extent in MLRAs 95B, 103, 104, 108A, 108B, 110, and 111D.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Ford County, Illinois, 1929.

REMARKS: Some pedons in the Harpster series do not have a calcic horizon that has 5 percent greater calcium carbonate content than the C horizon, but all pedons have at least 5 percent less calcium carbonate equivalent in some horizon below the calcic horizon. Flooded and nonponded phases are currently recognized. These soils will be evaluated during MLRA updating to determine if new series needed.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 46 cm (18 inches) (Apk and Ak horizons); cambic horizon - the zone from approximately 46 to 104 cm (18 to 41 inches) (Bg1, Bg2, Bg3, and Bg4 horizons); calcic horizon - the zone from the surface of the soil to a depth of about 46 cm (18 inches) (Apk and Ak horizons); aquic conditions - redoximorphic features present in the zone from approximately 46 to 152 cm (18 to 60 inches) (Bg1, Bg2, Bg3, Bg4, Cg1, and Cg2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION HOUGHTON MI+IA IL IN MN WI

Established Series
Rev. LWB-WEF-RAB-SLM
04/2007

HOUGHTON SERIES

The Houghton series consists of very deep, very poorly drained soils formed in herbaceous organic deposits more than 51 inches thick in depressions on lake plains, outwash plains, ground and end moraines and on floodplains. These soils have moderately slow to moderately rapid permeability. Slope ranges from 0 to 2 percent. Mean annual precipitation is about 35 inches, and mean annual temperature is about 50 degrees F.

TAXONOMIC CLASS: Euic, mesic Typic Haplosaprists

TYPICAL PEDON: Houghton muck - on a level area in a cultivated field. (Colors are for moist soils unless otherwise stated.)

Oa1--0 to 9 inches; black (N 2.5/0) broken face and rubbed muck (sapric material); about 5 percent fiber, a trace rubbed; weak coarse subangular blocky structure; neutral (pH 7.0 in KCl); abrupt smooth boundary.

Oa2--9 to 13 inches; black (N 2.5/0) broken face, very dark brown (7.5YR 2/2) rubbed muck (sapric material); about 5 percent fiber, a trace rubbed; weak medium granular structure; neutral (pH 7.0 in KCl); abrupt smooth boundary.

Oa3--13 to 24 inches; dark reddish brown (5YR 3/2) broken face, dark reddish brown (5YR 2/2) rubbed muck (sapric material); about 15 percent fiber, less than 5 percent rubbed; massive, breaking to thick platy fragments; neutral (pH 7.0 KCl); abrupt smooth boundary.

Oa4--24 to 32 inches; black (5YR 2/1) broken face and rubbed muck (sapric material); about 10 percent fiber, a trace rubbed; massive; about 1 percent woody fragments; neutral (pH 7.0 in KCl); clear wavy boundary.

Oa5--32 to 48 inches; dark reddish brown (5YR 2/2) broken face, black (5YR 2/1) rubbed muck (Sapric material); about 20 percent fiber, less than 10 percent rubbed; massive, breaking to thick platy fragments; neutral (pH 7.0 in KCl); abrupt smooth boundary.

Oa6--48 to 80 inches; dark reddish brown (5YR 2/2) broken face and rubbed muck (sapric material); about 10 percent fiber, less than 10 percent rubbed; massive; slightly sticky; about 15 percent mineral soil; neutral (pH 7.0 in KCl).

TYPE LOCATION: Clinton County, Michigan; about 3 miles northeast of the village of Bath; 200 feet north and 400 feet east of the southwest corner of sec. 12, T. 5 N., R. 1 W. USGS Bath topographic quadrangle, lat. 42 degrees 49 minutes 43.4 seconds N. and long. 84 degrees 52 minutes 56.9 seconds W.; NAD 27.

RANGE IN CHARACTERISTICS: The organic layers are more than 51 inches thick. The organic fibers are derived primarily from herbaceous plants, but some pedons contain individual layers which contain as much as 30 percent woody material, however, the woody fragment content averages less than 15 percent by volume in the control section. It is very strongly acid to slightly alkaline.

The organic layers have hue of 10YR, 7.5YR, or 5YR, value of 2 to 3, and chroma of 1 to 3, or is in 2.5/0. The layers are predominantly muck (sapric material), but in some pedons mucky peat (hemic material) has a combined thickness of less than 10 inches and peat (fibric material) less than 5 inches. Some pedons have coprogenous material or marly material below 51 inches

COMPETING SERIES: These are the Carlisle, Lena, Peteetneet, Saltese, and Semiahmoo series. Similar soils are the Adrian, Carbondale, Greenwood, Linwood, Lupton, Palms, Rifle, and Willette series. Carlisle soils derived dominantly from woody materials and contain an average of 15 to 30 percent woody fragments in the control section. Lena soils contain free carbonates throughout. Peteetneet soils are massive or platy in bottom tier, are on elevations of about 4,500 feet, and are substantially drier in the moisture control section during the 120 days following the summer solstice. Saltese and Semiahmoo soils are in areas with mild humid climates. Adrian, Linwood, Palms, and Willette soils have a mineral substrata depths ranging from 16 to about 50 inches. Carbondale, Greenwood, Lupton, and Rifle soils are frigid.

GEOGRAPHIC SETTING: Houghton soils occupy closed depressions within lake plains, outwash plains, ground and end moraines, and on floodplains. Slope gradients are less than 2 percent. The mean annual precipitation ranges from about 30 to 42 inches, and the mean annual temperature is about 48 to 53 degrees F.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Adrian, Edselton, Edwards, Moston, Muskego, Palms, and Willette soils. Edselton and Edwards soils are underlain by marly material at depths of 16 to 51 inches. Moston, and Muskego soils are underlain by coprogenous material between 16 and 51 inches. Poorly or very poorly drained mineral soils are commonly associated along the margins of the bogs.

DRAINAGE AND PERMEABILITY: Very poorly drained. Depth to the seasonal high water table ranges from 2 foot above the surface in ponded phases to 1 foot below the surface from September to June. The potential for surface runoff is very slow or ponded. Permeability is moderately slow to moderately rapid.

USE AND VEGETATION: A considerable area of these soils is used for cropland or pasture. Common crops are onions, lettuce, potatoes, celery, radishes, carrots, mint, and some corn. Native vegetation was primarily of marsh grasses, sedges, reeds, buttonbrush, and cattails. Some water-tolerant trees were near the margin of the bog.

DISTRIBUTION AND EXTENT: MLRA 95, 98, 104, 105, 110, 111. Southern part of the lower peninsula of Michigan, Wisconsin, Indiana, Iowa, Minnesota, and Illinois. The series is of large extent.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana

SERIES ESTABLISHED: Roscommon County, Michigan, 1924.

REMARKS: Diagnostic horizons and features recognized in this pedon are: Well decomposed organic material from the surface to greater than 51 inches (Oa1, Oa2, Oa3, Oa4, Oa5 and Oa6 horizons)
histic epipedon - muck from the surface to 16 inches (Oa1, Oa2, Oa3);
aquic conditions - from the surface to 40 inches.

ADDITIONAL DATA: Soil Interpretation Record - (MI0024, MI0291 (PONEED), MI0532 (SLOPING), MI0390 (MAAT>50), MI0383 (FREQUENTLY FLOODED). Transect data (T98-MI-003) is on file in MLRA project office, Plymouth, Indiana. Transect shows 100 percent Houghton.

National Cooperative Soil Survey
U.S.A.

LOCATION JASPER IL+IN MO WI

Established Series
Rev. DEC-TJE
04/2008

JASPER SERIES

The Jasper series consists of very deep, well drained soils that formed in loamy material and stratified loamy sediments on outwash plains. Some pedons have a thin mantle of loess or other silty material. Slopes range from 0 to 18 percent. Mean annual temperature is about 10 degrees C (50 degrees F), and mean annual precipitation is about 914 mm (36 inches).

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Typic Argiudolls

TYPICAL PEDON: Jasper loam - on a 2 percent slope in a cultivated field at an elevation of 197 meters (645 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 25 cm (0 to 10 inches); very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate very fine granular structure; friable; slightly acid; abrupt smooth boundary.

A--25 to 48 cm (10 to 19 inches); very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak very fine subangular blocky structure parting to moderate fine granular; friable; slightly acid; clear smooth boundary. [Combined thickness of the A horizons is 25 to 51 cm (10 to 20 inches).]

Bt1--48 to 69 cm (19 to 27 inches); dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; common distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; common distinct brown (10YR 4/3) clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2--69 to 97 cm (27 to 38 inches); dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; friable; many faint brown (10YR 4/3) clay films on faces of peds; moderately acid; diffuse smooth boundary.

Bt3--97 to 124 cm (38 to 49 inches); dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; friable; common faint brown (10YR 4/3) clay films on faces of peds; moderately acid; gradual smooth boundary. [Combined thickness of the Bt horizon is 38 to 140 cm (15 to 55 inches).]

C--124 to 170 cm (49 to 67 inches); dark yellowish brown (10YR 4/4) stratified loam, sandy loam, loamy sand, and sand; massive; friable; moderately acid.

TYPE LOCATION: Vermilion County, Illinois; about 1.6 km (1.0 mile) north and 1.2 km (0.75 mile) east of Muncie; 30 m (100 feet) south and 488 m (1,600 feet) west of the northeast corner of sec. 9, T. 19 N., R. 13 W.; USGS Collision topographic quadrangle; lat. 40 degrees 07 minutes 43 seconds N., and long. 87 degrees 49 minutes 54 seconds W.; NAD 27; UTM Zone

16, 0429144 easting and 4442378 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of the argillic horizon ranges from 89 to 152 cm (35 to 60 inches). The mollic epipedon ranges from 25 to 51 cm (10 to 20 inches) in thickness. Depth to carbonates is more than 89 cm (35 inches). The particle-size control section averages between 20 and 32 percent clay and between 15 and 55 percent fine sand or coarser.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 to 3. It is loam, silt loam, or fine sandy loam. Reaction is strongly acid to neutral.

Some pedons have an AB or BA horizon.

The Bt and/or 2Bt horizons have hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is clay loam, sandy clay loam, loam, silty clay loam, or silt loam. Clay content ranges from 20 to 32 percent and sand content ranges from 15 to 55 percent. Rock fragment content is less than 5 percent. Reaction ranges from strongly acid to neutral.

The BC or 2BC horizon, where present, has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is fine sandy loam, sandy loam, loam, or sandy clay loam. Clay content ranges from 12 to 30 percent and sand content ranges from 45 to 65 percent. It has less than 5 percent gravel. Reaction ranges from moderately acid to slightly alkaline.

The C or 2C horizon has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 6. It is stratified sandy clay loam, silt loam, loam, fine sandy loam, sandy loam, loamy sand, fine sand, and sand. Clay content ranges from 5 to 20 percent. Average sand content ranges from 45 to 70 percent, but individual subhorizons can range from 15 to 90 percent sand. Gravel content is less than 10 percent. Reaction ranges from moderately acid to moderately alkaline.

COMPETING SERIES: These are the Atkinson, Burchard, Calmar, Cokato, Cresco, Cresent, Durand, Friesland, Griswold, Hitt, Joslin, Keosauqua, Kishwaukee, Marbletown, Moingona, Morrill, Nuxmaruhanixete, Pana, Parmod, Penfield, Reedslake, Ringwood, Rockton, Schoolcraft, Shelby, Sibleyville, Velma, and Winnebago series in the same family. Atkinson, Calmar, Hitt, Marbletown, Rockton, and Sibleyville soils have a lithic or paralithic contact within a depth of 152 cm (60 inches). Burchard soils have carbonates within a depth of 89 cm (35 inches). Cokato, Friesland, Moingona, Reedslake, and Velma soils average less than 45 percent sand in the lower part of the series control section. Cresco, Joslin, and Shelby soils have more than 20 percent clay in the lower part of the series control section. Cresent, Keosauqua, and Schoolcraft soils average more than 70 percent sand in the lower part of the series control section. Durand, Morrill and Winnebago soils have hue redder than 7.5YR in some part of the argillic horizon. Griswold, Kishwaukee, Nuxmaruhanixete, Pana, and Ringwood soils have more than 10 percent gravel in the lower part of the series control section. Parmod soils have a well graded sand fraction in the lower part of the series control section. Penfield soils have redoximorphic features with chroma of 2 in the lower part of the series control section.

GEOGRAPHIC SETTING: Jasper soils are on outwash plains of Wisconsinan Age. Slope ranges from 0 to 18 percent. Jasper soils formed in loamy material and stratified loamy sediments. Some pedons have a thin mantle of loess or other silty material less than 56 cm (22

inches) thick. Mean air annual temperature ranges from 8 to 12 degrees C (46 to 54 degrees F), mean annual precipitation ranges from 740 to 1020 mm (29 to 40 inches), frost free period ranges from 160 to 180 days, and elevation ranges from 155 to 311 m (510 to 1,020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Brenton, Drummer, La Hogue, and Penfield soils. The somewhat poorly drained Brenton soils and the poorly drained Drummer soils are on lower parts of the landscape where the loess in thicker. The somewhat poorly drained La Hogue soils and the well drained Penfield soils form a drainage sequence with the Jasper soils.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Well drained. The potential for surface runoff is low or medium. Saturated hydraulic conductivity is moderately high or high (4.23 to 14.11 micrometers per second) to the base of the argillic horizon and moderately high to high or high (4.23 to 42.33 micrometers per second) in the substratum. Permeability is moderate to the base of the argillic horizon and moderate or moderately rapid in the substratum.

USE AND VEGETATION: Soils are cultivated. Corn, soybeans, wheat, and oats are principal crops. Native vegetation is tall prairie grasses, chiefly Big Blue stem.

DISTRIBUTION AND EXTENT: Central and northern Illinois, northwestern Indiana, and southern Wisconsin. It is of large extent in MLRAs 95B, 98, 108, and 110.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana

SERIES ESTABLISHED: Newton County, Indiana, 1948.

REMARKS: A sandy substratum phase was previously recognized. It was investigated during MLRA update activities, and as a result the Cresent series was established. A till substratum phase is currently recognized. These soils will be investigated during MLRA update activities to determine if new series is needed.
Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 48 cm (19 inches) (Ap and A horizons); argillic horizon - the zone from about 48 to 124 cm (19 to 49 inches) (Bt1, Bt2, and Bt3 horizons); udic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION MARKHAM IL+IN WI

Established Series
Rev. GOW-JBF-DEC
07/2007

MARKHAM SERIES

The Markham series consists of very deep, moderately well drained soils on Wisconsin till plains. They formed in a thin layer of loess or silty material and in the underlying silty clay loam till. Slopes range from 0 to 20 percent. Mean annual precipitation is about 890 mm (35 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine, illitic, mesic Mollic Oxyaquic Hapludalfs

TYPICAL PEDON: Markham silt loam on a north-facing slope of 3 percent at an elevation of 236 meters (775 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 13 cm (0 to 5 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; common very fine roots; moderately acid; clear smooth boundary.

A--13 to 20 cm (5 to 8 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure parting to weak fine granular; friable; common very fine roots; moderately acid; abrupt smooth boundary. [Combined thickness of the A horizon is 15 to 23 cm (6 to 9 inches).]

BA--20 to 30 cm (8 to 12 inches); brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; common very fine roots; common distinct very dark grayish brown (10YR 3/2) organic coatings on faces of peds; moderately acid; clear wavy boundary. [0 to 15 cm (0 to 6 inches) thick]

2Bt1--30 to 53 cm (12 to 21 inches); dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium prismatic structure parting to moderate fine subangular blocky; friable; common very fine and fine roots; few distinct very dark gray (10YR 3/1) organic coatings on faces of peds; common distinct brown (10YR 4/3) clay films on faces of peds; common fine strong brown (7.5YR 4/6) very weakly cemented iron oxide concretions throughout; 2 percent gravel; slightly acid; clear wavy boundary.

2Bt2--53 to 66 cm (21 to 26 inches); yellowish brown (10YR 5/4) silty clay loam; weak medium subangular blocky structure; friable; common very fine and fine roots; few distinct brown (10YR 4/3) clay films on faces of peds and in pores; common fine yellowish red (5YR 4/6) very weakly cemented iron oxide concretions throughout; common fine distinct grayish brown (10YR 5/2) iron depletions in the matrix; 7 percent gravel; slightly effervescent; slightly alkaline; gradual wavy boundary. [Combined thickness of the 2Bt horizon is 25 to 89 cm (10 to 35 inches).]

2BC--66 to 81 cm (26 to 32 inches); yellowish brown (10YR 5/4) silty clay loam; weak medium and coarse angular blocky structure; firm; common very fine roots; common fine yellowish red (5YR 5/6) very weakly cemented iron oxide concretions throughout; common fine distinct grayish brown (10YR 5/2) iron depletions in the matrix; 6 percent gravel; strongly effervescent; slightly alkaline; gradual wavy boundary. [0 to 25 cm (0 to 10 inches) thick]

2Cd1--81 to 99 cm (32 to 39 inches); yellowish brown (10YR 5/4) silty clay loam; massive; very firm; few very fine roots; common fine yellowish red (5YR 5/6) very weakly cemented iron oxide concretions throughout; 6 percent gravel; violently effervescent; moderately alkaline; gradual wavy boundary.

2Cd2--99 to 152 cm (39 to 60 inches); brown (10YR 5/3) silty clay loam; massive; very firm; common fine yellowish red (5YR 5/6) very weakly cemented iron oxide concretions throughout; 7 percent gravel; violently effervescent; moderately alkaline.

TYPE LOCATION: DuPage County, Illinois; 648 meters (2,125 feet) south and 419 meters (1,375 feet) east of the northwest corner of sec. 16, T. 40 N., R.9 E.; USGS West Chicago topographic quadrangle; lat. 41 degrees 57 minutes 09 seconds N. and long. 88 degrees 13 minutes 04 seconds W., NAD 27; UTM Zone 16, 399060E, 4645222N, NAD 83.

RANGE IN CHARACTERISTICS: Depth to the base of soil development is 51 to 140 cm (20 to 55 inches). Illite is the dominant clay mineral.

The upper part of the series control section (Ap or A horizon) has 10YR hue, value of 2 or 3 and chroma of 1 or 2. It is silt loam or silty clay loam.

Some pedons have an E horizon with hue of 10YR, value of 4 or 5, and chroma of 2 or 3.

The middle part of the series control section (Bt or 2Bt horizon) has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 8. It is silty clay loam or silty clay. The particle-size control section of the Bt horizon averages between 35 and 45 percent clay and contains less than 50 percent clay in any subhorizon. Reaction ranges from strongly acid to slightly acid in the upper part and from slightly acid to moderately alkaline in the lower part.

The lower part of the series control section (BC, 2BC, Cd or 2Cd horizon) has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 8. It is silty clay loam or clay loam. It is slightly to moderately alkaline and commonly contains carbonates.

COMPETING SERIES: There are no competing series.

GEOGRAPHIC SETTING: Markham soils are typically in transition areas between the Mollisols and Alfisols on Wisconsin till plains. Slopes are dominantly between 3 and 12 percent, and they range from 0 to 20 percent. The soils are formed in silty clay loam till of Wisconsin Age that has, in some places, mantles of less than 46 cm (18 inches) of loess or other silty material. Mean annual air temperature ranges from 7 to 11 degrees C (45 to 52 degrees F.), mean annual precipitation is 740 to 1020 mm (29 to 40 inches), frost free days is 140 to 180 days, and the elevation ranges from 165 to 311 meters (540 to 1020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Beecher, Elliott, Morley, Ozaukee, and Varna soils. The poorly drained Ashkum soils have a mollic epipedon and are lower positions on the landform. The somewhat poorly drained Beecher and Elliott soils are on slightly lower landform positions. Morley, Ozaukee, and Varna soils are also on similar landform positions. Morley and Ozaukee soils have surface layers with moist color values of 4 or more, and Varna soils have mollic epipedons.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Moderately well drained. The depth to a perched seasonal high water table is 61 to 107 cm (2.0 to 3.5 feet) at some time during the spring in most years. The potential for surface runoff is low to high. Saturated hydraulic conductivity is moderately low to moderately high (0.42 to 1.41 micrometers per second). Permeability is slow.

USE AND VEGETATION: Largely cropped to corn, soybeans, small grains, and hay. Native vegetation was probably prairie grass having recent encroachment of hardwood trees.

DISTRIBUTION AND EXTENT: Northern Illinois, southeastern Wisconsin, northern Indiana, and southern Michigan.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Lake County, Illinois, 1961.

REMARKS: Diagnostic horizons and features recognized in this pedon are: ochric epipedon (mollic intergrade) - the zone from the surface to 30 cm (12 inches) (Ap, A and BA horizons); argillic horizon - the zone from 30 to 66 cm (12 to 26 inches) (2Bt1 and 2Bt2 horizons); udic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION MILLBROOK IL+IN

Established Series
Rev. BWR-RDC
04/2008

MILLBROOK SERIES

The Millbrook series consists of very deep, somewhat poorly drained soils formed in loess or other silty material and in the underlying loamy stratified outwash. These soils are on outwash plains and stream terraces. Slope ranges from 0 to 5 percent. Mean annual precipitation is about 860 mm (34 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Udollic Endoaqualfs

TYPICAL PEDON: Millbrook silt loam - on a 1 percent slope in a cultivated field at an elevation of 201 meters (660 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 18 cm (0 to 7 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine and medium granular structure; friable; few fine rounded black (7.5YR 2.5/1) very weakly cemented iron-manganese nodules throughout; neutral; abrupt smooth boundary. [18 to 23 cm (7 to 9 inches) thick]

E--18 to 36 cm (7 to 14 inches); dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium platy structure parting to moderate medium granular; friable; many distinct very dark gray (10YR 3/1) organic coatings on faces of peds; few fine rounded black (7.5YR 2.5/1) very weakly cemented iron-manganese nodules throughout; many fine faint brown (10YR 4/3) extremely weakly cemented iron-manganese accumulations and few fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; neutral; clear smooth boundary. [8 to 30 cm (3 to 12 inches) thick]

Bt--36 to 53 cm (14 to 21 inches); yellowish brown (10YR 5/6) silty clay loam; moderate fine subangular blocky structure; friable; few distinct dark gray (10YR 4/1) clay films on faces of peds and on surfaces along pores; few medium irregular black (7.5YR 2.5/1) very weakly cemented iron-manganese nodules throughout; few fine distinct yellowish brown (10YR 5/8) masses of oxidized iron in the matrix; common medium prominent grayish brown (10YR 5/2) iron depletions in the matrix; moderately acid; clear smooth boundary.

Btg1--53 to 89 cm (21 to 35 inches); 70 percent gray (10YR 5/1) and 30 percent yellowish brown (10YR 5/6) silty clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; friable; few distinct dark gray (10YR 4/1) clay films on faces of peds and on surfaces along pores; common medium irregular black (7.5YR 2.5/1) very weakly cemented iron-manganese nodules throughout; moderately acid; clear smooth boundary. [Combined thickness of the Bt and Btg horizons is 20 to 64 cm (8 to 25 inches)].

2Btg2--89 to 112 cm (35 to 44 inches); gray (10YR 5/1) clay loam; moderate medium prismatic structure; friable; few distinct dark gray (10YR 4/1) clay films on faces of peds; few distinct very dark gray (10YR 3/1) organo-clay films on surfaces along pores; few medium irregular black (7.5YR 2.5/1) very weakly cemented iron-manganese nodules throughout; many coarse prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; slightly acid; clear smooth boundary. [10 to 38 cm (4 to 15 inches) thick]

2BCg--112 to 140 cm (44 to 55 inches); 60 percent gray (10YR 5/1) and 40 percent yellowish brown (10YR 5/4) stratified clay loam and sandy loam; weak medium prismatic structure; friable; few medium irregular black (7.5YR 2.5/1) iron-manganese coatings on faces of peds; common medium prominent yellowish brown (10YR 5/8) masses of oxidized iron in the matrix; 10 percent fine gravel in clay loam strata; neutral; clear smooth boundary. [0 to 28 cm (0 to 11 inches) thick]

2Cg1--140 to 185 cm (55 to 73 inches); 60 percent gray (10YR 5/1) and 40 percent yellowish brown (10YR 5/4) sandy loam stratified with thin lenses of coarse sand; massive; very friable; 5 percent fine gravel; neutral; abrupt smooth boundary.

2Cg2--185 to 203 cm (73 to 80 inches); 60 percent pale brown (10YR 6/3) and 40 percent light brownish gray (10YR 6/2) sandy loam; massive; very friable; 5 percent fine gravel; slightly effervescent; slightly alkaline.

TYPE LOCATION: Champaign County, Illinois; near the Champaign-Douglas county line about 15 miles (24.1 kilometers) south and 3 1/2 miles (5.6 kilometers) east of Urbana; 55 feet (16.8 meters) north and 2,240 feet (682.8 meters) west of the southeast corner of sec. 36, T. 17 N., R. 9 E.; USGS Villa Grove NW, Illinois topographic quadrangle; lat. 39 degrees 52 minutes 49 seconds N. and long. 88 degrees 7 minutes 51 seconds W.; NAD 27; UTM Zone 16, 403299 easting and 4415085 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of argillic horizon ranges from 102 to 152 cm (40 to 60 inches) in thickness. Depth to carbonates is greater than 102 cm (40 inches). The depth to horizons averaging more than 15 percent sand ranges from 61 to 102 cm (24 to 40 inches). The particle-size control section averages between 25 and 35 percent clay.

The Ap or A horizon has hue of 10YR, value of 2 or 3 (4 or 5 dry), and chroma of 1 to 3. It is silt loam. Reaction ranges from strongly acid to slightly alkaline depending upon liming practices.

The E horizon has hue of 10YR, value of 4 to 6, and chroma of 2 or 3. It is silt loam. Reaction ranges from strongly acid to neutral.

A BE horizon is present in some pedons.

The Bt or Btg horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. It is silty clay loam or silt loam. Reaction ranges from strongly acid to neutral.

The 2Bt, 2Btg, 2BC, or 2BCg horizon) has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. Texture is sandy loam, sandy clay loam, loam, or clay loam but includes thin strata of sand or silt loam in some pedons. Clay content averages between 18 and 35 percent and sand

content averages between 20 and 60 percent. Content of rock fragments is less than 15 percent. Reaction in the 2Bt or 2Btg horizon ranges from strongly acid to neutral. Reaction in the 2BC or 2BCg horizon ranges from strongly acid to slightly alkaline.

The 2C or 2Cg horizon has hue of 7.5YR, 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 to 8. It is typically stratified. Textures are dominantly sandy loam, loam, clay loam, sandy clay loam, or silt loam, but include thin strata of loamy sand, sand, or coarse sand. Clay content averages between 10 and 25 percent and sand content averages between 20 and 70 percent. Content of rock fragments is less than 15 percent. Reaction ranges from moderately acid to moderately alkaline.

COMPETING SERIES: These are the Atterberry, Bethalto, Canoe, Curran, Emery, Franklin, Koszta, Mulvey, Virgil, and Wauconda series. Atterberry, Bethalto, Canoe, and Koszta soils have less than 20 percent sand in the lower part of the series control section. Curran soils average more than 70 percent sand in the lower part of the series control section. Emery soils are not stratified with textures containing as much as 70 percent sand in the lower part of the series control section. Franklin soils do not have stratified silty and loamy horizons within the series control section. Mulvey soils have greater than 15 percent rock fragments in the lower part of the series control section. Virgil soils do not have horizons with more than 20 percent sand within a depth of 102 cm (40 inches). Wauconda soils contain carbonates within a depth of 102 cm (40 inches).

GEOGRAPHIC SETTING: Millbrook soils are on outwash plains and stream terraces. Slope ranges from 0 to 5 percent. Millbrook soils formed in 61 to 102 cm (24 to 40 inches) of loess or other silty material and in the underlying loamy stratified outwash. Mean annual air temperature ranges from 8 to 12 degrees C (46 to 54 degrees F), mean annual precipitation ranges from 740 to 1020 mm (29 to 40 inches), frost-free period ranges from 140 to 190 days, and elevation ranges from 122 to 311 meters (400 to 1020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Beardstown, Brenton, Drummer, Elburn, Harvard, Sexton, Starks, and Virgil soils. Beardstown, Brenton, Elburn, Starks, and Virgil soils are nearby on similar landscape positions. Brenton and Starks soils form a biosequence with Millbrook soils. The poorly drained Drummer soils and the well drained Harvard soils form a drainage sequence with Millbrook soils. Drummer soils are on lower parts of the landscape and Harvard soils are on adjoining higher elevations. The poorly drained Sexton soils form a drainage sequence with Millbrook soils near forested areas and are on lower parts of the landscape.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Somewhat poorly drained. An intermittent apparent seasonal high water table is at a depth of 0.5 to 2.0 feet (13 to 61 cm) at some time between January and May in most years. The potential for surface runoff is low or medium. Saturated hydraulic conductivity is moderately high or high (4.23 to 14.11 micrometers/s). Permeability is moderate.

USE AND VEGETATION: Most areas are used to grow corn and soybeans. Some areas are used for growing small grain or meadow. Native vegetation is prairie grass and widely spaced trees.

DISTRIBUTION AND EXTENT: Central and northern Illinois. The extent is moderate in MLRAs 95B, 108A, 108B, 110, 111D, and 114.
MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Kendall County, Illinois, 1940.

REMARKS: A till substratum phase is recognized. It will be investigated during MLRA update activities. Possibly a new soil series will be established, and a new data map unit will be developed.

Diagnostic horizons and features recognized in this pedon are: ochric epipedon - the zone from the surface to a depth of 36 cm (14 inches) (Ap and E horizons);
argillic horizon- the zone from approximately 36 to 112 cm (14 to 44 inches) (Bt, Btg1, and 2Btg2 horizons);
aquic conditions - endosaturation implied by redoximorphic features present in the zone from 18 to 203 cm (7 to 80 inches) (E, Bt, Btg1, 2Btg2, 2BCg, 2Cg1, and 2Cg2 horizons); mesic temperature regime.

ADDITIONAL DATA: University of Illinois Pedology Laboratory sample numbers 22279 to 22288 in DeKalb County and 20962 to 20970 in Stephenson County.

National Cooperative Soil Survey
U.S.A.

LOCATION OZAUKEE WI+IL

Established Series
Rev. HFG-AAC
12/2006

OZAUKEE SERIES

The Ozaukee series consists of moderately well drained soils that are moderately deep to a densic contact with till (Cd). They formed in thin loess and in the underlying loamy dense till on ground moraines. Permeability is slow. Slope ranges from 0 to 35 percent. Mean annual precipitation is about 30 inches.Mean annual air temperature is about 49 degrees F.

TAXONOMIC CLASS: Fine, illitic, mesic Oxyaquic Hapludalfs

TYPICAL PEDON: Ozaukee silt loam - on a 3 percent north-facing convex slope in a cultivated field at an elevation of about 1,015 feet above sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure parting to moderate medium granular; friable; many fine roots; neutral; abrupt smooth boundary. (6 to 9 inches thick)

E--8 to 10 inches; grayish brown (10YR 5/2) silt loam; weak medium platy structure; friable; many fine roots; neutral; clear wavy boundary. (0 to 4 inches thick)

Bt1--10 to 13 inches; brown (7.5YR 4/4) silty clay loam; moderate medium subangular blocky structure; firm; many fine roots; few faint dark brown (7.5YR 3/4) clay films on faces of peds; few distinct dark brown (7.5YR 3/2) organic stains on faces of peds; about 2 percent gravel; neutral; clear wavy boundary; (2 to 5 inches thick)

2Bt2--13 to 18 inches; brown (7.5YR 4/4) clay; weak coarse prismatic structure parting to moderate and strong medium angular blocky; firm; many fine roots; common faint dark brown (7.5YR 3/4) clay films on faces of peds; few distinct dark brown (7.5YR 3/2) organic stains on faces of peds; about 3 percent gravel; neutral; clear wavy boundary.

2Bt3--18 to 23 inches; brown (7.5YR 4/4) silty clay loam; weak coarse prismatic structure parting to moderate medium subangular blocky; firm; many fine roots; few faint brown (7.5YR 4/4) clay films on faces of peds; few distinct dark brown (7.5YR 3/2) organic stains on faces of peds; about 4 percent gravel; neutral; gradual irregular boundary.

2Bt4--23 to 29 inches; brown (7.5YR 5/4) silty clay loam; moderate medium subangular blocky structure; firm; few fine roots; few distinct dark brown (7.5YR 3/4) clay films on faces of peds; few faint brown (7.5YR 4/4) organic stains on vertical faces of peds; about 4 percent gravel; slightly alkaline; gradual irregular boundary. (Combined thickness of the 2Bt horizons ranges from 8 to 24 inches.)

2Cd--29 to 60 inches; brown (7.5YR 5/4) silty clay loam; weak medium subangular blocky structure; very firm; few fine roots; strongly effervescent; about 4 percent gravel; moderately alkaline.

TYPE LOCATION: Washington County, Wisconsin; about 5 miles southwest of West Bend; 150 feet west and 50 feet south of the northeast corner of sec. 11, T. 10 N., R. 19 E.;USGS Jackson Wisconsin Topographic Quadrangle; lat. 43 degrees 21 minutes 10 seconds N., and long. 88 degrees 12 minutes 07 seconds W., NAD 27.

RANGE IN CHARACTERISTICS: Depth to the base of the argillic horizon and soil development and depth to the densic contact ranges from 20 to 45 inches. Thickness of the loess mantle typically ranges from 6 to 18 inches but loess is absent in some severely eroded pedons. Carbonates are within 40 inches and are in the lower solum in some pedons. Rock fragments typically are few or absent in the loess. Rock fragments in the till are of mixed lithology but are mostly subangular or rounded dolomite fragments. Volume of gravel ranges from 0 to 1 percent in the loess and from 1 to 15 percent in the till. Volume of cobbles and stones ranges from 0 to 1 percent in the loess and from 0 to 10 percent in the till. Reaction ranges from slightly acid to slightly alkaline in the upper part of the solum and from neutral to moderately alkaline in the lower part. Reaction is moderately alkaline in the substratum. Saturation occurs within 40 inches and redox features typically occur there, also.

The Ap horizon has hue of 10YR, value of 3 or 4, and chroma of 2 or 3. Colors with moist value of 3 have value dry of 6 or more. Uncultivated pedons have an A horizon with hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Texture of the Ap or A is typically silt loam but is silty clay loam or clay loam in
severely eroded phases.

The E horizon has hue of 10YR, value of 4 or 5 and chroma of 2 or 3. Texture is silt loam.

The Bt1 horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 3 or 4. Texture is silt loam, or silty clay loam with less than 35 percent clay.

The 2Bt horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 or 5, and chroma of 2 to 4. Chroma of 2 is below the upper 10 inches of the argillic horizon. Texture is silty clay loam with 35 percent or more clay, silty clay, or clay.

Some pedons have a 2Btk horizon with color like the 2Bt horizon above. Texture is silty clay loam or clay loam with less than 35 percent clay.

The 2Cd horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 to 6, and chroma of 2 to 4. Texture is typically silty clay loam, but in some pedons it is clay loam. Clay content ranges from 27 to 35 percent and silt content averages more than 50 percent. Bulk density is more than 1.7 gm/cc.

COMPETING SERIES: These are the Alexandria, Brushcreek, Lairdsville, Lucas, Morley, Schoharie, and St. Clair series. Alexandria and Morley soils average less than 50 percent silt content in the lower part of the series control section. Brushcreek and Lairdsville soils have a paralithic contact within a depth of 60 inches. Lucas soils do not have rock fragments in the

lower part of the series control section. Schoharie and St. Clair soils have more than 35 percent clay in the lower part of the series control section.

GEOGRAPHIC SETTING: These soils are on ground moraines. Slope ranges from 0 to 35 percent. These soils formed in thin loess and in the underlying loamy dense till. Mean annual precipitation ranges from 28 to 37 inches. Mean annual air temperature ranges from 46 to 52 degrees F. The frost free period ranges from about 145 to 180 days. Elevation ranges from 680 to 1150 feet above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Hochheim, Kewaunee, Manawa, Mequon, and Theresa soils. The somewhat poorly drained Mequon soils and the poorly drained Ashkum soils form a drainage sequence with Ozaukee soils. Where the silty clay loam till of the Ozaukee borders on reddish clay drift, the well drained and moderately well drained Kewaunee and somewhat poorly drained Manawa soils occur. The well drained Theresa and Hochheim soils are nearby where the silty clay loam till borders on till with a loam texture.

DRAINAGE AND PERMEABILITY: Moderately well drained. The potential for surface runoff Rangs from medium to very high. Permeability is slow. These soils have a perched seasonal high water table at a depth of 1.5 to 3.5 feet for 1 month or more per year in 6 or more out of 10 years.

USE AND VEGETATION: The less sloping areas are mostly used for cropland. Common crops are corn, soybeans, small grain, and hay. The more sloping areas are mostly used for pastureland and woodland. Native vegetation is mixed hardwood forest. Common trees are northern red oak, American basswood, white ash, and sugar maple.

DISTRIBUTION AND EXTENT: Southeastern Wisconsin and northeastern and east-central Illinois. This soil is of moderate extent.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Milwaukee-Waukesha Counties, 1966.

REMARKS: A new typical pedon, which better reflects the drainage and classification, is needed.
Diagnostic horizons and features recognized in this pedon are: ochric epipedon - 0 to 10 inches (Ap, E); argillic horizon - 10 to 23 inches (Bt1, 2Bt2, 2Bt3, 2Bt4);
oxyaquic feature - saturation within 40 inches for 1 month per year in 6 or more out of 10 years; densic contact - 29 inches (2Cd).

ADDITIONAL DATA: Refer to Soil Survey Sample numbers 85WI089001 and 85WI131001 for NSSL data on two Ozaukee pedons. Refer to Soil Survey Sample numbers 85WI059003 and 85WI101004 for NSSL data sampled as Morley which now correlates to Ozaukee. All four pedons are also in Soil Survey Investigations Report No. 17 on pages 112-115 and 144-147.

National Cooperative Soil Survey
U.S.A.

LOCATION PELLA IL+IN MI WI

Established Series
Rev. JCD-SLE
04/2008

PELLA SERIES

The Pella series consists of very deep, poorly drained soils formed in loamy sediments and the underlying stratified loamy glacial sediments on outwash plains and till plains. Slope ranges from 0 to 3 percent. Mean annual precipitation is about 838 mm (33 inches), and mean annual air temperature is about 11 degrees C (52 degrees F).

TAXONOMIC CLASS: Fine-silty, mixed, superactive, mesic Typic Endoaquolls

TYPICAL PEDON: Pella clay loam - nearly level in a cultivated field at an elevation of 204 meters (670 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 15 cm (0 to 6 inches); black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure; friable; common fine roots; neutral; abrupt smooth boundary.

A--15 to 33 cm (6 to 13 inches); black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate and strong medium granular structure; friable; common fine roots; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; neutral; clear smooth boundary.[Combined thickness of the A horizon is 25 to 51 cm (10 to 20 inches).]

BA--33 to 43 cm (13 to 17 inches); very dark gray (10YR 3/1) clay loam; moderate and strong medium and coarse granular structure; firm; common fine roots; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; common black krotovina; neutral; clear smooth boundary. [0 to 28 cm (0 to 11 inches) thick]

Btg1--43 to 64 cm (17 to 25 inches); olive gray (5Y 4/2) clay loam; moderate medium prismatic structure parting to moderate medium angular and subangular blocky; firm; common fine roots; common faint olive gray (5Y 5/2) clay films on faces of prisms; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; common black krotovina; few fine prominent yellowish brown (10YR 5/8) masses of oxidized iron in the matrix; slightly alkaline; clear smooth boundary.

Btg2--64 to 79 cm (25 to 31 inches); olive gray (5Y 5/2) silty clay loam; moderate and strong medium prismatic structure parting to strong medium angular blocky; firm; common fine roots; common faint gray (5Y 5/1) clay films on faces of peds; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; common black krotovina; common fine prominent yellowish brown (10YR 5/8) masses of oxidized iron in the matrix; slightly alkaline; clear smooth boundary.

2Btg3--79 to 97 cm (31 to 38 inches); gray (5Y 5/1) stratified loam and silt loam; weak medium prismatic structure parting to weak medium angular and subangular blocky; firm; few fine roots; common faint gray (5Y 5/1) clay films on faces of prisms; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; common black krotovina; many medium prominent yellowish brown (10YR 5/6 and 5/8) masses of oxidized iron in the matrix; moderately alkaline; gradual wavy boundary. [Combined thickness of the Btg and 2Btg horizons is 23 to 64 cm (9 to 25 inches).]

2Cg1--97 to 130 cm (38 to 51 inches); gray (5Y 5/1) stratified sandy loam, silt loam, and clay loam; massive; friable and firm; very few fine roots; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; common black krotovina; many coarse prominent yellowish brown (10YR 5/6 and 5/8) masses of oxidized iron in the matrix; slightly effervescent (12 percent calcium carbonate); moderately alkaline; clear wavy boundary.

2Cg2--130 to 152 cm (51 to 60 inches); olive gray (5Y 5/2) stratified sandy loam, silt loam, and clay loam; massive; firm; few fine dark reddish brown (5YR 3/2) iron-manganese nodules and concretions throughout; few black krotovina; many medium prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/8) masses of oxidized iron in the matrix; strongly effervescent (24 percent calcium carbonate); moderately alkaline.

TYPE LOCATION: Iroquois County, Illinois; about 4.8 kilometers (3 miles) west and 1.6 kilometers (1 mile) north of Onarga; 187.5 meters (615 feet) east and 30.5 meters (100 feet) south of the center of sec. 16, T. 26 N., R. 10 E.; USGS Onarga West topographic quadrangle; lat. 40 degrees 43 minutes 40 seconds N. and long. 88 degrees 04 minutes 28 seconds W., NAD 27; UTM Zone 16, 409262 easting and 4509098 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of the cambic horizon ranges from 76 to 127 cm (30 to 50 inches). The depth to carbonates ranges from 41 to 102 cm (16 to 40 inches). The mollic epipedon ranges from 25 to 61 cm (10 to 24 inches) in thickness. The particle-size control section averages less than 15 percent fine and coarser sand and averages between 27 and 35 percent clay.

The Ap, A, and/or AB horizon has hue of 10YR or is neutral, value of 2 or 3, and chroma of 0 to 2. It is silty clay loam, silt loam, or clay loam. Reaction ranges from slightly acid to slightly alkaline. Some pedons contain redoximorphic features in the lower part, and some have organic coatings on faces of peds.

The Btg and/or Bg horizon has hue of 5Y, 2.5Y, or 10YR; value of 4 to 6; chroma of 1 or 2; and has redoximorphic features. In addition to the colors stated, redoximorphic features have chroma that ranges to 8. The Btg or Bg horizon has individual subhorizons that are silty clay loam, clay loam, or silty clay. Reaction is neutral or slightly alkaline and contains carbonates in some pedons.

The 2Btg, 2BCg, and/or 2Bg horizon has hue of 5Y, 2.5Y, or 10YR; value of 5 or 6; and chroma of 1 to 8; and has redoximorphic features. The 2Btg or 2Bg horizon is stratified. It is dominantly silty clay loam, clay loam, silt loam, or loam, and contains strata of sandy loam, loamy sand, or sand in some pedons. Sand content averages more than 10 percent and is not dominated by fine or very fine sand. Some pedons contain as much as 10 percent rock fragments. Reaction is

slightly alkaline or moderately alkaline and contains carbonates in most pedons.

The 2Cg horizon has hue of 5Y, 2.5Y, or 10YR; value of 5 or 6; and chroma of 1 to 8. In addition to the colors stated, some redoximorphic features have hue of 7.5YR. Typically some part of the matrix has chroma of 1 or 2 and redoximorphic features of higher chroma. This part is stratified silt loam, loam, silty clay loam, clay loam, or sandy loam, and some pedons contain thin lenses of sand or loamy sand. Sand content averages more than 10 percent and is not dominated by fine or very fine sand. Some pedons contain as much as 20 percent rock fragments. Reaction is moderately alkaline, or less commonly, slightly alkaline and contains carbonates.

COMPETING SERIES: These are the Chalmers, Chetomba, Dolbee, Drummer, Dunham, Elpaso, Elvira, Garwin, Gillett Grove, Hartsburg, Madelia, Marcus, Mascoutah Maxcreek, Maxfield, Maxmore, Ossian, Patton, Rushmore, Sable, and Wacousta soils. Chalmers, Chetomba, Dolbee, Drummer, Elpaso, Garwin, Maxfield, Maxmore, Ossian, Patton, and Sable soils do not have carbonates above a depth of 102 cm (40 inches). Dunham soils average more than 15 percent gravel in the lower part of the series control section. Elvira soils have iron and manganese oxides in the B horizon and iron and manganese accumulations in the A horizon. Gillett Grove soils formed in 102 to 152 cm (40 to 60 inches) of loess and in the underlying glacial till. Hartsburg, Mascoutah, and Sable soils average less than 10 percent sand in the lower half of the series control section. Madelia soils have in the lower half of the series control section a sand fraction dominated by very fine sand or fine sand. Marcus soils average less than 10 percent sand in the lower part of the B horizon, and the C horizon is not stratified in the series control section. Maxcreek and Rushmore soils have well graded sand fractions lower two parts of the series control section. Wacousta soils have the base of the cambic horizon within a depth of 76 cm (30 inches).

GEOGRAPHIC SETTING: Pella soils are on nearly level or depressional areas on outwash plains and till plains thought to be of Wisconsin Age. They have plane or convex slopes with gradients typically less than 1 percent, but ranging from 0 to 3 percent. They formed in 51 to 102 cm (20 to 40 inches) of silty material with less than 15 percent sand coarser than very fine sand and the underlying stratified loamy sediments. Mean annual air temperature ranges from 7 to 12 degrees C (45 to 54 degrees F), mean annual precipitation ranges from 71 to 102 cm (28 to 40 inches), frost-free period ranges from 140 to 180 days, and elevation ranges from 152 to 311 meters (500 to 1020 feet) above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the competing Drummer soils and the Barrington, Brenton, Elburn, Harpster, Mundelein, Peotone, and Wauconda soils. Drummer soils are slightly higher on the landform and commonly are adjacent to or surround areas of Pella. The moderately well drained Barrington soils and somewhat poorly drained Mundelein soils are on higher parts of the landform and form a drainage sequence with Pella. The somewhat poorly drained Brenton and Elburn soils have argillic horizons, lack carbonates within a depth of 102 cm (40 inches), and are on higher part of the landform. Harpster soils are on similar or slightly lower parts of the landform and are calcareous throughout. Peotone soils are on similar or slightly lower positions, have mollic epipedons more than 61 cm (24 inches) thick, and lack carbonates within a depth of 102 cm (40 inches). Wauconda soils lack mollic epipedons and are on slightly higher parts of the landscape.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. An

apparent seasonal high water table is at 15 cm (0.5 foot) above the surface to 31 cm (1.0 foot) below the surface at some time during spring in most years. The potential for surface runoff is negligible to low. Saturated hydraulic conductivity is moderately high or high (4.23 to 14.11 micrometers per second). Permeability is moderate.

USE AND VEGETATION: Most areas of these soils are used for cultivated crops. Corn and soybeans are the principal crops. Native vegetation is probably marsh grasses and sedges.

DISTRIBUTION AND EXTENT: Illinois, Indiana, Michigan, and Wisconsin in MLRA 95A, 95B, 98, 99, 108A, 108B, 110, 111A. 111B, 111C, 111D, and 115C. These soils are of large extent with more than 80,000 hectares (200,000 acres) mapped.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Ford County, Illinois, 1929.

REMARKS: This pedon in Iroquois County is pedon number 84 in appendix IV of Soil Taxonomy. A till substratum, stratified sandy substratum, and occasionally flooded phases are recognized. These phases will be evaluated during MLRA update activities to determine if new series are needed.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 0 to 43 cm (0 to 17 inches) (Ap, A, and BA horizons): cambic horizon - the zone from approximately 33 to 97 cm (13 to 38 inches) (BA, Btg1, Btg2 and 2Btg3).

National Cooperative Soil Survey
U.S.A.

LOCATION PEOTONE IL+IN

Established Series
Rev. JWS-AAC
04/2008

PEOTONE SERIES

The Peotone series consists of very deep, very poorly drained soils formed in colluvial sediments in depressional parts of till plains. Slope gradients are less than 2 percent. Mean annual air temperature is about 10 degrees C (50 degrees F), and mean annual precipitation is about 910 mm (36 inches).

TAXONOMIC CLASS: Fine, smectitic, mesic Cumulic Vertic Endoaquolls

TYPICAL PEDON: Peotone silty clay loam - on a slope with less than a 1 percent gradient in a cultivated field at an elevation of about 215 meters (707 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 18 cm (0 to 7 inches); black (N 2.5/) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common very fine roots; neutral; clear smooth boundary.

A--18 to 33 cm (7 to 13 inches); black (N 2.5/) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; common very fine roots; neutral; clear smooth boundary. [Combined thickness of the A horizon is 25 to 61 cm (10 to 24 inches).]

Bg1--33 to 69 cm (13 to 27 inches); black (N 2.5/) silty clay loam, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; friable; common very fine roots; neutral; clear smooth boundary.

Bg2--69 to 104 cm (27 to 41 inches); dark gray (10YR 4/1) silty clay; moderate fine prismatic structure; firm; common very fine roots; common fine faint dark grayish brown (10YR 4/2) iron depletions in the matrix; few fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; slightly alkaline; clear smooth boundary.

Bg3--104 to 127 cm (41 to 50 inches); dark gray (10YR 4/1) silty clay; moderate medium prismatic structure; few very fine roots; firm; common medium faint dark grayish brown (10YR 4/2) iron depletions in the matrix; common fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; slightly alkaline; clear smooth boundary. [Combined thickness of the Bg horizon is 30 to 127 cm (12 to 50 inches).]

Cg--127 to 152 cm (50 to 60 inches); dark gray (10YR 4/1) silty clay loam; massive; firm; few fine faint dark grayish brown (10YR 4/2) iron depletions in the matrix; few fine prominent yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; slightly effervescent; slightly alkaline.

TYPE LOCATION: Ford County, Illinois; about 1.6 kilometers (1 mile) south and 0.8 kilometers (0.5 mile) east of Cabery; 96 meters (315 feet) south and 681 meters (2,233 feet) east of the northwest corner of sec. 21, T. 29 N., R. 9 E.; USGS Cabery, Illinois, topographic quadrangle; lat. 40 degrees 58 minutes 49 seconds N. and long. 88 degrees 12 minutes 00 seconds W., NAD 27; UTM Zone 16, 399043 easting and 4537265 northing; NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of soil development is 97 cm (38 inches) or more. The depth to carbonates is 76 cm (30 inches) or more. The mollic epipedon ranges from 61 to 91 cm (24 to 36 inches) in thickness and includes the upper part of the Bg horizon in most pedons. The particle-size control section averages between 35 and 45 percent clay and less than 10 percent fine sand or coarser. The grade of structure commonly is moderate or strong in some or all subhorizons in the subsoil.

The Ap or A horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 2 to 3 (3 to 5 dry); and chroma of 0 or 1. It is silty clay loam. Reaction ranges from moderately acid to slightly alkaline.

The AB or BA horizon, where present, has the same range of colors and reaction as the Ap or A horizon. Redoximorphic features occur in some pedons.

The Bg horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 2 to 4 in the upper part (3 to 5 dry) and value of 4 to 6 in the lower part; and chroma of 0 to 2. It is silty clay loam or silty clay, except the lower part is silt loam in some pedons. Reaction ranges from slightly acid to slightly alkaline. Some pedons contain carbonates in the lower part.

The Cg horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 4 to 6; and chroma of 0 to 2. Redoximorphic features are commonly present with chroma of 1 to 8. Texture typically is silty clay loam but ranges to silt loam or silty clay in some subhorizons and is stratified in some pedons. Clay content ranges from 25 to 42 percent and sand content is less than 20 percent. Reaction ranges from neutral to moderately alkaline, and carbonates are present in some pedons.

COMPETING SERIES: These are the Chehalem, Clamo, Derrynane, Okoboji, Rantoul, Shiloh, Southbrook, Wabash, Zoe, and Zook series. Chehalem, Derrynane, and Southbrook soils average greater than 20 percent sand in the lower part of the series control section. Clamo soils have carbonates within a depth of 76 cm (30 inches). Okoboji soils are more than 61 cm (24 inches) to the top of the cambic horizon. Rantoul and Wabash soils average more than 45 percent clay in the particle-size control section. Shiloh soils average less than 5 percent sand in the particle-size control section and have less available phosphorous in the upper 91 cm (3 feet) (see remarks). Zoe soils contain more soluble salts and have a sodium absorption ratio of more than 13 in the series control section. Zook soils have mollic epipedons more than 91 cm (36 inches) thick.

GEOGRAPHIC SETTING: Peotone soils typically are in potholes and depressions on till plains of Wisconsinan Age and have concave or plane surfaces. Slope gradients are less than 2 percent. These soils formed in colluvial sediments from adjacent or surrounding nearly level or gently undulating soils. Mean annual air temperature ranges from 9 to 12 degrees C (48 to 53 degrees F), mean annual precipitation ranges from 790 to 1020 mm (31 to 40 inches), frost-free period ranges from 140 to 180 days, and elevation ranges from 155 to 311 meters (510 to 1020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Andres, Ashkum, Elliott, and Flanagan soils. The somewhat poorly drained Andres, Elliott, and Flanagan soils are on higher parts of the till plains. The poorly drained Ashkum soils are on adjacent low-lying areas but have mollic epipedons less than 61 cm (24 inches) in thickness.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Very poorly drained. These soils are subject to ponding. Where drained, an apparent seasonal high water table is at a depth of 15 cm (0.5 foot) above the surface to 30 cm (1.0 foot) below the surface at some time between January and June in normal years. In undrained conditions, an apparent seasonal high water table is at a depth of 30 cm (1.0 foot) above the surface to15 cm (0.5 foot) below the surface at some time between October and September in normal years. The potential for surface runoff is negligible. Saturated hydraulic conductivity is moderately high (1.41 to 4.23 micrometers/s). Permeability is moderately slow.

USE AND VEGETATION: Most drained areas are used for growing cultivated crops. Corn and soybeans are the principal crops. Most undrained areas are idle or are used for pasture. Native vegetation is marsh grasses and sedges.

DISTRIBUTION AND EXTENT: East-central and northeastern Illinois, and west-central Indiana. The extent is moderate in MLRA 95B, 108, and 110.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Will County, Illinois, 1951.

REMARKS: The differentiae needed to clearly separate the Peotone series from the Shiloh series is not well defined in terms of soil properties. Both Peotone and Shiloh soils are in depressional parts of broad interfluves. Peotone soils are on the Wisconsinan till plain and Shiloh soils are on the Illinoisan till plain. A marl substratum phase is currently recognized. These soils will be evaluated during MLRA updating to determine if new series are needed.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the soil surface to a depth of about 69 cm (0 to 27 inches) (Ap, A, and Bg1 horizons); cambic horizon - the zone from about 33 to 127 cm (13 to 50 inches) (Bg1, Bg2 and Bg3 horizons); aquic soil moisture regime - chroma of 1 in the matrix and redoximorphic features present in horizons below the mollic epipedon (Bg2, Bg3, and Cg horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION SELMA IL+IN

Established Series
Rev. JCD-RT-DEC
05/2008

SELMA SERIES

The Selma series consists of very deep, poorly drained soils formed in loamy outwash. They are on nearly level or slightly depressional parts of outwash plains, stream terraces, or lake plains. Slope ranges from 0 to 2 percent. Mean annual precipitation is about 890 mm (35 inches), and mean annual air temperature is about 11 degrees C (52 degrees F).

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Typic Endoaquolls

TYPICAL PEDON: Selma loam - on a nearly level lake plain in a cultivated field at an elevation of 200 meters (656 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 15 centimeters (0 to 6 inches); black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium granular structure; friable; common very fine and fine roots; neutral; gradual smooth boundary.

A--15 to 33 centimeters (6 to 13 inches); black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine roots; neutral; gradual wavy boundary. (Combined thickness of the A horizon is 25 to 58 centimeters or 10 to 23 inches.)

Btg1--33 to 48 centimeter (13 to 19 inches); dark grayish brown (2.5Y 4/2) clay loam; moderate fine and medium subangular blocky structure; friable; common fine roots; many prominent very dark gray (2.5Y 3/1) organo-clay films on faces of peds and on surfaces along pores; few fine distinct yellowish brown (10YR 5/4) masses of oxidized iron in the matrix; neutral; gradual wavy boundary.

Btg2--48 to 71 centimeters (19 to 28 inches); grayish brown (2.5Y 5/2) loam; moderate medium prismatic structure parting to moderate medium subangular blocky; friable; common fine roots; many prominent dark gray (2.5Y 4/1) clay films on faces of peds; few fine distinct light olive brown (2.5Y 5/4) iron-manganese nodules throughout; common medium distinct olive brown (2.5Y 4/4) iron-manganese accumulations in the matrix; slightly alkaline; gradual wavy boundary.

Btg3--71 to 99 centimeters (28 to 39 inches); grayish brown (2.5Y 5/2) loam; weak fine and medium subangular blocky structure; friable; common fine roots; few distinct dark gray (2.5Y 4/1) clay films on faces of peds; black (N 2.5/) krotovina at a depth of 76 to 99 centimeters (30 to 39 inches); few fine prominent dark yellowish brown (10YR 4/6) iron-manganese nodules throughout; few fine prominent light olive brown (2.5Y 5/6) masses of oxidized iron in the matrix; slightly alkaline; gradual wavy boundary. (Combined thickness of the Btg horizon is 33 to 84 centimeters or 13 to 33 inches.)

BCtg--99 to 112 centimeters (39 to 44 inches); grayish brown (2.5Y 5/2) loam; weak medium subangular blocky structure; friable; few very fine roots; few faint dark gray (2.5Y 4/1) clay films on faces of peds; few fine prominent dark yellowish brown (10YR 4/6) iron-manganese nodules throughout; few fine prominent light olive brown (2.5Y 5/6) masses of oxidized iron in the matrix; strongly effervescent; slightly alkaline; gradual wavy boundary. (0 to 30 centimeters thick or 0 to 12 inches thick)

Cg1--112 to 137 centimeters (44 to 54 inches); 55 percent dark gray (2.5Y 4/1), 35 percent gray (2.5Y 5/1), and 10 percent light yellowish brown (2.5Y 6/4) stratified sandy loam and loamy sand; massive in the sandy loam and single grain in the loamy sand; friable in the sandy loam and loose in the loamy sand; few very fine roots; violently effervescent; moderately alkaline; gradual wavy boundary.

Cg2--137 to 203 centimeters (54 to 80 inches); 45 percent dark gray (2.5Y 4/1), 45 percent gray (2.5Y 5/1), and 10 percent light olive brown (2.5Y 5/6) stratified silt loam, sandy loam, and loamy sand; massive in the silt loam and sandy loam and single grain in the loamy sand; friable in the silt loam and sandy loam and loose in the loamy sand; few very fine roots; strongly effervescent; moderately alkaline.

TYPE LOCATION: Iroquois County, Illinois; about 13 kilometers (8 miles) northwest of Ashkum; 16 meters (52 feet) south and 49 meters (160 feet) west of the northeast corner of sec. 18, T. 28 N., R. 10 E.; USGS Piper City NE topographic quadrangle; lat. 40 degrees 54 minutes 36 seconds N. and long. 88 degrees 06 minutes 44 seconds W., NAD 27; UTM Zone 16, 0406337 easting and 4529366 northing, NAD 83.

RANGE IN CHARACTERISTICS: The depth to the base of the cambic horizon ranges from 89 to 140 centimeters (35 to 55 inches). The mollic epipedon ranges from 25 to 61 centimeters (10 to 24 inches) in thickness and extends into the upper part of the B horizon in some pedons. The particle-size control section averages between 20 and 30 percent clay.

The Ap or A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is loam or clay loam, and less commonly is fine sandy loam, silt loam, or silty clay loam. Reaction ranges from slightly acid to slightly alkaline.

The Bg, Btg, BCg, or BCtg horizon has hue of 10YR, 2.5Y, 5Y, or is neutral; value of 4 to 6; and chroma of 0 to 2. Redoximorphic features have chroma ranging from 1 to 8. Texture is loam or clay loam, but subhorizons may be silty clay loam, silt loam, sandy clay loam, fine sandy loam, or sandy loam. The average clay content ranges from 20 to 30 percent and average sand content ranges from 25 to 45 percent. The content of rock fragments averages less than 10 percent. Reaction ranges from slightly acid to moderately alkaline.

The Cg or C horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 to 6. It is stratified sandy loam, loam, silt loam, loamy sand, or sand. Clay content ranges from 3 to 15 percent. Sand content averages between 50 and 90 percent of which less than 50 percent is very fine and fine. Individual subhorizons have as much as 95 percent sand. It contains from 0 to 15 percent rock fragments. Reaction ranges from neutral to moderately alkaline.

COMPETING SERIES: These are the Clyde, Faxon, Kossuth, Letri, Marengo, Mound Creek, Reddick, Selmass, Tripoli, Webster, and Wolcott series. Clyde soils have greater than 15 percent clay in the lower part of the series control section and less than 50 percent sand in the lower third of the series control section. Faxon and Mound Creek soils have a lithic contact within a depth of 152 centimeters (60 inches). Kossuth soils average more than 30 percent clay in the upper part of the particle-size control section. Letri soils have firm glacial till in the lower half of the series control section. Marengo, Reddick, and Wolcott soils average more than 15 percent clay and less than 50 percent total sand in the lower part of the series control section. Selmass soils average more than 80 percent sand and less than 10 percent clay in the lower part of the series control section. Tripoli soils have greater than 15 percent clay in the lower part of the series control section. Webster soils have a sand fraction in the lower part of the series control section which averages less than 50 percent medium or coarser sand.

GEOGRAPHIC SETTING: The Selma soils are in depressions or on broad low summits on outwash plains, stream terraces, high flood plains, or glacial lake plains. Slopes range from 0 to 2 percent. Selma soils formed in loamy material 102 to 152 centimeters (40 to 60 inches) thick and typically are underlain by stratified coarse-textured materials. Mean annual air temperature ranges from 7 to 12 degrees C (45 to 54 degrees F), mean annual precipitation ranges from 760 to 1,020 millimeters (30 to 40 inches), frost-free period ranges from 160 to 180 days, and elevation ranges from 207 to 311 meters (680 to 1,020 feet) above mean sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Darroch, Gilford, Jasper, La Hogue, and Ridgeville soils. The somewhat poorly drained Darroch soils and the well drained Jasper soils are in a drainage sequence with the Selma soils and are on higher landform positions. Gilford soils are coarse-loamy

and on similar landform positions nearby. La Hogue and Ridgeville soils are somewhat poorly drained and are on slightly higher landform positions.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Poorly drained. Where drained, the apparent seasonal high water table is 15 centimeters (0.5 foot) above the surface to 30 centimeters (1.0 foot) below the surface at some time between January and May in most years. In the undrained condition, the apparent seasonal high water table is 15 centimeters (0.5 foot) above the surface to 15 centimeters (0.5 foot) below the surface at some time between November and June in most years. The potential for surface runoff is negligible. Saturated hydraulic conductivity is moderately high to high (4.23 to 14.11 micrometers per second). Permeability is moderate.

USE AND VEGETATION: Most areas are cultivated. Principal crops are corn and soybeans. Native vegetation is hydrophytic grasses, reeds, and sedges.

DISTRIBUTION AND EXTENT: North-central and northern Illinois, and northern Indiana. The extent is large; more than 118,000 hectares (294,000 acres) are correlated in MLRAs 95B, 108A, 108B, 110, 111C, 111D, 115A, and 115C,

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Wabash County, Illinois, 1931.

REMARKS: A sandy loam surface, sandy substratum, and till substratum phase is recognized. The phases will be examined during MLRA update activities. Possibly new soil series will be established for these soils and minimally new data mapunits will be developed.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 33 centimeters (13 inches) (Ap and A horizons); cambic horizon - the zone from 33 to 112 centimeters (13 to 44 inches) (Btg1, Btg2, Btg3, and BCtg horizons); aquic moisture regime - redoximorphic features present in the zone from 33 to 203 centimeters (13 to 80 inches) (Btg1, Btg2, Btg3, BCtg, Cg1, and Cg2 horizons).

National Cooperative Soil Survey
U.S.A.

LOCATION SYMERTON IL+IN WI

Established Series
Rev. JDA-CCC
04/2008

SYMERTON SERIES

The Symerton series consists of very deep, moderately well drained soils formed in a thin mantle of loess, loamy outwash, and in the underlying till or lacustrine sediments. They are on till plains or former glacial lake plains. Slope ranges from 0 to 10 percent. Mean annual precipitation is about 914 mm (36 inches), and mean annual air temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine-loamy, mixed, superactive, mesic Oxyaquic Argiudolls

TYPICAL PEDON: Symerton silt loam - gently sloping in a cultivated field at an elevation of 218 meters (714 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 25 cm (0 to 10 inches); black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak very fine granular structure; friable; slightly acid; abrupt smooth boundary.

A--25 to 38 cm (10 to 15 inches); very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; friable; moderately acid; clear smooth boundary. [Combined thickness of the Ap and A horizon is 25 to 51 cm (10 to 20 inches).]

AB--38 to 48 cm (15 to 19 inches); very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine granular structure; friable; many distinct black (10YR 2/1) organic coatings on faces of peds; moderately acid; clear smooth boundary. [0 to 13 cm (0 to 5 inches) thick]

2Bt1--48 to 64 cm (19 to 25 inches); brown (10YR 4/3) gravelly clay loam; moderate very fine subangular blocky structure; firm; many distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; common fine black (10YR 2/1) very weakly cemented iron-manganese nodules throughout; about 18 percent gravel; moderately acid; clear smooth boundary.

2Bt2--64 to 79 cm (25 to 31 inches); brown (10YR 4/3) gravelly clay loam; moderate fine subangular blocky structure; firm; common distinct very dark grayish brown (10YR 3/2) organo-clay films on faces of peds; common fine black (10YR 2/1) very weakly cemented iron-manganese nodules throughout; about 18 percent gravel; neutral; clear smooth boundary.

2Bt3--79 to 89 cm (31 to 35 inches); yellowish brown (10YR 5/4) gravelly loam; weak fine and medium subangular blocky structure; firm; common distinct brown (10YR 4/3) clay films on faces of peds; common fine black (10YR 2/1) very weakly cemented iron-manganese nodules throughout; few fine prominent yellowish red (5YR 5/8) masses of oxidized iron in the matrix; about 18 percent gravel; slightly effervescent; slightly alkaline; clear smooth boundary.

[Combined thickness of the Bt or 2Bt horizon is 30 to 102 cm (12 to 40 inches).]

3Bt4--89 to 99 cm (35 to 39 inches); brown (10YR 5/3) silt loam; weak medium prismatic structure parting to weak medium subangular blocky; firm; few distinct brown (10YR 4/3) clay films on faces of peds; few fine prominent yellowish red (5YR 5/8) masses of oxidized iron in the matrix; slightly effervescent; slightly alkaline; clear smooth boundary. [10 to 30 cm (4 to 12 inches) thick]

3C--99 to 152 cm (39 to 60 inches); light olive brown (2.5Y 5/4) and light yellowish brown (2.5Y 6/4) silt loam; massive; firm; few fine prominent yellowish red (5YR 4/6) masses of oxidized iron in the matrix; few fine prominent gray (10YR 5/1) iron depletions in the matrix; strongly effervescent; slightly alkaline.

TYPE LOCATION: Iroquois County, Illinois; about 4.8 kilometers (3 miles) northwest of Hoopeston; 31 meters (102 feet) north and 550 meters (1,806 feet) west of the southeast corner of sec. 33, T. 24 N., R. 12 W.; USGS Hoopeston topographic quadrangle; lat. 40 degrees 29 minutes 17 seconds N. and long. 87 degrees 42 minutes 58 seconds W., NAD 27; UTM Zone 16, 439310 easting and 4482181 northing, NAD 83.

RANGE IN CHARACTERISTICS: Depth to the base of soil development ranges from 76 to 127 cm (30 to 50 inches). The mollic epipedon ranges from 25 to 51 cm (10 to 20 inches) in thickness and includes the upper part of the B horizon in some pedons. Depth to carbonates ranges from 61 to 140 cm (24 to 55 inches). Some pedons do not have carbonates in the lower part of the solum. The particle-size control section averages between 27 and 35 percent clay.

The Ap, A, or AB horizon has hue of 10YR, value of 2 to 4, and chroma of 1 to 4. It is silty clay loam, silt loam, loam, or gravelly loam. Reaction ranges from moderately acid to neutral.

Some pedons have a BA horizon.

The 2Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6, and has redoximorphic features in the lower part in some pedons. It is clay loam, silty clay loam, sandy clay loam, loam, or the gravelly analogues of these textures. Rock fragment content ranges from 0 to 20 percent gravel. Reaction ranges from moderately acid to slightly alkaline.

The 3Bt or 3BC horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 3 or 4. It is silty clay loam, silt loam, or clay loam. Clay content ranges from 20 to 35 percent. Reaction ranges from neutral to moderately alkaline.

The 3C horizon has hue of 5Y, 2.5Y, or 10YR, value of 4 to 6, and chroma of 3 or 4. It is silty clay loam or silt loam. Clay content ranges from 20 to 35 percent and average sand content ranges from 5 to 20 percent. Reaction is slightly alkaline or moderately alkaline and is calcareous.

COMPETING SERIES: These are the Balmoral, Barce, Mona, and Wagen Prairie series. Balmoral soils do not have carbonates within a depth of 140 cm (55 inches). Barce soils average less than 20 percent clay and more than 20 percent sand in the lower part of the series control section. Mona soils have more than 35 percent clay in the lower part of the series control section.

Wagen Prairie soils have a paralithic contact with shale within a depth of 102 cm (40 inches).

GEOGRAPHIC SETTING: Symerton soils are on nearly level to moderately sloping till plains or glacial lake plains of Wisconsinan Age. They formed in loamy outwash and in the underlying till or lacustrine sediments. They have as much as 61 cm (24 inches) of loess or other silty material on the surface of many pedons. Slope ranges from 0 to 10 percent. Mean annual air temperature ranges from about 8 to 12 degrees C (46 to 54 degrees F), mean annual precipitation ranges from about 740 to 1020 mm (29 to 40 inches), frost-free period ranges from 160 to 180 days, and elevation ranges from 155 to 311 meters (510 to 1020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Andres, Ashkum, Elliott, Lisbon, and Varna soils. The somewhat poorly drained Andres, Elliott, and Lisbon soils are slightly lower on the landscape than Symerton soils. The poorly drained Ashkum soils are on low-lying parts of the landscape and in upland drainageways and contain more clay in the particle-size control section. Varna soils are nearby on similar slopes, but have more clay in the control section.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Moderately well drained. A perched seasonal high water table is at a depth of 61 to 107 cm (2 to 3.5 feet) at some time between February and April in most years. The potential for surface runoff is low or medium. Saturated hydraulic conductivity is moderately high or high (4.23 to 14.11 micrometers/s) in the loess and loamy outwash, and moderately high or moderately low (0.42 to 4.23 micrometers per second) in the till or lacustrine sediments. Permeability is moderate in the loess and loamy outwash, and moderately slow or slow in the till or lacustrine sediments.

USE AND VEGETATION: Most areas of the soil are cultivated. Corn, soybeans, small grain, and forages are the principal crops. Native vegetation is tall prairie grasses.

DISTRIBUTION AND EXTENT: Northeastern Illinois, Indiana, and Wisconsin. Extent is moderate with about 19,425 hectares (48,000 acres) correlated in MLRAs 95B, 108, and 110.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED: Will County, Illinois, 1951.

REMARKS: Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface of the soil to a depth of 48 cm (0 to 19 inches) (Ap, A, and AB horizons); argillic horizon - the zone from approximately 48 to 99 cm (19 to 39 inches) (2Bt1, 2Bt2, 2Bt3, and 3Bt4 horizons); udic moisture regime.

National Cooperative Soil Survey
U.S.A.

LOCATION VARNA IL+IN WI

Established Series
Rev. JEP-JBF-JWS-DEC
04/2008

VARNA SERIES

The Varna series consists of very deep, moderately well drained soils on till plains. They formed in up to 46 cm (18 inches) of loess or silty material and in the underlying silty clay loam or clay loam till. Slope ranges from 1 to 18 percent. Mean annual precipitation is about 914 mm (36 inches), and mean annual air
temperature is about 10 degrees C (50 degrees F).

TAXONOMIC CLASS: Fine, illitic, mesic Oxyaquic Argiudolls

TYPICAL PEDON: Varna silt loam - on a northwest-facing, convex slope of 3 percent in a cultivated field at an elevation of about 220 meters (722 feet) above mean sea level. (Colors are for moist soil unless otherwise stated.)

Ap--0 to 20 cm (0 to 8 inches); very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; moderate fine granular structure; friable, neutral; abrupt smooth boundary.

A--20 to 30 cm (8 to 12 inches); very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary. [Combined thickness of the A horizon is 25 to 41 cm (10 to 16 inches).]

2Bt1--30 to 46 cm (12 to 18 inches); brown (10YR 4/3) silty clay loam; moderate very fine subangular blocky structure; firm; many distinct very dark gray (10YR 3/1) organo-clay films on faces of peds; 5 percent gravel, moderately acid; clear smooth boundary.

2Bt2--46 to 61 cm (18 to 24 inches); dark yellowish brown (10YR 4/4) silty clay; weak fine prismatic structure parting to moderate very fine and fine subangular blocky; firm; many distinct very dark grayish brown (10YR 3/2) organo-clay films on faces of peds; 5 percent gravel; moderately acid; clear smooth boundary.

2Bt3--61 to 76 cm (24 to 30 inches); light olive brown (2.5Y 5/4) silty clay; weak fine prismatic structure parting to moderate fine angular and subangular blocky; firm; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; many fine distinct yellowish brown (10YR 5/6) masses of oxidized iron in the matrix; 5 percent gravel; neutral; clear wavy boundary.

2Bt4--76 to 107 cm (30 to 42 inches); 60 percent yellowish brown (10YR 5/6) and 40 percent grayish brown (2.5Y 5/2) silty clay loam; moderate medium prismatic structure parting to moderate fine and medium angular and subangular blocky; firm; few distinct dark grayish brown (10YR 4/2) clay films on vertical faces of peds; 5 percent gravel; slightly effervescent; slightly

alkaline; gradual smooth boundary. [Combined thickness of the 2Bt horizon is 23 to 89 cm (9 to 35 inches).]

2BCt--107 to 122 cm (42 to 48 inches); 50 percent yellowish brown (10YR 5/6) and 50 percent gray (5Y 5/1) silty clay loam; weak medium prismatic structure parting to weak medium subangular and angular blocky; firm; few distinct dark grayish brown (10YR 4/2) clay films on vertical faces of peds; 2 percent gravel; slightly effervescent; moderately alkaline; gradual wavy boundary. [8 to 38 cm (3 to 15 inches) thick]

2Cd--122 to 152 cm (48 to 60 inches); 90 percent yellowish brown (10YR 5/4 and 10YR 5/6) and 10 percent gray (5Y 5/1) silty clay loam; massive; very firm; 5 percent gravel; strongly effervescent; moderately alkaline.

TYPE LOCATION: Kankakee County, Illinois; 35 feet (11 meters) north and 860 feet (262 meters) east of the southwest corner of sec. 6, T. 29 N., R. 11 E.; USGS Hersher topographic quadrangle; lat. 41 degrees 00 minutes 53 seconds N. and long. 88 degrees 00 minutes 49 seconds W., NAD 27; UTM Zone 16T, 414761 easting and 4540891 northing, NAD 83

RANGE IN CHARACTERISTICS: The depth to the base of soil development commonly is 91 to 122 cm (36 to 48 inches) and ranges from 61 to 152 cm (24 to 60 inches). The thickness of the mollic epipedon commonly ranges from 25 to 41 cm (10 to 16 inches), but can range to 8 inches (20 cm) for the 1/3 solum rule. The depth to carbonates ranges from 61 to 107 cm (24 to 42 inches). The particle-size control section averages between 35 and 50 percent clay. The series control section contains from 5 to 20 percent sand and as much as 10 percent by volume rock fragments throughout.

The Ap, A, or AB horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. Texture is silt loam or loam, but silty clay loam is recognized in eroded or severely eroded pedons. Reaction ranges from moderately acid to slightly alkaline depending upon liming practices.

The Bt or 2Bt horizon has hue of 10YR or 2.5Y, value of 4 through 6, and chroma of 3 or 4 in the upper part and 1 to 4 in the lower part. In some pedons the lower part of the Bt or 2Bt horizon has hue of 5Y. Redoximorphic features have chroma that ranges from 1 to 6. Texture is silty clay loam, silty clay, or less commonly clay. Reaction ranges from moderately acid to slightly alkaline.

The BC, 2BC, Cd, or 2Cd horizon has hue of 10YR, 2.5Y, or 5Y; value of 4 to 6; and chroma of 1 to 6. Texture is silty clay loam or clay loam but contains subhorizons of loam or silty clay in some pedons. It averages between 27 and 40 percent clay. Reaction ranges from neutral to moderately alkaline and commonly contains carbonates. Bulk density of the Cd or 2Cd horizons ranges from 1.7 to 1.9 gm/cc.

COMPETING SERIES: This is the only series in the family.

GEOGRAPHIC SETTING: Varna soils typically are on convex slopes of the relatively undissected till plains of Wisconsinan Age. Slope ranges from 1 to 20 percent. These soils formed in calcareous silty clay loam or clay loam till. In many places they have a surface layer of loess or silty material less than 46 cm (18 inches) thick. Mean annual air temperature ranges

from 7 to 12 degrees C (45 to 53 degrees F), mean annual precipitation ranges from 711 to 1016 mm (28 to 40 inches), frost-free period ranges from 140 to 180 days, and elevation ranges from 165 to 311 meters (541 to 1020 feet) above sea level.

GEOGRAPHICALLY ASSOCIATED SOILS: These are the Ashkum, Elliott, Markham, Morley, and Ozaukee soils. The poorly drained Ashkum soils and somewhat poorly drained Elliott soils form a drainage sequence with Varna soils. Typically, they are on lower parts of the landform and have lower slope gradients. Markham, Morley, and Ozaukee soils are on nearby similar landforms but lack mollic epipedons.

DRAINAGE AND SATURATED HYDRAULIC CONDUCTIVITY: Moderately well drained. The depth to a perched seasonal high water table is 61 to 107 cm (2.0 to 3.5 feet) at some time between February and April in most years. The potential for surface runoff is medium to very high. Saturated hydraulic conductivity is moderately low or moderately high (0.42 to 1.41 micrometers per second). Permeability is slow.

USE AND VEGETATION: Most areas are cultivated. Corn, soybeans, small grain, and meadow are the principal crops. Native vegetation is prairie grass.

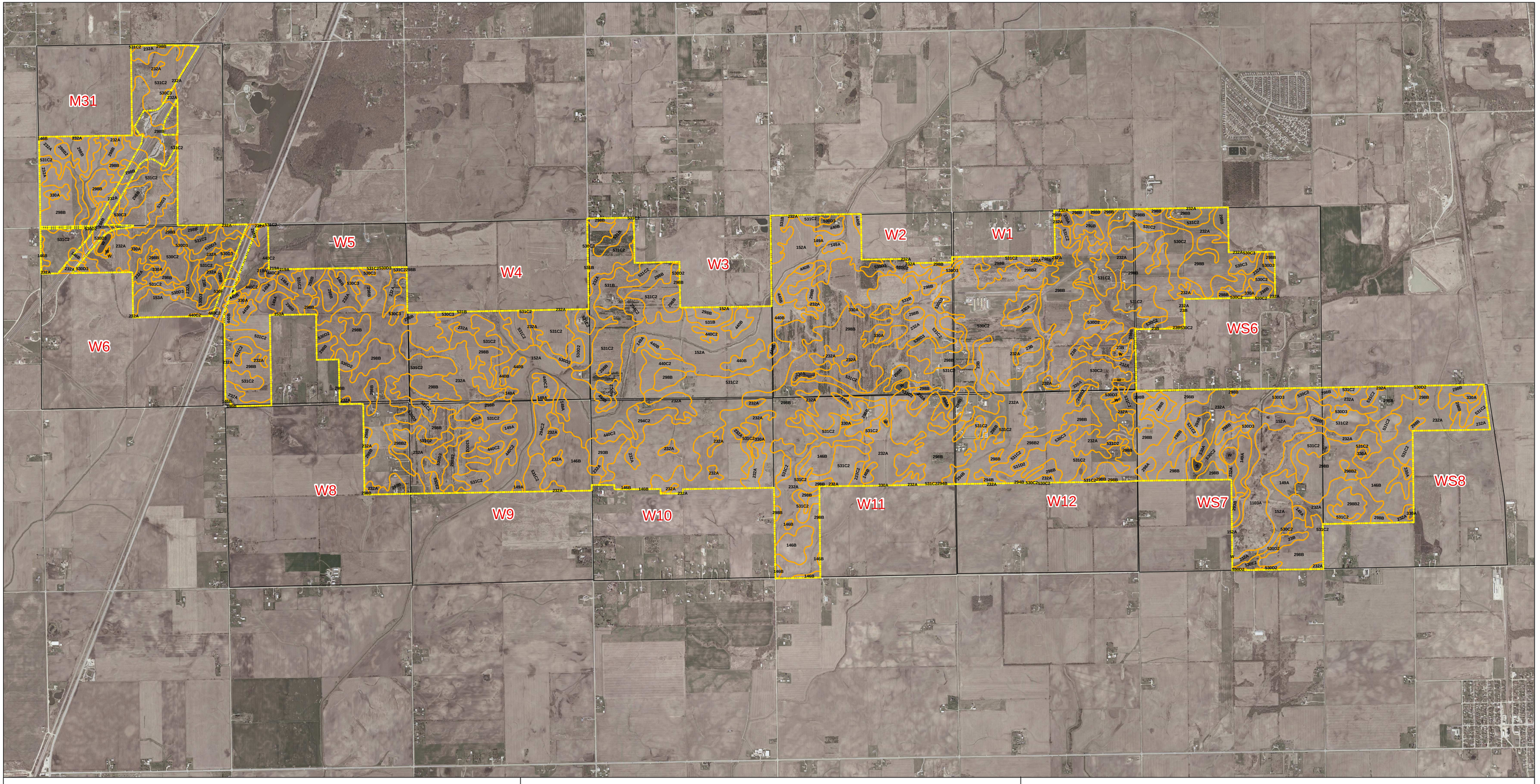
DISTRIBUTION AND EXTENT: Eastern and northern Illinois, southeastern Wisconsin, and northern Indiana. The series is of moderate extent in MLRAs 95B, 108A, 108B, 110, 111C, 111D, and 115C.

MLRA OFFICE RESPONSIBLE: Indianapolis, Indiana.

SERIES ESTABLISHED; Marshall County, Illinois, 1934.

Diagnostic horizons and features recognized in this pedon are: mollic epipedon - the zone from the surface to a depth of 12 inches (30 cm) (Ap and A horizons); argillic horizon - the zone from about 12 to 42 inches (30 to 107 cm) (2Bt1, 2Bt2, 2Bt3, and 2Bt4 horizons); udic moisture regime.

National Cooperative Soil Survey
U.S.A.



Legend

- Soil Unit Boundary
- 2008 Study Boundary
- Sections

Source: Soil Data - USDA NRCS Soil Data Mart - Will County, IL 2007
Aerial Photograph - IDOT April 2001

N

EXHIBIT C-1
SOILS UNIT MAP
South Suburban Airport

Illinois Department of Transportation
Division of Aeronautics

AECOM

0 2,000 4,000 8,000 12,000 Feet

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix D

Methodology

This appendix contains the following items:

1) **Global Positioning System: Trimble® GPS Specifications and AECOM Dataset Examples**
   a. **Trimble® Datasheet: GeoExplorer 3000 Series GeoXH Handheld**
   b. **Trimble® Datasheet: GeoExplorer 3000 Series GeoXT Handheld**
   c. **Trimble® Datasheet: TerraSync® Software**
   d. **Trimble® Datasheet: GPS Pathfinder® Office Software**
   e. **Four randomly selected AECOM datasets used in Table 3: GPS Post-Processed Data Results**

2) **Documents describing the Natural Resources Conservation Service (NRCS) methodology for wetland determination on agricultural lands including:**
   a. **Chicago USACE District memorandum on using the mapping conventions**
   b. **NRCS Mapping Conventions**
   c. **WETS table showing reference precipitation data for use with the NRCS mapping conventions**

3) **Wetlands and Deepwater Habitats Classification system from *Classification of Wetlands and Deepwater Habitats of the United States*, Cowardin *et al*. 1979**

4) **USACE delineation guidelines taken from the 2008 Midwest Supplement (USACE 2008)**
   a. **Hydrophytic vegetation determination methods**
   b. **Hydric Soil Indicators for the Land Resource Region M**
   c. **Hydric soil indicator correlation of the 1987 Manual and 2008 Supplement**
   d. **Wetland hydrology indicators for the Midwest Region**

5) **Table D-1: Illinois Breeding Bird Atlas---Breeding Status Classification**

6) **Access notification letter sent by the Illinois Department of Transportation (IDOT) to all landowners within the study area**

7) **USACE memorandum dated December 2, 2008 containing guidelines for interpreting Clean Water Act jurisdiction: *Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States***

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix D

Methodology

1) **Global Positioning System: Trimble® GPS Specifications and AECOM dataset examples**

   a. **Trimble Datasheet: GeoExplorer 3000 Series GeoXH Handheld**
   b. **Trimble Datasheet: GeoExplorer 3000 Series GeoXT Handheld**
   c. **Trimble Datasheet: TerraSync Software**
   d. **Trimble Datasheet: GPS Pathfinder Office Software**
   e. **Four randomly selected AECOM datasets used in Table 3: GPS Post-Processed Data Results**

DATASHEET

GEOEXPLORER 3000 SERIES
GEOXH HANDHELD

KEY FEATURES

Real-time H-Star technology for decimeter to subfoot accuracy in the field

High-resolution VGA display for crisp and clear map viewing

Bluetooth and wireless LAN connectivity options

1 GB onboard storage plus SD slot for removable cards

Windows Mobile version 6.1 operating system

Rugged handheld with all-day battery

THE PERFECT SOLUTION FOR HIGH-ACCURACY ASSET MANAGEMENT

For high-accuracy GIS data collection and asset relocation, the Trimble® GeoXH™ handheld is the perfect integrated solution. Engineered with H-Star™ technology, the GeoXH handheld delivers decimeter (10 cm / 4 inch) to subfoot (<30 cm) accuracy when you need it, making it the ideal device for electric and gas utilities, water and wastewater services, land reform projects, and other applications where on-the-spot positioning is crucial.

The GeoExplorer® 3000 series combines a Trimble GPS receiver with a rugged handheld computer, built for all-day use and packed with connectivity options. Technology this clever has never been more convenient.

Subfoot accuracy when you need it

When your GIS database requires the highest levels of accuracy, the GeoXH handheld is the answer. Using revolutionary Trimble H-Star technology, the GeoXH handheld delivers real-time subfoot accuracy with the internal antenna, and decimeter accuracy with an optional Tornado™ external antenna. Back-office data processing is eliminated, streamlining asset inventories and as-built mapping jobs.

Need to relocate assets in the field? The GeoXH handheld has you covered. Buried and hidden assets can be tracked down with ease, as the real-time high accuracy gets you straight to the point. Cables and pipes can be excavated without wasted effort or risk of damage to nearby assets. When you postprocess with Trimble office software you can be confident of achieving decimeter level accuracy with greater consistency at longer baselines, in tougher environments, and with shorter occupations.

Packed full of power

With a powerful 520 MHz processor, 128 MB RAM, and 1 GB of onboard storage, the GeoXH handheld is a high performance device designed to work as hard as you do. The handheld gives you all the power you need to work with maps and large data sets in the field, and its high resolution VGA display allows for crisp and clear viewing of your data.

The GeoXH handheld is powered by the industry-standard Windows Mobile® version 6.1 operating system so you can choose a software solution designed for your field requirements, whether off-the-shelf or purpose-built.

The Windows Mobile 6.1 operating system includes familiar Microsoft® software, including Word Mobile, Excel Mobile, and Outlook® Mobile, giving you all the tools you need for a seamless exchange of data between the field and the office.

Get the data you need, when you need it

With the GeoXH handheld you have the flexibility to work exactly the way you want to. Use the built-in wireless LAN connection to access your organization's secure network and get the most up-to-date information. You can also wirelessly connect to other devices such as Bluetooth®-enabled laser rangefinders and barcode scanners for convenient cable-free solutions that keep you productive in the field. Cellular connectivity can be added to the GeoXH handheld via the TDL 3G cellular modem. Connecting via wireless LAN or Bluetooth, the TDL 3G provides continuous network/internet access to real-time map data, web-based services, VRS™ corrections, and live update of field information.

Built for the field

The GeoXH handheld has an integrated battery, good for a full day's work; simply charge the battery overnight and you're ready to go again. The GeoXH handheld will last the distance, and its rugged design can take a lot of punishment. Rain, hail or shine, it's built to keep working, whatever the weather throws at you.

When accuracy is critical

Rugged design and powerful functionality are the hallmarks of the GeoExplorer series. And now with H-Star technology providing decimeter to subfoot accuracy in real time, the 3000 series GeoXH handheld is your ultimate solution for high-accuracy asset management.

When accuracy is critical, the GeoXH handheld delivers—with unprecedented efficiency and reliability, when and where you need it.

Trimble.

GEOEXPLORER 3000 SERIES GEOXH HANDHELD

STANDARD FEATURES

System
- Windows Mobile 6.1 (Classic edition)
- VGA display (480 x 640), sunlight-readable color touchscreen
- Integrated Bluetooth 1.2 wireless technology
- Integrated 802.11b/g wireless LAN
- Ergonomic cable-free handheld
- Rugged and water-resistant design
- All-day internally rechargeable Li-ion battery
- Marvell 520 MHz XScale processor
- 128 MB RAM
- 1 GB non-volatile Flash data storage
- Sealed SD/SDHC card slot
- Integrated speaker and microphone

GPS
- Integrated high-performance GPS/SBAS[1] receiver and L1/L2 antenna
- H-Star technology for subfoot (<30 cm) real-time accuracy or decimeter (10 cm / 4 inch) accuracy after postprocessing
- Decimeter accuracy is also available in real-time with the optional external Tornado antenna
- RTCM and CMR real-time correction support
- TSIP and NMEA[2] protocol support
- EVEREST™ multipath rejection technology

Standard Software
- GPS Controller for control of integrated GPS and in-field mission planning
- GPS Connector for connecting integrated GPS to external ports
- Microsoft Office Mobile
- Transcriber (handwriting recognition)

Standard Accessories
- Support module
- AC Power supply with International adapter kit
- USB data cable
- Stylus (x 2)
- Screen protectors (2-pack)
- Quick Start Guide
- Getting Started CD
- Hand strap
- Pouch

OPTIONAL FEATURES

Optional Software
- TerraSync™ software
- Trimble GPScorrect™ extension for Esri ArcPad software
- GPS Pathfinder® Tools Software Development Kit (SDK)
- GPS Pathfinder Office software
- Trimble GPS Analyst™ extension for Esri ArcGIS Desktop software
- TrimPix™ Pro system

Optional Accessories
- TDL 3G cellular modem accessory
- Power/serial clip (9-pin RS-232 serial connector and power input)
- Vehicle power adaptor[3]
- Null modem cable[3]
- Backpack kit
- Hard carry case
- Tornado antenna
- 2 meter range pole
- Range pole bracket
- GeoBeacon™ receiver
- Anti-glare screen protectors (2-pack)

TECHNICAL SPECIFICATIONS

Physical
Size	21.5 cm × 9.9 cm × 7.7 cm (8.5 in × 3.9 in × 3.0 in)
Weight	0.81 kg (1.79 lbs) with battery
Processor	520 MHz Marvell PXA-270 XScale processor
Memory	128 MB RAM and 1 GB internal Flash storage
Battery	Internal 7500 mAh lithium-ion 27.8 Watt-hours, rechargeable in unit
Power usage	
Low (no GPS or backlight)	1.8 Watts
Normal (with GPS and backlight[4])	3.2 Watts
High (with GPS, backlight[4], Bluetooth, and wireless LAN)[5]	4.3 Watts

Environmental
Operating temperature	–20 °C to +60 °C (–4 °F to 140 °F)
Storage temperature	–30 °C to +70 °C (–22 °F to 158 °F)
Casing	Dust-proof and resistant to heavy wind-driven rain per IP 65 standard Slip-resistant grip, shock and vibration resistant
Drop	1.2 m (4 ft) MIL-STD-810F, Method 516.5, Procedure IV

Input/Output
Expansion	SD card slot (SD or SDHC storage cards)
Display	8.9 cm (3.5 in) VGA (480 x 640 pixel) TFT, 16 bit (65,536) colors LED backlight
Interface	Touch screen, 10 hardware control keys, power status LED Audio system events, warnings, and notifications Soft Input Panel (SIP) virtual keyboard and handwriting recognition software
Audio	Microphone and speaker, record and playback utilities
I/O	USB 1.1 client via support module Serial via optional 9-pin RS-232 power/serial clip adaptor
Radios[6]	Bluetooth 1.2, Wireless LAN 802.11b/g

GPS
Channels	26 (12 L1 code and carrier, 12 L2 carrier, 2 SBAS)
Integrated real-time	SBAS[1] (dual-channel tracking)
Update rate	1 Hz
Time to first fix	30 seconds (typical)
Protocols	
Data output	TSIP, NMEA-0183 v3.0 (GGA, VTG, GLL, GSA, ZDA, GSV, RMC)[2]
Real-time corrections	RTCM 2.x, RTCM 3.0, CMR, CMR+

Accuracy (HRMS)[7] after differential correction
Real-time positioning	
H-Star[8] with internal antenna (within a VRS network, or <80 km)	Subfoot (<30 cm)
H-Star[8] with optional Tornado antenna	
Short baseline (within a VRS network, or <30 km)	10 cm
Long baseline (30–80 km)	Subfoot (<30 cm)
Code corrections (SBAS[1] or external correction source)	Submeter
Postprocessed positioning	
H-Star horizontal accuracy	10 cm + 1 ppm[9]
Carrier postprocessed accuracy with 45 minutes tracking satellites	1 cm + 2 ppm[10]
Code postprocessed	50 cm

1 SBAS (Satellite Based Augmentation System). Includes WAAS available in North America only, EGNOS available in Europe only, and MSAS available in Japan only.
2 NMEA output of real-time H-Star corrected data is not supported.
3 Power/serial clip also required.
4 With backlight at default setting (50% brightness).
5 Power draw will vary depending on radio usage.
6 Bluetooth and wireless LAN type approvals are country specific. GeoExplorer 3000 series handhelds have Bluetooth and wireless LAN approval in the U.S. and in most European countries. For further information please consult your local reseller.
7 Horizontal Root Mean Squared accuracy, 1-sigma (68%). Except in conditions where most GPS signals are affected by trees, or buildings, or other objects. Except when using VRS corrections, accuracy varies with proximity to base station by +1 ppm for code postprocessing and real-time.
8 H-Star specified accuracy is typically achieved within 2 minutes. Requires data to be collected using Trimble field software.
9 The following factors increase the availability of decimeter (10 cm / 4 inch) accuracy after H-Star postprocessing: longer elapsed time tracking uninterrupted L1/L2 carrier phase data, use of the optional external Tornado antenna, tracking of more satellites with L2 measurements, shorter distance to the base station(s), and use of more (than one) base stations for postprocessing.
10 45 minute carrier capability applies only to the GPS Pathfinder Office software and is limited to 10 km from the base station.

Specifications subject to change without notice.

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

NORTH & SOUTH AMERICA
Trimble Navigation Limited
10355 Westmoor Drive
Suite #100
Westminster, CO 80021
USA
+1-720-587-4574 Phone
+1-720-587-4878 Fax

EUROPE & AFRICA
Trimble Germany GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY
+49-6142-2100-0 Phone
+49-6142-2100-550 Fax

ASIA-PACIFIC & MIDDLE EAST
Trimble Navigation
Singapore PTE Limited
80 Marine Parade Road
#22-06 Parkway Parade
Singapore, 449269
SINGAPORE
+65-6348-2212 Phone
+65-6348-2232 Fax

www.trimble.com
store.trimble.com

DATASHEET

GEOEXPLORER 3000 SERIES
GEOXT HANDHELD

KEY FEATURES

Real-time submeter GPS with integrated SBAS and EVEREST multipath technology

Trimble DeltaPhase technology provides 50 cm accuracy after postprocessing

High-resolution VGA display for crisp and clear map viewing

Bluetooth and wireless LAN connectivity options

1 GB onboard storage plus SD slot for removable cards

Windows Mobile version 6.1 operating system

Rugged handheld with all-day battery

YOUR TOTAL GPS PLATFORM FOR FIELD DATA COLLECTION

The Trimble® GeoXT™ handheld, from the GeoExplorer® 3000 series, is the essential tool for maintaining your GIS. A high performance, GPS receiver combined with a rugged handheld computer, the GeoXT handheld is ideal for use by utility companies, local government organizations, federal agencies, or anyone managing assets or mapping critical infrastructure who needs accurate data to do the job right—the first time.

Delivering consistent submeter accuracy in real-time and 50 cm accuracy after postprocessing, the GeoXT handheld is the most dependable solution designed specifically with your GIS in mind.

Real-world submeter performance

The GeoXT handheld is optimized to provide reliable location data when and where you need it. With advanced features like EVEREST™ multipath rejection technology, the GeoXT handheld records quality GPS positions even under canopy, in urban canyons, and in all the everyday environments you work in.

If you need submeter performance in real time, you can use WAAS, EGNOS, or MSAS corrections, or use the built-in Bluetooth® wireless technology to connect to a Trimble GeoBeacon™ receiver.

And if you need that extra edge in precision, you can collect data with Trimble TerraSync™ software or the Trimble GPScorrect™ extension for Esri ArcPad software, and then postprocess it back in the office with Trimble GPS Pathfinder® Office software or the GPS Analyst™ extension for Esri ArcGIS Desktop software. These office processing suites use the new Trimble DeltaPhase™ technology to achieve 50 cm accuracy for GPS code measurements after postprocessing, and even higher levels of postprocessed accuracy are possible when you log GPS carrier data for extended periods.

Packed full of power

With a powerful 520 MHz processor, 128 MB RAM, and 1 GB of onboard storage, the GeoXT handheld is a high performance device designed to work as hard as you do. The handheld gives you all the power you need to work with maps and large data sets in the field, and its high resolution VGA display allows for crisp and clear viewing of your data.

The GeoXT handheld is powered by the industry-standard Windows Mobile® version 6.1 operating system so you can choose a software solution designed for your field requirements, whether off-the-shelf or purpose-built.

The Windows Mobile 6.1 operating system includes familiar Microsoft® software, including Word Mobile, Excel Mobile, and Outlook® Mobile, giving you all the tools you need for a seamless exchange of data between the field and the office.

Built for the field

The GeoXT handheld has an integrated battery, good for a full day's work; simply charge the battery overnight and you're ready to go again. The GeoXT handheld will last the distance, and its rugged design can take a lot of punishment. Rain, hail or shine, it's built to keep working, whatever the weather throws at you.

Convenient connectivity

With the GeoXT handheld you have the flexibility to work exactly the way you want to. Do you need to access the Internet or your organization's secure network to get the most up-to-date data? No problem—with the GeoXT handheld you have built-in wireless LAN and Bluetooth technology to ensure you stay connected.

With Bluetooth wireless technology the GeoXT handheld also offers wireless connection to external devices such as Bluetooth-enabled laser rangefinders and barcode scanners for convenient cable-free solutions that keep you productive in the field.

Cellular connectivity can be added to the GeoXT handheld via the TDL 3G cellular modem. Connecting via wireless LAN or Bluetooth, the TDL 3G provides continuous network/internet access to real-time map data, web-based services, VRS™ corrections, and live update of field information.

Accuracy you can rely on

Accurate information is crucial to making informed decisions and improving the way you do business. The GeoXT handheld delivers consistent submeter accuracy in real-time and 50 cm accuracy after postprocessing, so you know your GIS has the information that others can depend on to do the job right—this time, next time and every time.

Trimble.

GEOEXPLORER 3000 SERIES GEOXT HANDHELD

STANDARD FEATURES

System
- Windows Mobile 6.1 (Classic edition)
- VGA display (480 x 640), sunlight-readable color touchscreen
- Integrated Bluetooth 1.2 wireless technology
- Integrated 802.11b/g wireless LAN
- Ergonomic cable-free handheld
- Rugged and water-resistant design
- All-day internally rechargeable Li-ion battery
- Marvell 520 MHz XScale processor
- 128 MB RAM
- 1 GB non-volatile Flash data storage
- Sealed SD/SDHC card slot
- Integrated speaker and microphone

GPS
- Integrated high-performance GPS/SBAS[1] receiver and L1 antenna
- Submeter real-time or 50 cm postprocessed accuracy
- RTCM and CMR real-time correction support
- TSIP and NMEA protocol support
- EVEREST multipath rejection technology

Standard Software
- GPS Controller for control of integrated GPS and in-field mission planning
- GPS Connector for connecting integrated GPS to external ports
- Microsoft Office Mobile
- Transcriber (handwriting recognition)

Standard Accessories
- Support module
- AC Power supply with International adapter kit
- USB data cable
- Stylus (x 2)
- Screen protectors (2-pack)
- Quick Start Guide
- Getting Started CD
- Hand strap
- Pouch

OPTIONAL FEATURES

Optional Software
- TerraSync software
- Trimble GPScorrect extension for Esri ArcPad software
- GPS Pathfinder Tools Software Development Kit (SDK)
- GPS Pathfinder Office software
- Trimble GPS Analyst™ extension for Esri ArcGIS Desktop software
- TrimPix™ Pro system

Optional Accessories
- TDL 3G cellular modem accessory
- Power/serial dip (9-pin RS-232 serial connector and power input)
- Vehicle power adaptor[2]
- Null modem cable[2]
- Backpack kit
- Hard carry case
- Tempest™ antenna
- External patch antenna
- Pole-mountable ground plane
- Baseball cap with patch antenna pocket
- 2 meter range pole
- Range pole bracket
- GeoBeacon receiver
- Anti-glare screen protectors (2-pack)

TECHNICAL SPECIFICATIONS

Physical
Size . . . . . 21.5 cm × 9.9 cm × 7.7 cm (8.5 in × 3.9 in × 3.0 in)
Weight . . . . . 0.80 kg (1.76 lbs) with battery
Processor . . . . . 520 MHz Marvell PXA-270 XScale processor
Memory . . . . . 128 MB RAM and 1 GB internal Flash storage
Battery . . . . . Internal 7500 mAh lithium-ion
27.8 Watt-hours, rechargeable in unit
Power usage
Low (no GPS or backlight) . . . . . 1.8 Watts
Normal (with GPS and backlight[3]) . . . . . 2.6 Watts
High (with GPS, backlight[3], Bluetooth, and wireless LAN)[4] . . . . . 3.7 Watts

Environmental
Operating temperature . . . . . –20 °C to +60 °C (–4 °F to 140 °F)
Storage temperature . . . . . –30 °C to +70 °C (–22 °F to 158 °F)
Casing . . . . . Dust-proof and resistant to heavy wind-driven rain per IP 65 standard
Slip-resistant grip, shock and vibration resistant
Drop . . . . . 1.2 m (4 ft) MIL-STD-810F, Method 516.5, Procedure IV

Input/Output
Expansion . . . . . SD card slot (SD or SDHC storage cards)
Display . . . . . 8.9 cm (3.5 in) VGA (480 x 640 pixel) TFT, 16 bit (65,536) colors
LED backlight
Interface . . . . . Touch screen, 10 hardware control keys, power status LED
Audio system events, warnings, and notifications
Soft Input Panel (SIP) virtual keyboard and handwriting recognition software
Audio . . . . . Microphone and speaker, record and playback utilities
I/O . . . . . USB 1.1 client via support module
Serial via optional 9-pin RS-232 power/serial dip adaptor
Radios[5] . . . . . Bluetooth 1.2, Wireless LAN 802.11b/g

GPS
Channels . . . . . 14 (12 L1 code and carrier, 2 SBAS)
Integrated real-time . . . . . SBAS[1] (dual-channel tracking)
Update rate . . . . . 1 Hz
Time to first fix . . . . . 30 seconds (typical)
Protocols
Data output . . . . . TSIP, NMEA-0183 v3.0 (GGA, VTG, GLL, GSA, ZDA, GSV, RMC)
Real-time corrections . . . . . RTCM 2.x, RTCM 3.0, CMR, CMR+

Accuracy (HRMS)[6] after differential correction
Code postprocessed . . . . . 50 cm
Carrier postprocessed[7]
With 10 minutes tracking satellites . . . . . 20 cm
With 20 minutes tracking satellites . . . . . 10 cm
With 45 minutes tracking satellites . . . . . 1 cm
Real-time (SBAS[1] or external correction source) . . . . . Submeter

1 SBAS (Satellite Based Augmentation System). Includes WAAS available in North America only, EGNOS available in Europe only, and MSAS available in Japan only.
2 Power/serial clip also required.
3 With backlight at default setting (50% brightness).
4 Power draw will vary depending on radio usage.
5 Bluetooth and wireless LAN type approvals are country specific. GeoExplorer 3000 series handhelds have Bluetooth and wireless LAN approval in the U.S. and in most European countries. For further information please consult your local reseller.
6 Horizontal Root Mean Squared accuracy, 1-sigma (68%). Except in conditions where most GPS signals are affected by trees, or buildings, or other objects. Except when using VRS corrections, accuracy varies with proximity to base station by +1 ppm for code postprocessing and real-time.
7 Postprocessed carrier accuracy varies with proximity to base station by +2 p.p.m. 45 minute carrier capability applies only to the GPS Pathfinder Office software and is limited to 10 km from the base station.

Specifications subject to change without notice.

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

NORTH & SOUTH AMERICA
Trimble Navigation Limited
10355 Westmoor Drive
Suite #100
Westminster, CO 80021
USA
+1-720-587-4574 Phone
+1-720-587-4878 Fax

EUROPE & AFRICA
Trimble Germany GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY
+49-6142-2100-0 Phone
+49-6142-2100-550 Fax

ASIA-PACIFIC & MIDDLE EAST
Trimble Navigation
Singapore PTE Limited
80 Marine Parade Road
#22-06 Parkway Parade
Singapore, 449269
SINGAPORE
+65-6348-2212 Phone
+65-6348-2232 Fax

DATASHEET

TERRASYNC SOFTWARE

KEY FEATURES

Software designed for efficient field GIS data collection and maintenance

Intelligent data capture based on conditional attribute collection requirements

Customizable user interface data to simplify the field worker experience

Robust support for vector or raster map backgrounds for verification of field data

Seamless GNSS control in the field for high quality position data

Runs on a wide range of Trimble handheld and tablet computers

H-Star data collection for high accuracy with compatible Trimble receivers and handhelds

Real-time and postprocessed GLONASS support with compatible Trimble receivers and handhelds

Data collection for Trimble DeltaPhase processing provides improved postprocessed accuracy

SOFTWARE FOR HIGHLY PRODUCTIVE FIELD GIS DATA COLLECTION AND MAINTENANCE

The Trimble® TerraSync™ software is designed for fast and efficient field GIS data collection and maintenance. Paired with a supported Trimble GNSS receiver and handheld computer, it's a powerful system for the collection of high quality feature and position data for GIS update and maintenance.

Effortless and intelligent field data collection

Regardless of the field data collection workflow required and the complexity of the GIS data to be collected, the TerraSync software captures high quality data quickly and easily.

The TerraSync software makes the field data collection workflow seamless by including intelligent features such as map-centric operation, graphical status display, and the ability to record a position offset at the field worker's fingertips. The TerraSync software also makes it easy to incorporate photo capture into the data collection workflow using a Trimble handheld with an integrated camera or the Trimble TrimPix™ Pro system with any supported camera. Field workers can take and preview photos, automatically attaching them to the current feature, and stamping each photo with the time, date, and location at which it was taken.

The TerraSync software also includes the ability to use a data dictionary previously created in the Trimble GPS Pathfinder® Office software, based on the enterprise GIS. A data dictionary allows field workers to create features and assign attribute values that not only comply with the GIS data structure, but also preserve data integrity. Data capture forms can also dynamically adapt to previously entered attribute values for maximum data collection efficiency with a minimum of training.

Powerful simplicity

To improve the field worker experience, the TerraSync user interface can be simplified, removing functionality to ensure maximum field productivity and eliminate potential configuration errors. The TerraSync Studio utility within the GPS Pathfinder Office software provides a rich environment to develop and test customized TerraSync user interfaces. The result is that field workers see the overview of a data form more clearly, avoiding confusion and guiding them through only required form sections, speeding up form completion without sacrificing accuracy.

As part of the customizable user interface, intuitive data entry controls such as radio buttons and check boxes can be used to aid faster data entry, improved data accuracy, and more efficient field workflows. Data entry based on pre-loaded image galleries allows features to be uniquely identified by direct visual comparison to a reference image, minimizing the need for specialist training.

Smart data maintenance

The TerraSync software provides additional benefits for field workers involved in data maintenance activities. Assets imported from a GIS can be sorted and filtered based on the order they are to be visited for efficient route planning. Assets can be viewed as a simple list, or on a color-coded map with an aerial photo or satellite image in the background for reference. Fast raster map background redraw makes it possible to work with much larger images in TerraSync, resulting in increased productivity and creating a more dynamic field worker experience.

To revisit an asset, a field worker can select the corresponding feature from the list or map, and the intuitive graphical GNSS navigation tools will guide them to the asset's precise location. Once a feature or waypoint is reached, the TerraSync software marks it as visited and if an existing feature is edited, the TerraSync software marks it as updated.

Quality control made easy

With the TerraSync software, field workers can collect data and achieve the required level of accuracy, either in real time or after postprocessing. Accuracy-based logging settings specify the GNSS data quality that the enterprise GIS demands and the TerraSync software does the rest. To ensure that time in the field will be productive, field workers can use the Plan section to view a graphical prediction of the GPS satellite constellation and identify the best times for data collection.

The TerraSync software integrates seamlessly with a range of Trimble GNSS receivers to deliver the required accuracy level to meet company or regulatory requirements. The software supports postprocessing the data back in the office or using real-time differential GNSS corrections to improve data quality and accuracy. The TerraSync software can also be used with supported Trimble GNSS receivers to collect H-Star™ data for extra precision. Alternatively, optimal GNSS code processing accuracy can be achieved with a Trimble DeltaPhase™ technology-capable receiver.

Simple, efficient, and productive in the field—the TerraSync software is the clear choice for collecting and maintaining high quality GIS data.

Trimble.

TERRASYNC SOFTWARE

FEATURES AND OPTIONS

Key features

- Efficient field data collection of features, positions, and attribute data
- Configurable user interface for simple, efficient workflows and data entry
- Conditional attributes for dynamically adapting data capture forms
- Industry-leading GNSS receiver configuration and control
- Map display support for multiple raster and vector background maps
- Quick navigation to features or waypoints
- Mission planning to find the best time to collect GNSS data
- Multimedia support for attributes such as voice and image files
- Optimized for Trimble handhelds with integrated digital cameras
- Read/write support for Esri Shapefiles
- Customizable splash screen

GNSS accuracy

- Real-time differential correction (available sources depend on GNSS receiver and base station used)
- Record GPS and GLONASS data for subsequent postprocessing
- Achieve up to decimeter (10 cm / 4 inch) accuracy using real-time or postprocessed H-Star technology (dependent on H-Star-capable receiver and antenna combination used)
- Supports logging of DeltaPhase data for optimal code accuracy after postprocessing
- Support for collection of RTK data with Trimble 5800 and Trimble R8 GNSS receiver

Software editions

- TerraSync Standard edition for data collection
- TerraSync Professional edition for data collection and maintenance

For a product comparison of the Standard and Professional editions visit: www.trimble.com/mgis_prodcomp.shtml

Supported GNSS receivers

- GPS Pathfinder ProXT receiver
- GPS Pathfinder ProXH receiver
- GPS Pathfinder ProXRT receiver
- Trimble 5800 receiver
- Trimble R8 GNSS receiver (Models 2 and 3)

Supported handheld computers with integrated GNSS

- GeoXH handheld
- GeoXT handheld
- GeoXM handheld
- Juno® series handheld
- Trimble Nomad® G series handheld
- Trimble Yuma® rugged tablet computer

Supported handheld computers

- Trimble Ranger™ handheld
- Trimble Recon handheld

Available languages

- Chinese (Simplified)
- English
- French
- Russian
- German
- Italian
- Japanese
- Korean
- Portuguese
- Spanish

RECOMMENDED PLATFORM

Windows Mobile field computer

Operating system . . . . . Windows Mobile® version 5.0 software or Windows Mobile version 6.x
Processor type . . . . . ARM, XScale, or OMAP
Processor speed . . . . . 200 MHz or faster
Memory . . . . . 32 MB RAM at least 8 MB free memory
Input/output . . . . . Serial cable and RS-232 serial port (or appropriate adaptor) or Bluetooth® technology for connection to GPS Pathfinder Pro series receiver
Display . . . . . Color touch screen (240 x 320 pixels or larger) Transflective screen (or other screen suitable for outdoor viewing)

Windows field computer

Operating system:
Windows® 7 . . . . . Home Premium, Professional, Ultimate Editions SP 2 (32- or 64-bit)
Windows Vista® . . . . . Home Premium, Business, Ultimate Editions SP 1 (32- or 64-bit)
Windows XP . . . . . Professional or Tablet PC Edition (32- or 64-bit)
Processor speed . . . . . 500 MHz or faster
Memory . . . . . 64 MB RAM at least 8 MB free memory
Input/output . . . . . Serial cable and RS-232 serial port (or appropriate adaptor) or Bluetooth technology for connection to GPS Pathfinder Pro series receiver

SUPPORTED BACKGROUND FILE FORMATS

Vector formats

- Trimble SSF format (.ssf, .cor, .imp)
- Esri Shapefiles (.shp)

Raster (image) formats

- JPEG (.jpg)
- JPEG 2000 (.jp2, .j2c)
- Enhanced Compression Wavelet (.ecw)
- MrSID (.sid)
- TIFF (.tif)
- Windows bitmap (.bmp)

GNSS POSTPROCESSING OPTIONS

- GPS Pathfinder Office software
- Trimble GPS Analyst™ extension for Esri ArcGIS Desktop software

Specifications subject to change without notice.

Bluetooth®

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

NORTH & SOUTH AMERICA
Trimble Navigation Limited
10355 Westmoor Drive
Suite #100
Westminster, CO 80021
USA
+1-720-587-4574 Phone
+1-720-587-4878 Fax

EUROPE & AFRICA
Trimble Germany GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY
+49-6142-2100-0 Phone
+49-6142-2100-550 Fax

ASIA-PACIFIC & MIDDLE EAST
Trimble Navigation
Singapore PTE Limited
80 Marine Parade Road
#22-06 Parkway Parade
Singapore, 449269
SINGAPORE
+65-6348-2212 Phone
+65-6348-2232 Fax

Trimble.

DATASHEET

GPS PATHFINDER OFFICE SOFTWARE

KEY FEATURES

Differential corrections to improve the quality of GNSS data collected in the field

H-Star data processing for high accuracy with the GPS Pathfinder ProXRT and ProXH receivers and the GeoXH handheld

Supports GLONASS postprocessing for data collected with Trimble GLONASS-enabled GNSS receivers

Data import and export in a variety of GIS and CAD formats

Sophisticated data dictionary editor to ensure consistency between the field and the office

Quality control of GNSS data before exporting to GIS

POWERFUL AND EASY TO USE GNSS DATA PROCESSING SOFTWARE

The Trimble® GPS Pathfinder® Office software is a powerful and easy-to-use software package of GNSS postprocessing tools incorporating Trimble® DeltaPhase™ differential correction technology, designed to develop GIS information that is consistent, reliable, and accurate from GNSS data collected in the field.

Improve the accuracy of GNSS data

Postprocessing with the GPS Pathfinder Office significantly improves the autonomous accuracy of data collected in the field all the way down to decimeter (10 cm / 4 inch) level, depending on the environment and the GNSS receiver. Decimeter accuracy can be achieved with the GPS Pathfinder ProXH™ and ProXRT receivers or the GeoXH™ handheld, which incorporate Trimble H-Star™ technology. Alternatively, with a GeoXT™, GeoXM™, Juno®, or Nomad® 900G series handheld, or a ProXT™ receiver, you can achieve optimal GNSS code processing accuracy with the Trimble DeltaPhase technology.

The GPS Pathfinder Office software also includes the unique Integrity Index grading system, which ensures that GNSS field data is differentially corrected using the best quality base station data available.

Increase field work efficiency and productivity

Data can be imported to the GPS Pathfinder Office software from a number of GIS and database formats, allowing previously collected GIS data to be taken back to the field for verification and update. The software's Data Dictionary Editor creates custom lists of features and attributes for field data collection and supports the development of conditional attribute data capture forms in Trimble TerraSync™ software that dynamically adapt to previously entered attribute values for maximum data collection efficiency.

By creating a data dictionary or importing one from a GIS based on its exact data schema, GIS administrators can be confident that data collected in the field will integrate seamlessly with the GIS repository and that data returned will be accurate and consistent. In the field, the data capture form prompts field workers to enter specific information, ensuring data integrity and compatibility with the GIS.

The TerraSync Studio utility within the GPS Pathfinder Office software is used to develop and test customized TerraSync user interfaces. To improve the field worker experience, the TerraSync user interface can be simplified with this utility, removing functionality to ensure maximum field productivity and eliminate potential configuration errors.

Waypoint files can also be created in the software to assist with navigation and efficient asset relocation.

Ensure consistently high quality data

The GPS Pathfinder Office software includes quality control features critical for enterprise GIS data development. For example, collected features can be compared against any number of background datasets such as vector GIS data, aerial photographs or satellite imagery in order to verify accuracy and detect conflicts. Background data can be imported to the GPS Pathfinder Office software from GIS systems, directly from imagery files, or referenced directly from a web map server.

In addition, before transferring collected features to a GIS, CAD, or database system, they can be analyzed to confirm they are complete and free of errors. Positions and attributes can be changed and unnecessary or unwanted GNSS positions can be deleted with the GPS Pathfinder Office software to ensure that only the highest quality data is exported to the GIS.

The Trimble GPS Pathfinder Office software makes it easy to manage, correct, and update GIS data from GNSS data collected in the field.

Trimble.

GPS PATHFINDER OFFICE SOFTWARE

FEATURES AND OPTIONS

GNSS accuracy
- Improve GNSS position accuracy through differential postprocessing, including GLONASS postprocessing
- Postprocess real-time differential GNSS data to improve accuracy and consistency
- Review and edit GNSS data before transferring it to a GIS

GIS compatibility
- Import data from popular GIS, CAD, and database formats
- Export data into a variety of GIS, CAD, and database formats
- Create data dictionaries to ensure data collected is consistent with GIS schemas
- Additional import and export formats supported via Trimble SSF and DDF data format extensions for FME

Field-Office workflow optimization
- Plan GNSS field sessions to ensure productive use of field time
- Manage data dictionaries and background data for entire fleets of devices
- Automate data transfer from field devices, differential correction, and data export to GIS
- Configure and simplify the TerraSync software interface to increase field worker productivity

Available languages
- Chinese (Simplified)
- English
- French
- Spanish
- German
- Italian
- Japanese
- Korean
- Portuguese
- Russian

Field software options
- Trimble TerraSync software
- Trimble GPScorrect™ extension for Esri ArcPad software

RECOMMENDED PLATFORM

Operating system:

Windows® 7	Home Premium, Professional, Ultimate Editions SP 2 (32- or 64-bit)
Windows Vista®	Home Premium, Business, Ultimate Editions SP 1 (32- or 64-bit)
Windows XP	Professional or Tablet PC Edition (32- or 64-bit)
Free disk space	270 MB
Input/output	RS-232 serial port and/or USB port

GPS RECEIVERS AND ACCURACY (HRMS)[1] SPECIFICATIONS

Typical autonomous accuracy for all Trimble Mapping & GIS GNSS receivers is approximately 10 meters. The following table shows differentially corrected accuracy specifications for supported receivers:

Receiver/Handheld	Postprocessed
GPS Pathfinder ProXRT receiver	decimeter[2] / 1 cm[3]
GPS Pathfinder ProXH receiver	50 cm / decimeter[2] / 1 cm[3]
GPS Pathfinder ProXT receiver	50 cm / 1 cm[3]
GeoXH handheld	50 cm / decimeter[2] / 1 cm[3]
GeoXT handheld	50 cm / 1 cm[3]
GeoXM™ handheld	1–3 m
Juno series handheld	1–3 m
Trimble Nomad 900G series handheld	1–3 m
Trimble Nomad 800G series handheld	2–5 m
Trimble Yuma® rugged tablet computer	2–5 m

Refer to relevant datasheet for full details.

SUPPORTED FORMATS

Import formats
- AutoCAD 2000 ASCII DXF
- dBASE
- Esri Shapefiles
- MapInfo MIF
- Microsoft Access MDB
- Additional formats supported via Trimble SSF and DDF data format extensions for FME

Export formats
- ARC/INFO (for NT and UNIX) Generate
- AutoCAD 2000 ASCII DXF (with or without blocks)
- dBASE
- Esri Shapefiles
- GRASS
- IDRISI Vector
- Google Earth KML and KMZ
- MapInfo MIF
- MGAL
- Microsoft Access MDB
- Microstation version 7 DGN
- PC-ARC/INFO Generate
- PC-MOSS
- Additional formats supported via Trimble SSF and DDF data format extensions for FME

Vector background formats
- AutoCAD 2000 ASCII and binary DXF (.dxf)
- Esri Shapefiles (.shp)
- Trimble SSF format (.ssf, .cor, .imp, .phs, .wpt)

Raster (image) background formats
- JPEG (.jpg)
- JPEG 2000 (.jp2, .j2c)
- Enhanced Compression Wavelet (.ecw)
- MrSID (.sid)
- TIFF (.tif)
- Windows bitmap (.bmp)

Web map servers
- ArcIMS
- OpenGIS

SUPPORTED BASE FILE AND COMPRESSION FORMATS

Base file formats
- Hatanaka (Compressed RINEX)
- RINEX
- Trimble DAT format
- Trimble SSF format

Compression types
- GZip (.gz)
- Self-extracting executable (.exe)
- Zip (.zip)

1 Horizontal Root Mean Squared accuracy. Specifications apply except in conditions where most GNSS signals are affected by trees, or buildings, or other objects. The Trimble Nomad 800G series handheld must be held horizontally; the Juno and Nomad 900G series handhelds must be held vertically. Postprocessed code accuracy varies with proximity to reference station by +1 ppm.

2 The following factors increase the availability of specified H-Star accuracy: availability of GPS & GLONASS data at the base station(s) used for corrections, longer elapsed time tracking uninterrupted L1/L2 carrier phase data, use of the optional external Tornado™ or Zephyr™ Model 2 antennas, tracking of more satellites with L2 measurements, shorter distance to the base station(s), and use of more (than one) base stations for postprocessing. Specified H-Star accuracy can normally be achieved for baseline lengths of 100 km or less. H-Star accuracy is typically achieved within 2 minutes. Except when using VRS corrections, accuracy varies with proximity to base station by +1 ppm for code postprocessing and real-time. The ProXH receiver will only achieve decimeter postprocessed accuracy with the optional Tornado or Zephyr Model 2 external antenna.

3 Centimeter accuracy is achieved only within 10 km of base station, with a minimum of 45 minutes continuous carrier lock. Accuracy degrades by 2 ppm as baseline lengthens. Carrier accuracy is 20 cm after 10 minutes; 10 cm after 20 minutes.

Specifications subject to change without notice.

YOUR LOCAL TRIMBLE OFFICE OR REPRESENTATIVE

NORTH & SOUTH AMERICA
Trimble Navigation Limited
10355 Westmoor Drive
Suite #100
Westminster, CO 80021
USA
+1-720-587-4574 Phone
+1-720-587-4878 Fax

EUROPE & AFRICA
Trimble Germany GmbH
Am Prime Parc 11
65479 Raunheim
GERMANY
+49-6142-2100-0 Phone
+49-6142-2100-550 Fax

ASIA-PACIFIC & MIDDLE EAST
Trimble Navigation
Singapore PTE Limited
80 Marine Parade Road
#22-06 Parkway Parade
Singapore, 449269
SINGAPORE
+65-6348-2212 Phone
+65-6348-2232 Fax

```
Searching for base files...

File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA Week 2\Base\COOP_CORS,
Orland Hills, IL\ka102390.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA Week 2\Base\COOP_CORS,
Orland Hills, IL\ka102400.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA Week 2\Base\COOP_CORS,
Orland Hills, IL\ka102410.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA Week 2\Base\COOP_CORS,
Orland Hills, IL\ka102420.zip downloaded.
Successfully found or downloaded 4 of 4 files.
Search complete.

--------Base Data Details:--------------------
Using reference position from base provider:
  Name: COOP_CORS, Orland Hills, IL
  Position: 41°35'53.86230"N,  87°50'50.04788"W,  192.29 m
Source: C:\Documents and Settings\Sarah.Johnson\Desktop\SSA Week 2\Base\COOP_CORS,
Orland Hills, IL
  ka102390.zip
    Local time: 8/25/2008 6:59:46 PM to 8/26/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102400.zip
    Local time: 8/26/2008 6:59:46 PM to 8/27/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102410.zip
    Local time: 8/27/2008 6:59:46 PM to 8/28/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102420.zip
    Local time: 8/28/2008 6:59:46 PM to 8/29/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m

--------Coverage Details:--------------------
Rover file: SSA-082608-UNIT3.SSF
  Local time: 8/26/2008 8:02:56 AM to 8/29/2008 12:29:41 PM
100% total coverage
  34% coverage by ka102390.zip
  34% coverage by ka102390.zip
  32% coverage by ka102400.zip
  32% coverage by ka102400.zip
  12% coverage by ka102410.zip
  22% coverage by ka102420.zip

------------------------------------------------
Differentially correcting...
  Differential correction settings:
    Use data collection filter settings: On
    Correct velocity records: On
    Re-correct real-time positions: On
    Velocity filtering: Off
    Output positions: Corrected and uncorrected

------------------------------------------------
Processing rover file, SSA-082608-UNIT3.SSF ...
...to output file, C:\Documents and Settings\Sarah.Johnson\Desktop\SSA Week
2\SSA-082608-UNIT3.cor
    Carrier processing...
        No carrier processing performed as file has no carrier data
        Corrected 0 positions
```

```
    Code processing...
        Selected 2567 positions for post-processing
        Corrected 2315 positions
        Failed to correct 219 positions
            2 of these were due to insufficient satellites for position fix
            217 of these were due to excessive multipath error
        Excluded 33 positions
            33 of these were due to high DOP values

--------------------------------------------------
Differential Correction Summary:
    1 file processed.  In this file:
        2315 (90.2%) of 2567 selected positions were code corrected by
post-processing
        0 (0.0%) of 0 selected positions were carrier corrected by post-processing

    Estimated accuracies for 2315 corrected positions are as follows:
            Range       Percentage
            ----------  ----------
             0-15cm           -
            15-30cm           -
            30-50cm        4.0%
             0.5-1m       83.0%
               1-2m       11.4%
               2-5m        1.6%
                >5m           -

Differential correction complete.
```

```
Searching for base files...

File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102530.zip downloaded.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102540.zip downloaded.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102550.zip downloaded.
Successfully found or downloaded 3 of 3 files.
Search complete.

--------Base Data Details:--------------------
Using reference position from base provider:
  Name: COOP_CORS, Orland Hills, IL
  Position: 41°35'53.86230"N,  87°50'50.04788"W,  192.29 m
Source: c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL
  ka102530.zip
    Local time: 9/8/2008 6:59:46 PM to 9/9/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102540.zip
    Local time: 9/9/2008 6:59:46 PM to 9/10/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102550.zip
    Local time: 9/10/2008 6:59:46 PM to 9/11/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m

--------Coverage Details:--------------------
Rover file: Unit_2_week3.ssf
  Local time: 9/9/2008 8:31:51 AM to 9/11/2008 4:47:50 PM
100% total coverage
  37% coverage by ka102530.zip
  37% coverage by ka102530.zip
  33% coverage by ka102540.zip
  33% coverage by ka102540.zip
  29% coverage by ka102550.zip
  29% coverage by ka102550.zip

------------------------------------------------
Differentially correcting...
  Differential correction settings:
    Use data collection filter settings: On
    Correct velocity records: On
    Re-correct real-time positions: On
    Velocity filtering: Off
    Output positions: Corrected and uncorrected

------------------------------------------------
Processing rover file, Unit_2_week3.ssf ...
...to output file, C:\Documents and Settings\Ann.Amelse\Desktop\South Suburban\GPS
files\Week Three\Unit_2_week3.cor
    Carrier processing...
        No carrier processing performed as file has no carrier data
        Corrected 0 positions
    Code processing...
        Selected 2338 positions for post-processing
        Corrected 2252 positions
        Failed to correct 72 positions
            4 of these were due to insufficient satellites for position fix
            68 of these were due to excessive multipath error
        Excluded 14 positions
            14 of these were due to high DOP values

------------------------------------------------
```

```
Differential Correction Summary:
    1 file processed.  In this file:
        2252 (96.3%) of 2338 selected positions were code corrected by
post-processing
        0 (0.0%) of 0 selected positions were carrier corrected by post-processing

    Estimated accuracies for 2252 corrected positions are as follows:
            Range       Percentage
            ----------  ----------
             0-15cm          -
            15-30cm          -
            30-50cm      16.3%
             0.5-1m      79.4%
               1-2m       4.0%
               2-5m       0.4%
                >5m           -

Differential correction complete.
```

```
Searching for base files...

Base Provider: COOP_CORS, Chicago, IL (mwrd)
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Chicago, IL (mwrd)\mwrd2660.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Chicago, IL (mwrd)\mwrd2670.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Chicago, IL (mwrd)\mwrd2680.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Chicago, IL (mwrd)\mwrd2690.zip downloaded.
Unable to transfer files.
Unable to download file from url
ftp://ftp.karaco.com/Public/GPS_DATA/rinex24/2008/270/mwrd/mwrd2700.zip.
Successfully found or downloaded 4 of 5 files.

Base Provider: COOP_CORS, Orland Hills, IL
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Orland Hills, IL\ka102660.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Orland Hills, IL\ka102670.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Orland Hills, IL\ka102680.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Orland Hills, IL\ka102690.zip downloaded.
Unable to transfer files.
Unable to download file from url
ftp://ftp.karaco.com/Public/GPS_DATA/rinex24/2008/270/ka10/ka102700.zip.
Successfully found or downloaded 4 of 5 files.

Base Provider: CORS, Wolcott, IN
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS, Wolcott,
IN\wlci26608148.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS, Wolcott,
IN\wlci26708139.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS, Wolcott,
IN\wlci268081310.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS, Wolcott,
IN\wlci26908139.zip downloaded.
File C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS, Wolcott,
IN\wlci27008134.zip downloaded.
Successfully found or downloaded 5 of 5 files.
Unable to extract base data from C:\Documents and
Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS, Wolcott, IN\wlci268081310.zip.
This file may contain empty or corrupted base data files.

Search complete.

--------Base Data Details:--------------------
Using reference position from base provider:
  Name: COOP_CORS, Chicago, IL (mwrd)
  Position: 41°40'05.70248"N,  87°35'51.09002"W,  153.65 m
Source: C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Chicago, IL (mwrd)
  mwrd2660.zip
    Local time: 9/21/2008 6:59:46 PM to 9/22/2008 6:59:41 PM
    Position: 41°40'05.67413"N, 87°35'51.06985"W, 154.67 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  mwrd2670.zip
    Local time: 9/22/2008 6:59:46 PM to 9/23/2008 6:59:41 PM
    Position: 41°40'05.67413"N, 87°35'51.06985"W, 154.67 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  mwrd2680.zip
```

```
    Local time: 9/23/2008 6:59:46 PM to 9/24/2008 6:59:41 PM
    Position: 41°40'05.67413"N, 87°35'51.06985"W, 154.67 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  mwrd2690.zip
    Local time: 9/24/2008 6:59:46 PM to 9/25/2008 6:59:41 PM
    Position: 41°40'05.67413"N, 87°35'51.06985"W, 154.67 m, 0.00 m Antenna height
    Distance from base provider: 0.99m

Using reference position from base provider:
  Name: COOP_CORS, Orland Hills, IL
  Position: 41°35'53.86230"N,  87°50'50.04788"W,  192.29 m
Source: C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\COOP_CORS,
Orland Hills, IL
  ka102660.zip
    Local time: 9/21/2008 6:59:46 PM to 9/22/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102670.zip
    Local time: 9/22/2008 6:59:46 PM to 9/23/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102680.zip
    Local time: 9/23/2008 6:59:46 PM to 9/24/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102690.zip
    Local time: 9/24/2008 6:59:46 PM to 9/25/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m

Using reference position from base provider:
  Name: CORS, Wolcott, IN
  Position: 40°48'30.26953"N,  87°03'07.14910"W,  180.49 m
Source: C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week 4\Base\CORS,
Wolcott, IN
  wlci26608148.zip
    Local time: 9/22/2008 8:59:46 AM to 9/22/2008 4:59:46 PM
    Position: 40°48'30.24157"N, 87°03'07.12926"W, 181.56 m, 0.00 m Antenna height
    Distance from base provider: 0.98m
  wlci26708139.zip
    Local time: 9/23/2008 7:59:46 AM to 9/23/2008 4:59:46 PM
    Position: 40°48'30.24157"N, 87°03'07.12926"W, 181.56 m, 0.00 m Antenna height
    Distance from base provider: 0.98m
  wlci26908139.zip
    Local time: 9/25/2008 7:59:46 AM to 9/25/2008 4:59:46 PM
    Position: 40°48'30.24157"N, 87°03'07.12926"W, 181.56 m, 0.00 m Antenna height
    Distance from base provider: 0.98m
  wlci27008134.zip
    Local time: 9/26/2008 7:59:46 AM to 9/26/2008 11:59:46 AM
    Position: 40°48'30.24157"N, 87°03'07.12926"W, 181.56 m, 0.00 m Antenna height
    Distance from base provider: 0.98m

--------Coverage Details:--------------------
Rover file: 092208ST.SSF
  Local time: 9/22/2008 9:35:56 AM to 9/26/2008 11:54:43 AM
91% coverage by COOP_CORS, Chicago, IL (mwrd)
  21% coverage by mwrd2660.zip
  23% coverage by mwrd2670.zip
  27% coverage by mwrd2680.zip
  22% coverage by mwrd2690.zip
91% coverage by COOP_CORS, Orland Hills, IL
  21% coverage by ka102660.zip
  23% coverage by ka102670.zip
```

```
  27% coverage by ka102680.zip
  22% coverage by ka102690.zip
73% coverage by CORS, Wolcott, IN
  21% coverage by wlci26608148.zip
  23% coverage by wlci26708139.zip
  22% coverage by wlci26908139.zip
  9% coverage by wlci27008134.zip

------------------------------------------------
Differentially correcting...
  Differential correction settings:
    Use data collection filter settings: On
    Correct velocity records: On
    Re-correct real-time positions: On
    Velocity filtering: Off
    Output positions: Corrected and uncorrected

------------------------------------------------
Processing rover file, 092208ST.SSF ...
...to output file, C:\Documents and Settings\Sarah.Johnson\Desktop\SSA_Week
4\092208ST.cor
    Carrier processing using base provider COOP_CORS, Chicago, IL (mwrd)...
    Reference station data gap encountered:  9/23/2008 6:27:25 PM
    Possible reduced accuracy
    Reference station data gap encountered:  9/23/2008 6:39:55 PM
    Possible reduced accuracy
    Reference station data gap encountered:  9/23/2008 6:27:25 PM
    Possible reduced accuracy
    Reference station data gap encountered:  9/23/2008 6:39:55 PM
    Possible reduced accuracy
        Selected 5482 positions for post-processing
        Corrected 4467 positions
        Failed to correct 164 positions
    Code processing using base provider COOP_CORS, Chicago, IL (mwrd)...
        Selected 5482 positions for post-processing
        Corrected 4486 positions
        Failed to correct 909 positions
            13 of these were missing SuperCorrect data
              856 of these were due to missing base data
            12 of these were due to insufficient satellites for position fix
            28 of these were due to excessive multipath error
        Excluded 87 positions
            87 of these were due to high DOP values
    Carrier processing using base provider COOP_CORS, Orland Hills, IL...
        Selected 5482 positions for post-processing
        Corrected 4478 positions
        Failed to correct 153 positions
    Code processing using base provider COOP_CORS, Orland Hills, IL...
        Selected 5482 positions for post-processing
        Corrected 4495 positions
        Failed to correct 909 positions
            13 of these were missing SuperCorrect data
              850 of these were due to missing base data
            10 of these were due to insufficient satellites for position fix
            36 of these were due to excessive multipath error
        Excluded 78 positions
            78 of these were due to high DOP values
    Carrier processing using base provider CORS, Wolcott, IN...
        Selected 5482 positions for post-processing
        Corrected 3955 positions
        Failed to correct 131 positions
    Code processing using base provider CORS, Wolcott, IN...
        Selected 5482 positions for post-processing
```

```
        Corrected 4032 positions
        Failed to correct 1407 positions
            13 of these were missing SuperCorrect data
              1391 of these were due to missing base data
            3 of these were due to insufficient satellites for position fix
        Excluded 43 positions
            43 of these were due to high DOP values
    Chose 89 code solutions over the carrier solutions
        89 code solutions were of higher quality

-------------------------------------------------
Differential Correction Summary:
    1 file processed.  In this file:
        13013 (79.1%) of 16446 selected positions were code corrected by
post-processing against 3 base providers
        12900 (78.4%) of 16446 selected positions were carrier corrected by
post-processing against 3 base providers
        89 (1.7%) of code positions chosen over carrier, as they were of higher
quality

    Estimated accuracies for 5479 corrected positions are as follows:
            Range       Percentage
            ----------  ----------
             0-15cm           -
            15-30cm         8.0%
            30-50cm        26.5%
             0.5-1m        50.1%
               1-2m        13.9%
               2-5m         1.2%
                >5m         0.3%

Differential correction complete.
```

```
Searching for base files...

File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102800.zip downloaded.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102810.zip (2 of 5) found
locally.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102820.zip downloaded.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102830.zip downloaded.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102840.zip downloaded.
Successfully found or downloaded 5 of 5 files.
Search complete.

--------Base Data Details:--------------------
Using reference position from base provider:
  Name: COOP_CORS, Orland Hills, IL
  Position: 41°35'53.86230"N,  87°50'50.04788"W,  192.29 m
Source: c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL
  ka102800.zip
    Local time: 10/5/2008 6:59:46 PM to 10/6/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102810.zip
    Local time: 10/6/2008 6:59:46 PM to 10/7/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102820.zip
    Local time: 10/7/2008 6:59:46 PM to 10/8/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102830.zip
    Local time: 10/8/2008 6:59:46 PM to 10/9/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102840.zip
    Local time: 10/9/2008 6:59:46 PM to 10/10/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m

--------Coverage Details:---------------------
Rover file: SSA_100608_UNIT2.SSF
  Local time: 10/6/2008 9:37:51 AM to 10/10/2008 11:50:37 AM
100% total coverage
  27% coverage by ka102800.zip
  15% coverage by ka102810.zip
  15% coverage by ka102810.zip
  24% coverage by ka102820.zip
  24% coverage by ka102820.zip
  30% coverage by ka102830.zip
  4% coverage by ka102840.zip

------------------------------------------------
Differentially correcting...
  Differential correction settings:
    Use data collection filter settings: On
    Correct velocity records: On
    Re-correct real-time positions: Off
    Velocity filtering: Off
    Output positions: Corrected and uncorrected

------------------------------------------------
Processing rover file, SSA_100608_UNIT2.SSF ...
...to output file, C:\Documents and Settings\Ann.Amelse\Desktop\South Suburban\GPS
files\Week five\SSA_100608_UNIT2.cor
    Carrier processing...
```

```
        No carrier processing performed as file has no carrier data
        Corrected 0 positions
    Code processing...
        Ignored 6378 positions
            6378 of these were real-time code
                ("Correct Real-time positions" option was disabled)
        Selected 384 positions for post-processing
        Corrected 384 positions

------------------------------------------------
Differential Correction Summary:
    1 file processed.  In this file:
        384 (100.0%) of 384 selected positions were code corrected by
post-processing
        0 (0.0%) of 0 selected positions were carrier corrected by post-processing

    Estimated accuracies for 384 corrected positions are as follows:
            Range       Percentage
            ----------  ----------
             0-15cm           -
            15-30cm           -
            30-50cm       15.1%
             0.5-1m       75.5%
               1-2m        8.6%
               2-5m        0.8%
                >5m           -

Differential correction complete.
```

```
Searching for base files...

File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102800.zip (1 of 5) found
locally.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102810.zip (2 of 5) found
locally.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102820.zip (3 of 5) found
locally.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102830.zip (4 of 5) found
locally.
File c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL\ka102840.zip (5 of 5) found
locally.
Successfully found or downloaded 5 of 5 files.
Search complete.

--------Base Data Details:--------------------
Using reference position from base provider:
  Name: COOP_CORS, Orland Hills, IL
  Position: 41°35'53.86230"N,  87°50'50.04788"W,  192.29 m
Source: c:\Pfdata\Default\Base\COOP_CORS, Orland Hills, IL
  ka102800.zip
    Local time: 10/5/2008 6:59:46 PM to 10/6/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102810.zip
    Local time: 10/6/2008 6:59:46 PM to 10/7/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102820.zip
    Local time: 10/7/2008 6:59:46 PM to 10/8/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102830.zip
    Local time: 10/8/2008 6:59:46 PM to 10/9/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m
  ka102840.zip
    Local time: 10/9/2008 6:59:46 PM to 10/10/2008 6:59:41 PM
    Position: 41°35'53.83409"N, 87°50'50.02759"W, 193.31 m, 0.00 m Antenna height
    Distance from base provider: 0.99m

--------Coverage Details:--------------------
Rover file: SSA_100608_UNIT2.SSF
  Local time: 10/6/2008 9:37:51 AM to 10/10/2008 11:50:37 AM
100% total coverage
  27% coverage by ka102800.zip
  15% coverage by ka102810.zip
  15% coverage by ka102810.zip
  24% coverage by ka102820.zip
  24% coverage by ka102820.zip
  30% coverage by ka102830.zip
  4% coverage by ka102840.zip

------------------------------------------------
Differentially correcting...
  Differential correction settings:
    Use data collection filter settings: On
    Correct velocity records: On
    Re-correct real-time positions: On
    Velocity filtering: Off
    Output positions: Corrected and uncorrected

------------------------------------------------
```

```
Processing rover file, SSA_100608_UNIT2.SSF ...
...to output file, C:\Documents and Settings\Ann.Amelse\Desktop\South Suburban\GPS
files\Week five\SSA_100608_UNIT2_1.cor
    Carrier processing...
        No carrier processing performed as file has no carrier data
        Corrected 0 positions
    Code processing...
        Selected 6762 positions for post-processing
        Corrected 6758 positions
        Failed to correct 1 positions
            1 of these were due to insufficient satellites for position fix
        Excluded 3 positions
            3 of these were due to high DOP values

------------------------------------------------
Differential Correction Summary:
    1 file processed.  In this file:
        6758 (99.9%) of 6762 selected positions were code corrected by
post-processing
        0 (0.0%) of 0 selected positions were carrier corrected by post-processing

    Estimated accuracies for 6758 corrected positions are as follows:
            Range       Percentage
            ----------  ----------
             0-15cm          -
            15-30cm          -
            30-50cm      18.5%
             0.5-1m      72.0%
               1-2m       8.9%
               2-5m       0.5%
                >5m           -

Differential correction complete.
```

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix D

Methodology

2) **NRCS Methodology for Wetland Determination on Agricultural Lands including:**

   a. **Chicago USACE District Memorandum on Using the Mapping Conventions**
   b. **NRCS Mapping Conventions**
   c. **WETS Table for use with the NRCS Mapping Conventions**

Chicago District Regulatory Bulletin

January 10, 2006

SUBJECT: Determinations of Wetlands on Agricultural Lands

Determinations must be completed using the National Food Security Act Manual (NFSAM) methodology. The NRCS no longer certifies agricultural wetlands on cropland planned for development. Please contact the appropriate NRCS office to become familiar with the NFSAM methodology for identifying agricultural wetlands on your parcel. Once you have completed your determination submit your findings to this office so we may determine your information for acceptability. This information requirement will be added to our application checklist.

We are including theWETS tables for the major NWS precipitation recording stations in the Chicagoland area. Use the data from the station closest to the site in question. We have designated the wet years, normal years and alternate years of aerial slides to be reviewed. Make sure you read the legend on the WETS tables carefully in order to review the proper years of slides.

1. Select a wet year as your base aerial photograph. Typically, consistently wet areas should show wetland signatures in this year. Reviewing this aerial photograph will make it easy to identify all the potential farmed wetlands. If the wet year you have selected is not available, we have provided an alternate wet year that you can review. If neither of these years are available, choose the most recent wet year available as your base map.
2. Review the normal years we have selected for wetland signatures and to see how many years the areas identified in step 1 persist. If the selected normal years are unavailable, we have provided alternate years to review. If you are still having difficulty with slides that are unavailable or shadows on slides, select the most recent normal year(s) that are available.
3. In the Chicago Region, use the hydrology criteria from the NRCS Wetland Mapping Conventions for the "Prairie Pothole and saturated soils in the Wisconsinan Glaciated Region", except for areas that flood. For areas that flood (alluvial soils), use the criteria for Flooded or Ponded Soils.

The following information shall be submitted to this office as part of the wetland determination on agricultural lands:

1. Submit a copy of the NRCS Farmed Wetland Inventory for the subject property. Please note that this will be used by our office to identify potential farmed wetland areas on the subject property. Areas designated as PC (Prior Converted Wetlands) are no longer relevant to the Corps. PC areas may contain wetlands that redeveloped after NRCS completed their inventory, due to the failure of the drainage tile or the lack of maintenance to the drainage system. The Chicago

District is trying to identify the farmed wetlands that currently exist on the subject property.

2. Submit a legible copy of the aerial photograph for every aerial slide year reviewed with the size and the shape of the wetland signatures identified and numbered. For example, if you review 6 years, you should submit 6 aerial photographs of the subject property. Each photograph shall have the interpretation of the wetland signatures corresponding to that specific year reviewed. The year should be written on the aerial photograph;
3. Provide a final farmed wetland determination exhibit which shows all of the areas that showed wetland signatures in 50% or more of the photos reviewed. For example, if an area shows up in 3 out of the 5 normal years then this area should be designated as a farmed wetland. Take an average boundary of all of the years wetland signatures were apparent in that area. You should identify the area (for example, Farmed Wetland 1) on the aerial photograph so that we can identify it in our jurisdictional determination letter;
4. A copy of the worksheet used to plot the presence of wetland signatures for each aerial photograph reviewed;
5. A site visit should be made to verify that the areas that appeared as wetland signatures on the aerial photographs are in fact wetlands in the field. A detailed data point should be taken in each farmed wetland within the project site limits. Field visits may also identify small wetlands that were not visible during the slide review.

Bramstedt
Wetlands

USDA NRCS
Natural Resources Conservation Service

United States
Department of
Agriculture

1902 Fox Drive
Champaign, IL
61820

December 18, 1997

ILLINOIS BULLETIN NO. IL 190-8-4

SUBJECT: ECS - Wetland Mapping Conventions

Purpose: To distribute the revised IL Mapping Conventions

Expiration Date: September 30, 1998.

Filing Instructions: File the attached Illinois Wetland Mapping Conventions December 1997 Draft in the National Food Security Act Manual in front of Section 514.

With recent policy changes requiring on-site wetland determinations (see Illinois Bulletin No. IL-190-1) and in an attempt to be more consistent across state lines, it was necessary to revise the Illinois Mapping Conventions dated 1994. Attached is an operational draft which is to be put into use when received. The final draft will be distributed when all the signatory parties have signed it.

The mapping conventions is only a tool for making a wetland inventory. The inventory may aid in making a wetland determination, which requires an on-site visit. The mapping conventions should be utilized along with Section 514 of the Food Security Act Manual and an on-site visit when making a determination on cropland. This applies to wetland consultants, Corps of Engineers, as well as NRCS personnel.

If you have questions about it contact the NRCS Biologist assisting your office.

WILLIAM J. GRADLE
State Conservationist

need year +
slide #'s.

Attachment

Distribution: All Offices

cc: State Technical Comm. Members

filename: bulletin/mapcon.doc

WETLAND MAPPING CONVENTIONS
NRCS ILLINOIS 1998

INTRODUCTION

Mapping conventions are a set of accepted practices or procedures used to guide the wetland delineator in making off site wetland inventories, and on site determinations. The conventions developed for Illinois were done so with guidance from the NRCS Technical Service Center and revised according to the Midwest Regional Wetland Team recommendations. They were discussed and formulated with input from local, state and federal agency personnel.

The off site techniques rely on the interpretation of aerial photography and other inventories such as the County Soil Survey and the National Wetland Inventory (NWI). This requires training in properly identifying wetland signatures for the different types of aerial photography available. Off site techniques shall only be used by personnel trained in both wetland delineation and in identifying wetland signatures in the area.

Before a certified determination is made potential sites identified in the off-site phase will be field verified by making a field investigation of the site. The field investigation shall include:

1. For identified potential sites in intensively used and managed wetland areas (potential FW and FWP), as per definitions in the National Food Security Act Manual (NFSAM), verify that the site is wetland by documenting the presence of hydric soils, and any hydrophytic plants or hydrology indicators observed. Adjust site locations and wetland boundaries based upon observations during the field visit.

2. For identified potential sites in naturally vegetated wetland areas, document as per Corps of Engineer's 87 Manual requirements and set boundaries accordingly.

3. Any delineations omitted during the off-site phase may be added; any sites incorrectly delineated should be omitted.

GENERAL INFORMATION - ALL CONVENTIONS

Size of an area is not part of the wetland criteria. However, only areas large enough to detect and delineate on a map when interpreting aerial photography will be mapped as wetlands using this procedure. The on-site investigation may revise the determination to add small wetlands missed in the off-site inventory.

Mapping Tools - The following materials will be used in this procedure:

1) County Soil Survey with approved County Hydric Soil Legend

2) Base Map - Usually a NHAPP black and white aerial photo, 8 inch to mile scale, 24 X 24 inch sheet.

3) National Wetland Inventory (NWI) - The NWI provides an excellent overview of the extent and type of wetlands in the area. This inventory was done in the early 1980's (see photo date on each map) using infrared photography. In most cases, it has been very consistent with the Farm Bill wetland inventories. However, it does not delineate prior converted cropland, it did not use soils information, and in some cases it did not inventory wetlands in cropland due to the policy they were working under.

4) Climatic Data - Precipitation records from the area being mapped.

5) Long Duration Flooding Data - Elevations of 15 day flooding along major rivers were developed by the Illinois State Water Survey from stream gauge data.

6) FSA Slides - Aerial compliance (crop history) color slides (low altitude) used by FSA. At least five years of FSA slides must be used in this procedure. When making an individual determination, it is recommended that all available slides be viewed for general reference, but slides used for making the determination should be from years that are determined to have normal periods of precipitation before the slides where taken (see below). When inventorying a large area (an entire county or large part of a county), select five years, from those with slides available, with the closest to normal precipitation in the three months before the slides were taken. Use slides from these 5 years to complete the inventory.

Selection of slides with "normal precipitation"
Using records from weather reporting stations nearest the area to be mapped, assemble the long term precipitation averages and precipitation averages for each slide year for April, May, June, and for July alone. The slides are usually taken in July. Ponding in May and June can be observed on the slides taken in July, as areas where the crop was not planted because it was too wet, or was killed by the ponded water. Select the five years that are closest to the long term precipitation averages. Further information and procedures for determining "normal years" can be found in Section I of the Field Office Technical Guide under Climate Data. Balance, as well as possible, the number of wet and dry years. Select as many years as possible in the 1980 - 1985 range. This will help to establish conditions present on December 23, 1985 which is important to know when making the determination. If slides for years 1983, 1984 and 1985 are not selected because they do not represent years of "normal" precipitation, then review them before making the final determination to establish the conditions present on December 23, 1985.

Identification of wetland signatures
A wetland signature is the indication left in a field, recorded by a photograph, of ponding, flooding or impacts of saturation for sufficient duration that meets wetland hydrology and possibly wetland vegetation criteria. Being identified as a wetland on the NWI is also considered a wetland signature. Wetland signatures in Illinois are:

- NWI - Area is labeled as a wetland on the National Wetland Inventory
- Hydrophytic vegetation (observed as different color than crop or forage)
- Surface water
- Drowned-out crops or crop damage due to wetness.
- Differences in vegetation (within a field) due to different planting dates.
- Isolated areas that are not farmed with rest of the field (includes areas not planted due to wetness at time of planting).
- Inclusion of wet areas as set-aside if other signs of wetness are evident.
- Patches of greener vegetation (crop) during years of below normal precipitation
- Crop stress can be used only if the District Conservationist believes that it is a valid indicator in that area. Crop stress is seen on the FSA slides as areas of yellow crop, or sparse canopy coverage of crop, that has been in stress due to wetness.

The wetland delineator must be trained to interpret the above signatures in each region being mapped. This training should include field verification of the signatures observed.

WETLAND MAPPING CONVENTIONS

Three mapping conventions will be used in Illinois. The first convention will be used in the prairie pothole region of the state (see attached map). The second one will be used in the remainder of the state. The third convention will be used anywhere ponding or flooding is encountered. Ponding can occur anywhere while flooding is restricted primarily along the lower reaches of larger rivers.

The three mapping conventions are:

1. Prairie potholes and saturated soils in the Wisconsin Glaciation Region. It does not include alluvial soils. In cropland and non-native pastureland/hayland, farmed wetland and farmed wetland pasture areas must have 7 day ponding or 14 day saturation, during the growing season for greater than a 50 percent chance of occurrence each year (5 out of 10 years). In naturally vegetated wetlands soil saturation must be present at least 5% of the growing season to meet wetland hydrology criteria.

2. Saturated soils outside the Wisconsin Glaciation Region. Includes saturated alluvial soils state wide. In cropland, farmed wetland areas must have 15 days of ponding during the growing season for greater than a 50 percent chance of occurrence each year (5 out of 10 years). In non-native pastureland/hayland farmed wetland pasture areas must be have 7 day ponding or 14 day saturation during the growing season. In naturally vegetated wetlands soil saturation must be present at least 5% of the growing season to meet wetland hydrology criteria.

3. Flooded or ponded soils. These soils must be inundated for the required periods (below), during the growing season for greater than a 50 percent chance of occurrence each year (5 out of 10 years):

   a) Cropland manipulated and farmed before December 23, 1985 that floods or ponds for 15 consecutive days during the growing season.
   b) Pasture/hayland manipulated and farmed before December 23, 1985 that floods or ponds for 7 days during the growing season.
   c) In naturally vegetated wetlands inundation and/or soil saturation must be present at least 5% of the growing season to meet wetland hydrology criteria.

PRAIRIE POTHOLES AND SATURATED SOILS IN THE WISCONSIN GLACIATION REGION

Wetlands will be mapped using the following procedure as the basis for making inventories of wetlands in prairie pothole soils. These soils include all saturated soils in the Wisconsin Glaciation Region except for alluvial soils along streams and rivers.

Step 1.--Review base map. Note location of areas that appear to be wet (usually areas with dark soil tones).

Step 2. - Review NWI. Note location of any wetlands.

Step 3. - Review Soil Survey. Note location of hydric soil map units, and location of map units with hydric inclusions.

Step 4. - Review FSA slides for all years, and at least 5 years of slides that are determined to represent normal periods of precipitation (see General Information, #6 FSA Slides above). Note any areas converted from other land uses to cropland. Note location and year of wetland signatures from the slides.

Step 5. - Document the various wetlands, etc., on the inventory base map according to the following rules according to apparent land use:

Cropland:

- In every cropland field, place a "PC"* if the soils in the field are all hydric.
- Place a "NW" in each cropland field, if all the soils in the field are non-hydric.
- Place a NW/PC* in each cropland field, if there are both non-hydric and hydric soils, or if there are soils with hydric inclusions.
- For areas of the field that have hydric soils or soil with possible hydric inclusions, review the FSA slides and NWI. Delineate and label areas "FW" that have wetland signatures greater than 50% of the time (3 or more years out of 5; or 2 out of 5 years if the area also is shown on the NWI as a wetland) for years that have been determined to represent normal periods of precipitation. For the extent of the area to be delineated, use the wetland signature boundary during a year of normal precipitation and conditions.
- If the area meets FW criteria, record the years wetland signatures were observed beside the FW (e.g.: FW '86'88'91).

* NOTE: For this inventory procedure, the assumption is made that all hydric prairie soils in Illinois have had some manipulation if they are being cropped. If it is discovered that a cropland field with prairie soils has not had any subsurface or surface drainage, then the "PC" or "FW" will be changed to "W" for the hydric soils and cropping can continue as weather permits.

Areas of Woodland or Herbaceous Vegetation (not pastured or hayed):

- Areas too small to delineate within cropland, including single trees and single tree wide fence rows that are not also drainage ways, are considered part of the cropland field and are considered whatever the surrounding field is (e.g. PC, NW, FW).
- If on NWI and a hydric soil, outline the area and label with "W"
- If not a hydric soil or soil with hydric inclusions, and not on the NWI, outline the area and label with "NW".
- All other cases are to be outlined and labeled "NI" for "Not Inventoried". Areas of NW within areas of NI are only delineated out of the NI area only if apparent landmarks allow for accurate separation of the two areas.

Note: On any wetland determination or copy of a wetland inventory given out to a client, an explanation of "NI" must be included. This note should state that NI areas may or may not contain wetlands. If any manipulation is planned for this area, a determination should first be requested for Farm Bill or section 404 of the Clean Water Act purposes.

Pasture: (<25% canopy coverage of woody species, and not cropped from 1980 - 1985)

- Areas with all hydric soil, outline and label "FWP"
- Areas with soils with hydric inclusions, and on the NWI, outline and label "FWP"
- Areas with only non-hydric soils, not on the NWI, outline and label "NW"
- All other cases, outline and label the area "NI".

Ponds:

- Outline all ponds. Large lakes do not have to be outlined if it is clear where the boundaries are.
- If the pond is surrounded by predominantly hydric soils or soils with hydric inclusions, label "W".
- If the pond is surrounded by predominantly non-hydric soils, label "AW".

Streams:

- All ditches, creeks, streams, and rivers, should be delineated as NI on a wetland inventory. The upstream extent to which they are delineated generally should be no father than that which is labeled as a riparian area on the NWI. For a determination, the delineation of these areas should be the same unless there is a proposed manipulation that would affect an area labeled NI, in which case the determination must be coordinated with the Corps of Engineers for a determination of "Waters of the U.S."

Converted Wetland *:

The 1985 FSA slide, or other 1985 aerial photography, should always be compared with the latest aerial photography available. Note all wetlands, farmed wetlands, and farmed wetland pastures in 1985 that have been manipulated and converted to cropland. Natural wetlands cropped under natural conditions (e.g., during a drought) is not a converted wetland for Farm Bill purposes if woody vegetation was not cleared. Otherwise, use the following procedure.

- Determine the part or parts of the area made croppable that was a wetland, farmed wetland or farmed wetland pasture in 1985 using the above convention.

- From the FSA slides, or other aerial photography, determine the year in which the area was manipulated (cleared, drained, levied, etc.) and made croppable.

- Outline and label the area "CW" if the conversion occurred in 1990 or before (converted on the 1990 FSA slide). Label the area "CW+year" (e.g. CW+91) for the year in which the conversion occurred after 1990.

- If an area has been converted (cleared, drained, filled, etc.) since 1985 but not made croppable (this will probably require a field investigation to determine) outline the area and label it WX.

* NOTE: Converted wetland in this sections refers to its use as a wetland label for Farm Bill purposes, not necessary for Section 404 of the Clean Water Act.

Orchards, Nurseries, and Vineyards:

Orchards, nurseries, and vineyards are assumed to be in long term rotations with crops in Illinois. Inventory the same way as cropland. However, if a determination is being done as the result of planned manipulation of the area, a site investigation should be done if the area has hydric soils.

Step 6. - Additional Documentation - For all areas except "NI" that are labeled add the following check marks to wetland inventories:

X - if the area is on the NWI.
✓ - check if the area has hydric soils.
✗ - check with a slash if the area has soils with hydric inclusions.

For inventories completed before 1994, the following documentation can be found:

Red check if the area is on the NWI.
Green check if the area has hydric soils.
Green check with a slash if the area has soils with hydric inclusions.

SATURATED SOILS OUTSIDE THE WISCONSIN GLACIATION REGION

Areas outside the Wisconsin Glaciation area of Illinois are mapped under this convention. In non-cropped areas the wetland criteria are the same as for the Potholes and Saturated Prairie Soils convention. In cropland the National Food Security Act Manual (NFSAM) requires surface water to be present for 15 consecutive days (except for potholes) during the growing season to be a wetland. In Illinois, the evaluation of the FSA aerial slides for this convention is the same as for the Potholes and Saturated Prairie Soils convention. Training on interpretation of the wetland signatures must be adjusted at the regional level to correspond to wetlands in each region.

Therefore, under this convention follow the same steps and procedures in the Potholes and Saturated Prairie Soils convention above.

FLOODED OR PONDED SOILS

The hydrology criteria on cropland and non-native pasture/hayland is: 7 days ponding or flooding in non-native pasture/hayland and all potholes; OR 15 days in cropland that is not a pothole.

In naturally vegetated wetlands inundation and/or soil saturation must be present at least 5% of the growing season to meet wetland hydrology criteria.

This convention is to be used in conjunction with the first two conventions.

Ponded

The evidence of ponding in cropland is observed as wetland signatures on the FSA aerial slides (see "FSA Slides" on page 2). Therefore, the other conventions cover this condition. In non-cropped areas, the soils and NWI will identify it as a wetland in the other conventions, or require that a site investigation be made.

Flooded

Long duration (15 days or more) on cropland during the growing season can result from flooding by a major river. The Illinois State Water Survey developed elevation data from stream gage data, for the 15 day duration flood (50% chance of occurrence) during the growing season along major rivers where the data was available. This has been given to each county for which there was data. The following procedure should be used for where there is data. Otherwise, it is assumed that this type of flooding will be captured under the first two conventions (observed as ponding) or does not exist. Where flooding data exist:

Step 1) Delineated on the base map that areas unprotected by levee below the 15 day duration flooding elevation for the nearest river mile to that location.

Step 2) Label the delineated area above, as "FW" if cropland.

Step 3) Label all non-cropped areas delineated above as "W".

SUMMARY OF DOCUMENTATION

Code	Definition
AW	Artificial Wetland
CW	Converted Wetland between 1985 - 1990
CW+year	Converted Wetland after 1990
FW	Farmed Wetland
FWP	Farmed Wetland Pasture
NI	Not Inventoried, no determination/delineation has been made for this area.
NW	Non Wetland
PC	Prior Converted Cropland
W	Wetland
WX	Manipulated but cropping is not possible
Year by FW	Year in which a wetland signature was observed on aerial photography
✓	Area has a hydric soil map unit
✓	Area has a soil map unit with possible hydric inclusion
X or a Red Check	Area is on the NWI

mapcon3.doc

WETS Station: Peotone, IL6725

	Average	<30%	>30%
April	3.99	2.32	4.74
May	4.68	3.07	5.62
June	5.08	3.16	6.76

CLIMATIC EVALUATION OF PRECIPITATION
3 MONTHS BEFORE AERIAL CROP
HISTORY SLIDES

Year	April Percip-itation	Type of Month	May Percip-itation	Type of Month	June Percip-itation	Type of Month	April Score 1X	May Score 2X	June Score 3X	Score for Year	Type of Year	Year
1980	2.20	Dry	4.02	Normal	5.77	Normal	1	4	6	11	NORMAL	1980
1981	11.02	Wet	7.29	Wet	7.63	Wet	3	6	9	18	WET	1981
1982	2.84	Normal	3.74	Normal	2.43	Dry	2	4	3	9	DRY	1982
1983	6.57	Wet	3.40	Normal	2.70	Dry	3	4	3	10	NORMAL	1983
1984	2.08	Dry	5.64	Wet	3.57	Normal	1	6	6	13	NORMAL	1984
1985	1.41	Dry	2.16	Dry	2.50	Dry	1	2	3	6	DRY	1985
1986	1.30	Dry	6.43	Wet	7.24	Wet	1	6	9	16	WET	1986
1987	2.88	Normal	8.41	Wet	5.32	Normal	2	6	6	14	NORMAL	1987
1988	2.01	Dry	1.68	Dry	0.85	Dry	1	2	3	6	DRY	1988
1989	2.01	Dry	3.74	Normal	6.43	Normal	1	4	6	11	NORMAL	1989
1990** IR	1.44	Dry	7.74	Wet	5.55	Normal	1	6	6	13	NORMAL	1990** IR
1991**	3.78	Normal	6.21	Wet	0.28	Dry	2	6	3	11	NORMAL	1991**
1992	1.08	Dry	1.01	Dry	0.93	Dry	1	2	3	6	DRY	1992
1993W	5.21	Wet	2.96	Dry	11.95	Wet	3	2	9	14	NORMAL	1993W
1994	4.29	Normal	2.42	Dry	3.55	Normal	2	2	6	10	NORMAL	1994
1995	6.72	Wet	5.34	Normal	3.33	Normal	3	4	6	13	NORMAL	1995
1996	3.79	Normal	8.12	Wet	3.85	Normal	2	6	6	14	NORMAL	1996
1997*	1.72	Dry	5.72	Wet	6.08	Normal	1	6	6	13	NORMAL	1997*
1998*	3.63	Normal	4.97	Normal	5.70	Normal	2	4	6	12	NORMAL	1998*
1999	7.75	Wet	4.00	Normal	4.76	Normal	3	4	6	13	NORMAL	1999
2000W	4.01	Normal	3.29	Normal	9.92	Wet	2	4	9	15	WET	2000W
2001*	2.66	Normal	3.50	Normal	3.57	Normal	2	4	6	12	NORMAL	2001*
2002*	5.51	Wet	7.61	Wet	3.02	Dry	3	6	3	12	NORMAL	2002*
2003*	2.05	Dry	3.53	Normal	3.25	Normal	1	4	6	11	NORMAL	2003*
2004	1.45	Dry	6.10	Wet	4.66	Normal	1	6	6	13	NORMAL	2004
2005	1.62	Dry	2.01	Dry	1.65	Dry	1	2	3	6	DRY	2005

SCORE

Dry =	1
Normal =	2
Wet =	3

TYPE OF YEAR

Dry =	6 to 9
Normal =	10 to 14
Wet =	14 to 18

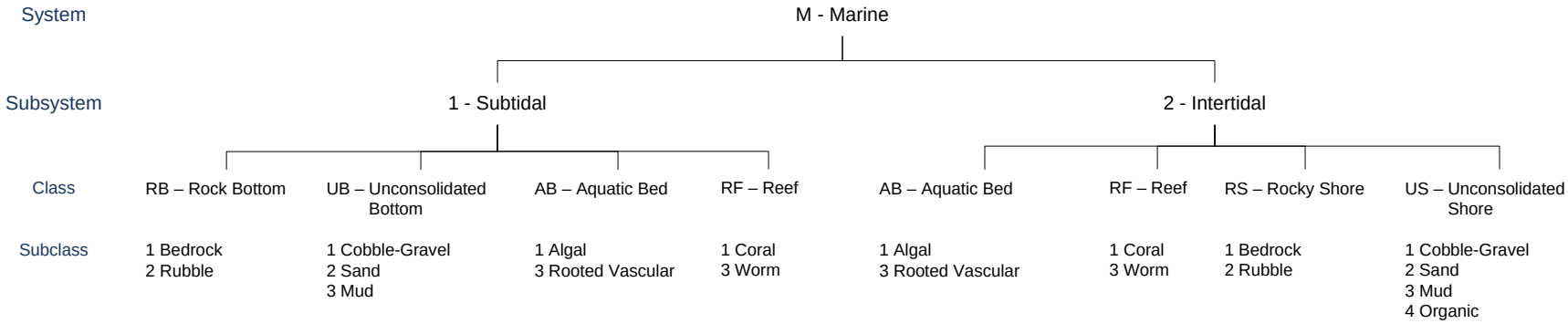
* Preferred NORMAL slide years
** Alternate NORMAL slide years
W -- Preferred WET slide years
IR -- Infrared slides

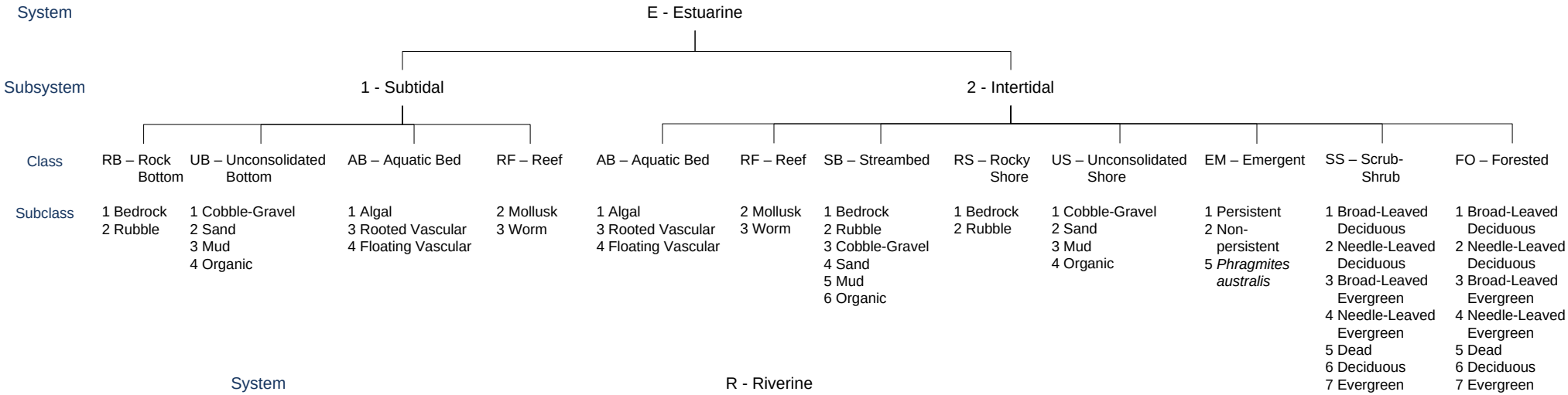
Appendix D

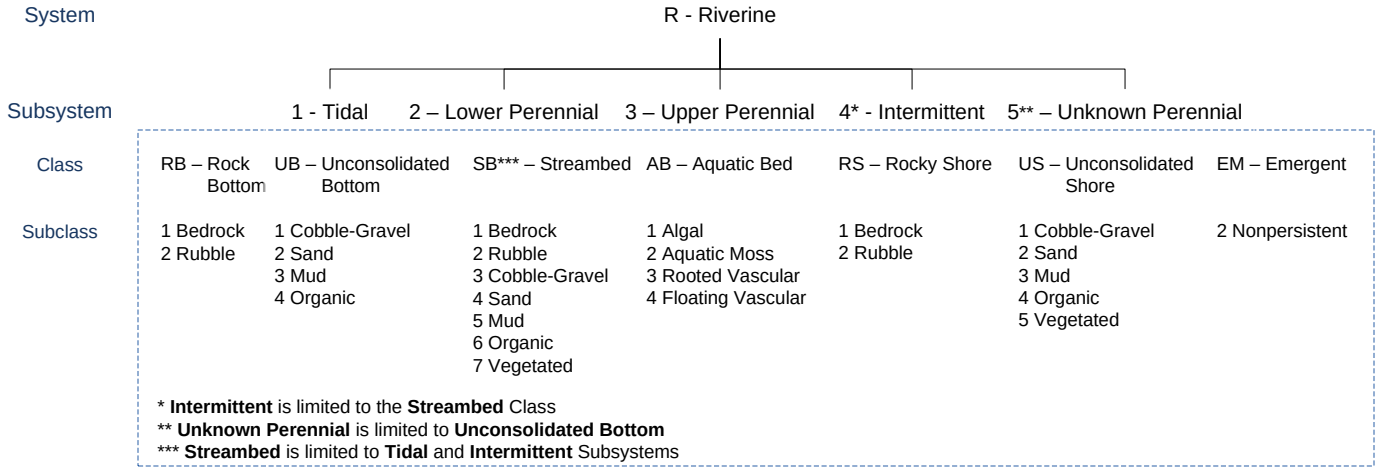
Methodology

3) **Wetlands and Deepwater Habitats Classification system from *Classification of Wetlands and Deepwater Habitats of the United States*, Cowardin *et al*. 1979.**

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION

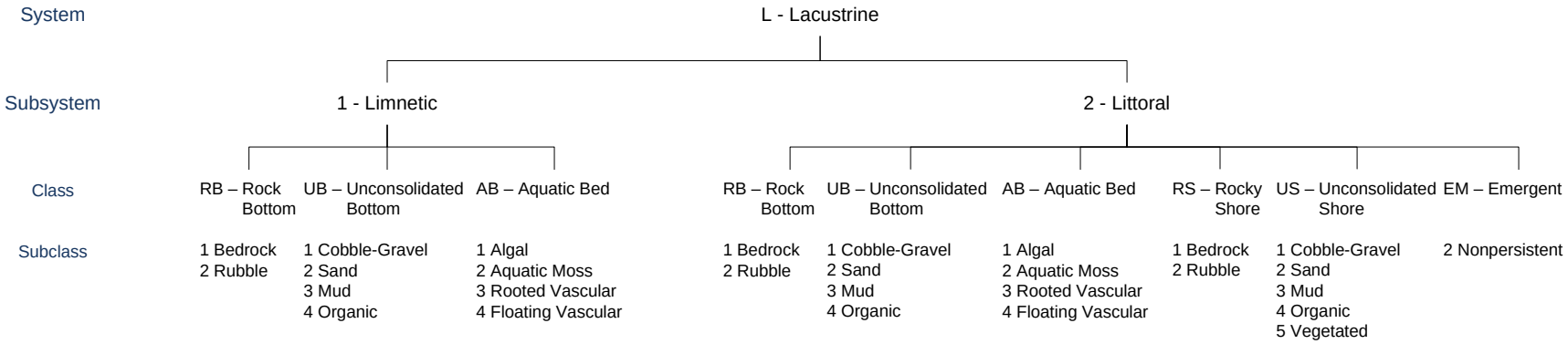


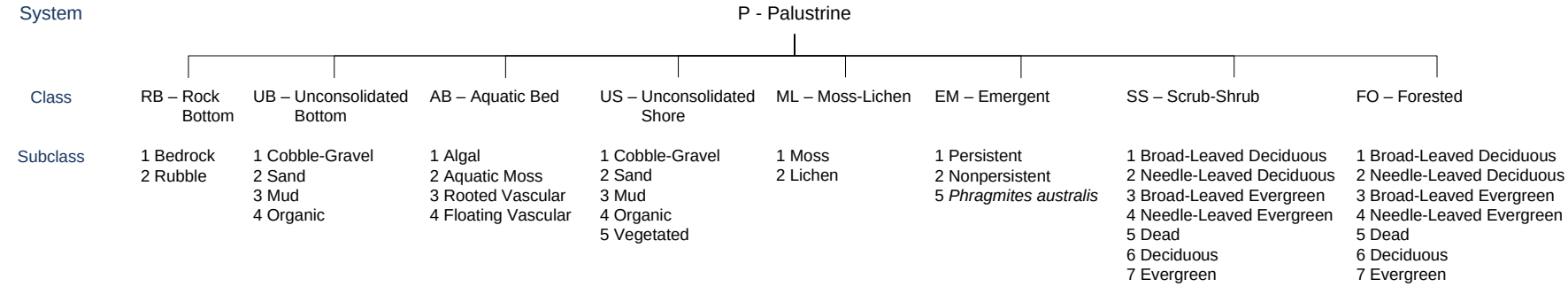




* **Intermittent** is limited to the **Streambed** Class
** **Unknown Perennial** is limited to **Unconsolidated Bottom**
*** **Streambed** is limited to **Tidal** and **Intermittent** Subsystems

WETLANDS AND DEEPWATER HABITATS CLASSIFICATION





MODIFIERS

In order to more adequately describe the wetland and deepwater habitats, one or more of the water regime, water chemistry, soil, or special modifiers may be applied at the class or lower level in the hierarchy. The farmed modifier may also be applied to the ecological system.

Water Regime			Special Modifiers	Water Chemistry			Soil
Nontidal	**Saltwater Tidal**	**Freshwater Tidal**		**Coastal Halinity**	**Inland Salinity**	**pH Modifiers for all Fresh Water**	
A Temporarily Flooded	L Subtidal	S Temporarily Flooded-Tidal	b Beaver	1 Hyperhaline	7 Hypersaline	a Acid	g Organic
B Saturated	M Irregularly Exposed	R Seasonally Flooded-Tidal	d Partly Drained/Ditched	2 Euhaline	8 Eusaline	t Circumneutral	n Mineral
C Seasonally Flooded	N Regularly Flooded	T Semipermanently Flooded-Tidal	f Farmed	3 Mixohaline (Brackish)	9 Mixosaline	l Alkaline	
E Seasonally Flooded/ Saturated	P Irregularly Flooded	V Permanently Flooded-Tidal	h Diked/Impounded	4 Polyhaline	0 Fresh		
F Semipermanently Flooded			r Artificial	5 Mesohaline			
G Intermittently Exposed			s Spoil	6 Oligohaline			
H Permanently Flooded			x Excavated	0 Fresh			
J Intermittently Flooded							
K Artificially Flooded							

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix D

Methodology

4) **USACE 2008 Midwest Supplement Delineation Guidelines:**

   a. **Hydrophytic vegetation determination methods**
   b. **Hydric Soil Indicators for the Land Resource Region M**
   c. **Hydric soil indicator correlation of the 1987 Manual and 2008 Supplement**
   d. **Wetland hydrology indicators for the Midwest Region**

Plot and sample sizes

Hydrophytic vegetation determinations under the Corps Manual are based on samples taken in representative locations within each community. Random sampling of the vegetation is not required except for certain sampling approaches in Comprehensive determinations or in rare cases where representative sampling might give misleading results. For Routine determinations in fairly uniform vegetation, one or more plots in each community are usually sufficient for an accurate determination. Sampling of a multi-layered community is usually accomplished using a graduated series of plots, one for each stratum, or a number of small plots nested within the largest plot (Figure 2). Nested plots to sample the herb stratum can be helpful in forested areas with highly variable understories or in very diverse communities. The smaller plots should be randomly distributed within the large plot, and plant abundance data averaged across the small plots.

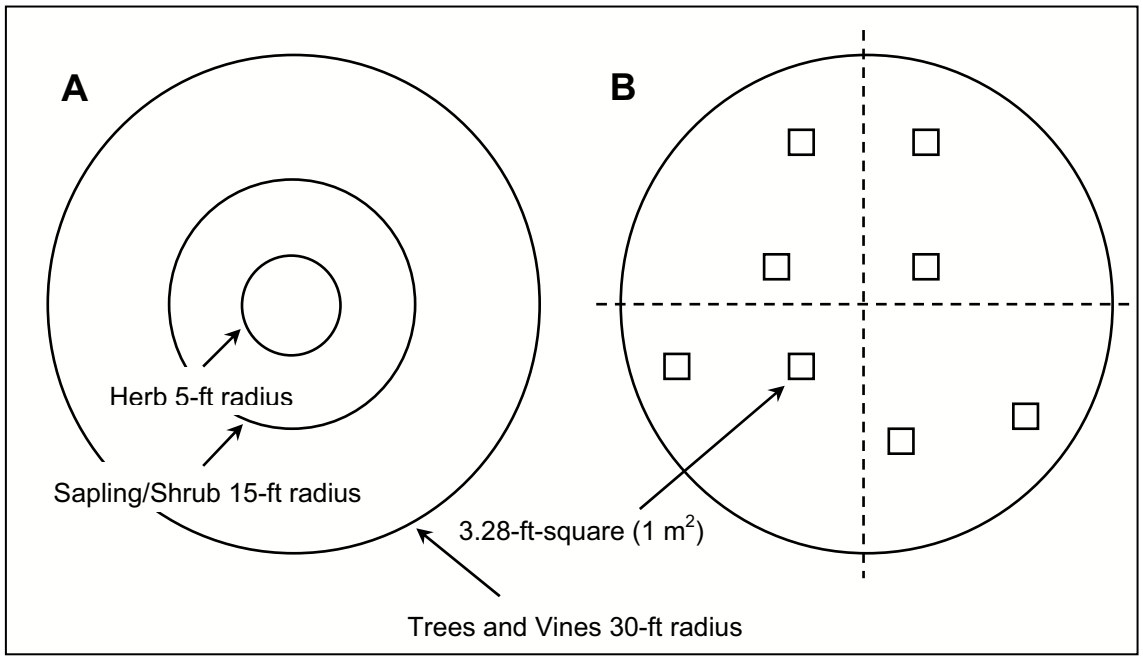


Figure 2. Suggested plot arrangements for vegetation sampling. (A) Single plots in graduated sizes. (B) Nested 3.28- by 3.28-ft square (1-m²) plots for herbs within the 30-ft radius plot.

The appropriate size and shape for a sample plot depend on the type of vegetation (i.e., trees, shrubs, herbaceous plants, etc.) and the size or shape of the plant community or patch being sampled. The size of a plot needs to be large enough to include significant numbers of individuals in all strata, but small enough so that plant species or individuals can be separated and measured without duplication or omission, and the

more than one stratum (e.g., a woody species may be dominant in both the tree and sapling/shrub strata).

Table 2. Example of the selection of dominant species by the 50/20 rule and determination of hydrophytic vegetation by the dominance test.

Stratum	Species Name	Wetland Indicator Status	Absolute Percent Cover	Dominant?
Herb	*Impatiens capensis*	FACW	15	Yes
	Geranium carolinianum	UPL	7	Yes
	Toxicodendron radicans	FAC	5	No
	Lonicera tatarica	FACU	2	No
	Glyceria striata	OBL	2	No
	Parthenocissus quinquefolia	FACU	1	No
	Arisaema triphyllum	FACW	0.5	No
	Carex laxiflora	FACU	0.5	No
		Total cover	33.0	
		50/20 Thresholds: 50% of total cover = 16.5% 20% of total cover = 6.6%		
Sapling/shrub	*Carpinus caroliniana*	FAC	35	Yes
	Carya ovata	FACU	10	No
	Acer saccharum	FACU	5	No
	Quercus rubra	FACU	5	No
		Total cover	55.0	
		50/20 Thresholds: 50% of total cover = 27.5% 20% of total cover = 11.0%		
Tree	*Quercus bicolor*	FACW	40	Yes
	Fraxinus pennsylvanica	FACW	17	Yes
	Ulmus americana	FACW	10	No
	Carya ovata	FACU	8	No
		Total Cover	75.0	
		50/20 Thresholds: 50% of total cover = 37.5% 20% of total cover = 15.0%		
Woody vine	*Toxicodendron radicans*	FAC	1	No[1]
Hydrophytic Vegetation Determination	Total number of dominant species across all strata = 5. Percent of dominant species that are OBL, FACW, or FAC = 80%. Therefore, this community is hydrophytic by Indicator 1 (Dominance Test).			

[1] A stratum with less than 5 percent cover is not considered in the dominance test, unless it is the only stratum present.

Table 3. Example of the Prevalence Index using the same data as in Table 2.

Indicator Status Group	Species name	Absolute Percent Cover by Species	Total Cover by Group	Multiply by:[1]	Product
OBL species	*Glyceria striata*	2	2	1	2
FACW species	*Impatiens capensis* *Arisaema triphyllum* *Quercus bicolor* *Fraxinus pennsylvanica* *Ulmus americana*	15 0.5 40 17 10	82.5	2	165
FAC species	*Toxicodendron radicans*[2] *Carpinus caroliniana*	6 35	41	3	123
FACU species	*Lonicera tatarica* *Parthenocissus quinquefolia* *Carex laxiflora* *Carya ovata*[2] *Acer saccharum* *Quercus rubra*	2 1 0.5 18 5 5	31.5	4	126
UPL species	*Geranium carolinianum*	7	7	5	35
Sum			164 (A)		451 (B)
Hydrophytic Vegetation Determination		Prevalence Index = B/A = 451/164 = 2.75 Therefore, this community is hydrophytic by Indicator 2 (Prevalence Index).			

[1] Where OBL = 1, FACW = 2, FAC = 3, FACU = 4, and UPL = 5.

[2] This species was recorded in two or more strata (see Table 2), so the cover estimates were summed across strata.

Indicator 3: Morphological adaptations

Description: The plant community passes either the dominance test (Indicator 1) or the prevalence index (Indicator 2) after reconsideration of the indicator status of certain plant species that exhibit morphological adaptations for life in wetlands.

User Notes: Some hydrophytes in the Midwest develop easily recognized physical characteristics, or morphological adaptations, when they occur in wetland areas. Some of these adaptations may help them to survive prolonged inundation or saturation in the root zone; others may simply be a consequence of living under such wet conditions. Common morphological adaptations in the Midwest include but are not limited to adventitious roots, multi-stemmed trunks, shallow root systems developed on or near the soil surface, and buttressing in tree species. Users need to be cautious that shallow roots were not caused by erosion or near-surface

HYDRIC SOIL INDICATORS for LAND RESOURCE REGION M
(Errata corrected)

Hydric Soil Indicators for All Soils:

A1. Histosol: 16" or more of the upper 32" is organic soil material.

A2. Histic Epipedon: Surface horizon ≥8" thick of organic soil underlain by mineral soil material with chroma ≤2. Aquic conditions or artificial drainage required.

A3. Black Histic: Layer of peat, mucky peat, or muck ≥8" thick that starts within the upper 6" of the soil surface; has hue of 10YR or yellower, value ≤ 3, and chroma ≤ 1; and is underlain by mineral soil with chroma ≤2.

A4. Hydrogen Sulfide: A hydrogen sulfide odor within 12" of the soil surface.

A5. Stratified Layers: Several stratified layers starting within the upper 6" of the soil surface. At least one of the layers has a value 3 or less with chroma of 1 or less, or it is muck, mucky peat, or peat or has a mucky modified mineral texture. The remaining layers have a chroma ≤ 2. Any sandy material that constitutes the "value of 3 or less with a chroma of 1 or less" layer must have at least 70% of the visible soil particles, coated, covered or similarly masked with organic material.

A10. 2 cm Muck: Layer of muck ≥ 0.75" thick with value ≤ 3 and chroma ≤ 1 and starting within 6" of the soil surface.

A11. Depleted Below Dark Surface: Layer with depleted or gleyed matrix that has 60% or more chroma ≤ 2, starting within 12" of the soil surface, and having a minimum thickness of either: 6" **OR** 2" if the 2" consists of fragmental soil material. Loamy or clayey layers above depleted or gleyed matrix must have value ≤ 3 and chroma ≤ 2. Sandy material above depleted or gleyed matrix must have value ≤ 3 and chroma ≤ 1, and at least 70% of the visible soil particles must be coated or similarly masked with organic material.

A12. Thick Dark Surface: A layer ≥6" thick with a depleted or gleyed matrix that has 60% or more chroma ≤ 2 and starting below 12" of the surface. The layer(s) above depleted or gleyed matrix must have value ≤2.5 and chroma ≤1 to a depth of at least 12" and value ≤3 and chroma ≤1 in any remaining layers above depleted or gleyed matrix. Sandy material above depleted or gleyed matrix must have ≥70% visible soil particles masked with organic material.

Hydric Soil Indicators for Sandy Soil:

S1. Sandy Mucky Mineral: Layer of mucky modified sandy soil material 2" or more thick starting within 6" of the soil surface.

S4. Sandy Gleyed Matrix: Gleyed matrix that occupies 60% or more of a layer starting within 6" of the soil surface.

S5. Sandy Redox: Layer starting within 6" of the soil surface that is at least 4" thick and has matrix with 60% or more chroma $\leq$ 2 or less with 2% or more distinct or prominent redox concentrations occurring as soft masses and/or pore linings.

S6. Stripped Matrix: Layer starting within 6" of the soil surface in which iron-manganese oxides and/or organic matter have been stripped from the matrix and the primary base color of the soil material has been exposed. The stripped area and translocated oxides and/or organic matter from a faint diffuse splotchy pattern of two or more colors. The stripped zones are 10% or more of the volume; they are rounded and approximately 0.5 to 1" in diameter.

Hydric Soil Indicators for Loamy and Clayey Soils:

F1. Loamy Mucky Mineral: layer of mucky modified loamy or clayey soil material 4" or more thick starting within 6" of the soil surface.

F2. Loamy Gleyed Matrix: Gleyed matrix that occupies 60% or more of a layer starting within 12" of the soil surface.

F3. Depleted Matrix: Layer that has a depleted matrix with 60% or more chroma $\leq$2 and has minimum thickness of either: 2" if the 2" is entirely within the upper 6" of the soil, **OR** 6" starting within 10" of the soil surface. Redox concentrations are required in soils with matrix colors of 4/1, 4/1, and 5/2.

F6. Redox Dark Surface: Layer that is at least 4" thick, is entirely within the upper 12" of the mineral soil, and has: matrix value $\leq$3 and chroma $\leq$1and $\geq$2% distinct or prominent redox concentrations, **OR** matrix value $\leq$3 and chroma $\leq$2 and $\geq$5% distinct or prominent redox concentrations. Redox concentrations are required in soils with matrix colors of 4/1, 4/1, and 5/2.

F7. Depleted Dark Surface: Redox depletions with value >5 and chroma <2 in a layer that is at least 4" thick, is entirely within the upper 12" of the mineral soil, and has matrix value $\leq$3 and chroma $\leq$1 and $\geq$10% redox depletions, **OR** matrix value <3 and chroma $\leq$2 and $\geq$20% redox depletions.

F8. Redox Depressions: In closed depressions subject to ponding, $\geq$5% distinct or prominent redox concentrations occurring as soft masses or pore linings in a layer that is $\geq$2" thick and is entirely within the upper 6" of the soil.

Appendix 3: Indicator Correlations

1987 COE Manual	Regional Indicators
Nonsandy soils:	
a. Organic soils (Histosols)	A1 (Histosol or Histel) A3 (Black Histic)
b. Histic epipedon	A2 (Histic Epipedon) A3 (Black Histic)
c. Sulfidic material	A4 (Hydrogen Sulfide)
d. Aquic or peraquic moisture regime	None
e. Reducing soil conditions	F18 (Reduced Vertic)
f (1). Gleyed soils (gray color)	A13 (Alaska Gleyed) A14 (Alaska Redox) A15 (Alaska Gleyed Pores) F2 (Loamy Gleyed Matrix)
f (2). Soils with bright mottles and/or low matrix chroma	F3 (Depleted Matrix) F9 (Vernal Pools) F11 (Depleted Ochric) F16 (High Plains Depressions) F17 (Delta Ochric)
g. Soils appearing on the hydric soils list	None
h. Iron and manganese concretions	F12 (Iron-Manganese Masses)
Sandy soils:	
a. Organic soils (Histosols)	A1 (Histosol or Histel) A3 (Black Histic)
b. Histic epipedon	A2 (Histic Epipedon) A3 (Black Histic)
c. Sulfidic material	A4 (Hydrogen sulfide)
d. Aquic or peraquic moisture regime	None
e. Reducing soil conditions	None
f. Iron and Manganese concretions	None

Appendix 3: Indicator Correlations—Continued

1987 COE Manual	Regional Indicators
Sandy soils—continued	
g. High organic matter content in the surface horizon	A7 (5 cm Mucky Mineral) A8 (Muck Presence) A9 (1 cm Muck) A10 (2 cm Muck) S1 (Sandy Mucky Mineral) S2 (2.5 cm Mucky Peat or Peat) S3 (5 cm Mucky Peat or Peat) S7 (Dark Surface)
h. Streaking of subsurface horizons by organic matter	S6 (Stripped Matrix) S8 (Polyvalue Below Surface)
i. Organic pan	S8 (Polyvalue Below Surface) S9 (Thin Dark Surface)
j. Soils appearing on the hydric soils list	None
Problem soils:	
Sandy soils	A5 (Stratified Layers) A6 (Organic Bodies) A16 (Coast Prairie Redox) S4 (Sandy Gleyed Matrix) S5 (Sandy Redox) S6 (Stripped Matrix) S8 (Polyvalue Below Surface) S9 (Thin Dark Surface)
Soils with thick dark A horizons	A11 (Depleted Below Dark Surface) A12 (Thick Dark Surface) F6 (Redox Dark Surface) F7 (Depleted Dark Surface) F13 (Umbric Surface) F16 (High Plains Depressions) F18 (Reduced Vertic) TA5 (Alaska Alpine Swales)
Soils with red parent material	A16 (Coast Prairie Redox) F8 (Redox Depressions) F9 (Vernal Pools) F12 (Iron-Manganese Masses) F19 (Piedmont Flood Plain Soils) F20 (Anomalous Bright Loamy Soils) TA4 (Alaska Color Change) TF2 (Red Parent Material)
Soils with low-chroma parent material	A13 (Alaska Gleyed) S4 (Sandy Gleyed Matrix) F10 (Marl)

Table 9. Wetland hydrology indicators for the Midwest Region.

Indicator	Category	
	Primary	Secondary
Group A – Observation of Surface Water or Saturated Soils		
A1 – Surface water	X	
A2 – High water table	X	
A3 – Saturation	X	
Group B – Evidence of Recent Inundation		
B1 – Water marks	X	
B2 – Sediment deposits	X	
B3 – Drift deposits	X	
B4 – Algal mat or crust	X	
B5 – Iron deposits	X	
B7 – Inundation visible on aerial imagery	X	
B8 – Sparsely vegetated concave surface	X	
B9 – Water-stained leaves	X	
B13 – Aquatic fauna	X	
B14 – True aquatic plants	X	
B6 – Surface soil cracks		X
B10 – Drainage patterns		X
Group C – Evidence of Current or Recent Soil Saturation		
C1 – Hydrogen sulfide odor	X	
C3 – Oxidized rhizospheres along living roots	X	
C4 – Presence of reduced iron	X	
C6 – Recent iron reduction in tilled soils	X	
C7 – Thin muck surface	X	
C2 – Dry-season water table		X
C8 – Crayfish burrows		X
C9 – Saturation visible on aerial imagery		X
Group D – Evidence from Other Site Conditions or Data		
D9 – Gauge or well data	X	
D1 – Stunted or stressed plants		X
D2 – Geomorphic position		X
D5 – FAC-neutral test		X

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix D

Methodology

5) **Table D-1: Illinois Breeding Bird Atlas---Breeding Status Classification**

Table D-1: Illinois Breeding Bird Atlas---Breeding Status Classification (Kleen et al, 1990)

LEVEL	CODE	EVIDENCE	DESCRIPTION
OBSERVED	OB	Direct Observation	Species (Male or Female) observed during breeding season.
POSSIBLE	PO1	Suitable Habitat	Species (Male or Female) observed in suitable nesting habitat during the breeding season.
	PO2	Singing Male	Singing male observed in suitable habitat during the breeding season.
PROBABLE	PRM	Multiple Males	Multiple Males (7 or more) singing in suitable nesting habitat during the species' breeding season.
	PRP	Pair	Pair in suitable habitat.
	PRT	Territory	Bird or pair on territory, including singing male present at the same location on at least two occasions a week or more apart.
	PRC	Courtship/Copulation	Courtship behavior or copulation.
	PRN	Nest-site	Visiting probable nest-site.
	PRA	Agitation	Agitated behavior or anxiety calls from adult.
	PRB	Nest Building (wrens and peckers)	Nest building by wrens or excavation of holes by woodpeckers.
CONFIRMED	CONB	Nest Building (all other species)	Nest building by all except wrens and woodpeckers.
	COPE	Physiological Evidence	Physiological evidence based upon examination of bird in hand.
	CODD	Distraction Display	Distraction display or injury feigning.
	COUN	Used Nest	Used nest or eggshells found.
	COFL	Fledged Young	Recently fledged young not capable of long flight.
	COON	Occupied Nest	Adults entering or leaving nest site in circumstances indicating occupied nest.
	COFS	Fecal Sac	Adults carrying fecal sac.
	COFY	Food for Young	Adults carrying food for young, or feeding recently fledged young.
	CONE	Nest with Eggs	Nest with eggs.
	CONY	Nest with Young	Nest with young (seen or heard).

Appendix D

Methodology

6) **Access notification letter sent by the Illinois Department of Transportation (IDOT) to all landowners within the study area.**

Illinois Department of Transportation
Division of Aeronautics
1 Langhorne Bond Drive / Springfield, Illinois / 62707-8415

Date

Name
Address
City, Illinois Zip Code

Re: South Suburban Airport (SSA)
Peotone, Illinois
Wetland / Stream Surveys
PIN Number

Dear Landowner:

The State of Illinois is in the process of conducting an Airport Master Plan for the possible development of a supplemental, commercial service airport to serve the Chicago region. As a part of the Airport Master Plan an Environmental Impact Statement (EIS) is required by the Federal Aviation Administration. We are required to survey the existing wetlands and streams, to determine if there are any potential impacts to those resources.

This letter is to inform you that personnel from the firm of Earth Tech | AECOM at 10 South Riverside Plaza, Suite 1900, Chicago, Illinois 60606 have been retained by the State of Illinois, acting through the Illinois Department of Transportation, Division of Aeronautics, to conduct wetland and stream surveys within the Inaugural Airport property limits and as such will need to access your property.

As provided in Illinois State Statute 620 ILCS 5/36, *"Right to enter upon the land, buildings and structures of others"* Earth Tech, as agent of the State of Illinois **"shall have the right to enter upon the land within this State of any person, municipality or other political subdivision and enter the buildings and structures thereon for the purposes, when and to the extent that their duty so requires, of making surveys, ascertaining necessary facts, and making investigations relating to the State airport plan,…"** The complete citation is attached herein.

All wetland and stream surveyors will be carrying identification and if you have any questions please contact Peter Quattrocchi, Project Manager at the South Suburban Airport Project Office at (708) 258-6783. Additional information can be found on the SSA web site at www.southsuburbanairport.com.

We appreciate your cooperation in allowing our surveyors onto your property.

Sincerely,

Susan R. Shea, Ph.D.
Director

Attachment

(620 ILCS 5/36) (from Ch. 15 1/2, par. 22.36)

Sec. 36. Right to enter upon the land, buildings and structures of others. In exercising its powers and performing its functions under the laws of this State pertaining to aeronautics, and the rules, rulings, regulations, orders and decisions issued pursuant thereto, the Department, each officer thereof, and each employee designated by it, and such other departments, agencies, representatives, officers and employees of this State and of the municipalities and other political subdivisions thereof as may be designated by it, or who are charged with the enforcement of the laws of this State pertaining to aeronautics, whether or not designated by the Department to do so, shall have the right to enter upon the land within this State of any person, municipality or other political subdivision and enter the buildings and structures thereon for the purposes, when and to the extent that their duty so requires, of making surveys, ascertaining necessary facts, and making investigations relating to the State airport plan, a proposed or existing air navigation facility, any airport hazard, the obtaining of airport protection privileges, the establishment of zoning areas, the investigation of accidents concerning aircraft in this State, the condemning of property, the investigation of any violation of the laws of this State pertaining to aeronautics and the rules, rulings, regulations, orders and decisions issued pursuant thereto, and for any other purpose within the purview of the laws of this State pertaining to aeronautics and the rules, rulings, regulations, orders and decisions issued pursuant thereto; provided that such entry shall occur at reasonable times and with due regard for the safety of the owner, persons in possession or occupants thereof, and the protection of the buildings, structures, crops, or personal property located thereon; provided, further, that in the event any damage may be caused by virtue of any such entry, the Department may pay, as compensation, the amount of said damage as determined by it, in full satisfaction thereof, within the limits of available appropriations, or, if the Department does not pay the amount of any such damage, the person claiming compensation therefore may file his claim in connection therewith in the Court of Claims of this State.

(Source: P.A. 92-341, eff. 8-10-01.)

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK

Appendix D

Methodology

7) **USACE memorandum dated December 2, 2008 containing guidelines for interpreting Clean Water Act jurisdiction:** ***Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States***

Clean Water Act Jurisdiction Following the U.S. Supreme Court's Decision in Rapanos v. United States & Carabell v. United States

This memorandum[1] provides guidance to EPA regions and U.S. Army Corps of Engineers ["Corps"] districts implementing the Supreme Court's decision in the consolidated cases Rapanos v. United States and Carabell v. United States[2] (herein referred to simply as "Rapanos") which address the jurisdiction over waters of the United States under the Clean Water Act.[3] The chart below summarizes the key points contained in this memorandum. This reference tool is not a substitute for the more complete discussion of issues and guidance furnished throughout the memorandum.

Summary of Key Points

The agencies will assert jurisdiction over the following waters:

- **Traditional navigable waters**
- **Wetlands adjacent to traditional navigable waters**
- **Non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months)**
- **Wetlands that directly abut such tributaries**

The agencies will decide jurisdiction over the following waters based on a fact-specific analysis to determine whether they have a significant nexus with a traditional navigable water:

- **Non-navigable tributaries that are not relatively permanent**
- **Wetlands adjacent to non-navigable tributaries that are not relatively permanent**
- **Wetlands adjacent to but that do not directly abut a relatively permanent non-navigable tributary**

The agencies generally will not assert jurisdiction over the following features:

- **Swales or erosional features (e.g., gullies, small washes characterized by low volume, infrequent, or short duration flow)**
- **Ditches (including roadside ditches) excavated wholly in and draining only uplands and that do not carry a relatively permanent flow of water**

The agencies will apply the significant nexus standard as follows:

- **A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by all wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical and biological integrity of downstream traditional navigable waters**
- **Significant nexus includes consideration of hydrologic and ecologic factors**

[1] This guidance incorporates revisions to the EPA/Army Memorandum originally issued on June 6, 2007, after careful consideration of public comments received and based on the agencies' experience in implementing the *Rapanos* decision.

[2] 126 S. Ct. 2208 (2006).

[3] 33 U.S.C. §1251 et seq.

Background

Congress enacted the Clean Water Act ("CWA" or "the Act") "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters."[4] One of the mechanisms adopted by Congress to achieve that purpose is a prohibition on the discharge of any pollutants, including dredged or fill material, into "navigable waters" except in compliance with other specified sections of the Act.[5] In most cases, this means compliance with a permit issued pursuant to CWA §402 or §404. The Act defines the term "discharge of a pollutant" as "any addition of any pollutant to navigable waters from any point source[,]"[6] and provides that "[t]he term 'navigable waters' means the waters of the United States, including the territorial seas[,]." [7]

In Rapanos, the Supreme Court addressed where the Federal government can apply the Clean Water Act, specifically by determining whether a wetland or tributary is a "water of the United States." The justices issued five separate opinions in Rapanos (one plurality opinion, two concurring opinions, and two dissenting opinions), with no single opinion commanding a majority of the Court.

The Rapanos Decision

Four justices, in a plurality opinion authored by Justice Scalia, rejected the argument that the term "waters of the United States" is limited to only those waters that are navigable in the traditional sense and their abutting wetlands.[8] However, the plurality concluded that the agencies' regulatory authority should extend only to "relatively permanent, standing or continuously flowing bodies of water" connected to traditional navigable waters, and to "wetlands with a continuous surface connection to" such relatively permanent waters.[9]

Justice Kennedy did not join the plurality's opinion but instead authored an opinion concurring in the judgment vacating and remanding the cases to the Sixth Circuit Court of Appeals.[10] Justice Kennedy agreed with the plurality that the statutory term "waters of the United States" extends beyond water bodies that are traditionally considered navigable.[11] Justice Kennedy, however, found the plurality's interpretation of the scope of the CWA to be "inconsistent with the Act's text, structure, and purpose[,]" and he instead presented a different standard for evaluating CWA jurisdiction over wetlands and other water bodies.[12] Justice Kennedy concluded that wetlands are "waters

---

[4] 33 U.S.C. § 1251(a).
[5] 33 U.S.C. § 1311(a), §1362(12)(A).
[6] 33 U.S.C. § 1362(12)(A)
[7] 33 U.S.C. § 1362(7). See also 33 C.F.R. § 328.3(a) and 40 C.F.R. § 230.3(s).
[8] Id. at 2220.
[9] Id. at 2225-27.
[10] Id. at 2236-52. While Justice Kennedy concurred in the Court's decision to vacate and remand the cases to the Sixth Circuit, his basis for remand was limited to the question of "whether the specific wetlands at issue possess a significant nexus with navigable waters." 126 S. Ct. at 2252. In contrast, the plurality remanded the cases to determine both "whether the ditches and drains near each wetland are 'waters,'" and "whether the wetlands in question are 'adjacent' to these 'waters' in the sense of possessing a continuous surface connection...." Id. at 2235.
[11] Id. at 2241.
[12] Id. at 2246.

of the United States" "if the wetlands, either alone or in combination with similarly situated lands in the region, significantly affect the chemical, physical, and biological integrity of other covered waters more readily understood as 'navigable.' When, in contrast, wetlands' effects on water quality are speculative or insubstantial, they fall outside the zone fairly encompassed by the statutory term 'navigable waters.'"[13]

Four justices, in a dissenting opinion authored by Justice Stevens, concluded that EPA's and the Corps' interpretation of "waters of the United States" was a reasonable interpretation of the Clean Water Act.[14]

When there is no majority opinion in a Supreme Court case, controlling legal principles may be derived from those principles espoused by five or more justices.[15] Thus, regulatory jurisdiction under the CWA exists over a water body if either the plurality's or Justice Kennedy's standard is satisfied.[16] Since Rapanos, the United States has filed pleadings in a number of cases interpreting the decision in this manner.

The agencies are issuing this memorandum in recognition of the fact that EPA regions and Corps districts need guidance to ensure that jurisdictional determinations, permitting actions, and other relevant actions are consistent with the decision and supported by the administrative record. Therefore, the agencies have evaluated the Rapanos opinions to identify those waters that are subject to CWA jurisdiction under the reasoning of a majority of the justices. This approach is appropriate for a guidance document. The agencies will continue to monitor implementation of the Rapanos decision in the field and recognize that further consideration of jurisdictional issues, including clarification and definition of key terminology, may be appropriate in the future, either through issuance of additional guidance or through rulemaking.

---

[13] Id. at 2248. Chief Justice Roberts wrote a separate concurring opinion explaining his agreement with the plurality. See 126 S. Ct. at 2235-36.

[14] Id. at 2252-65. Justice Breyer wrote a separate dissenting opinion explaining his agreement with Justice Stevens' dissent. See 126 S. Ct. at 2266.

[15] See Marks v. United States, 430 U.S. 188, 193-94 (1977); Waters v. Churchill, 511 U.S. 661, 685 (1994) (Souter, J., concurring) (analyzing the points of agreement between plurality, concurring, and dissenting opinions to identify the legal "test ... that lower courts should apply," under Marks, as the holding of the Court); cf. League of United Latin American Citizens v. Perry, 126 S. Ct. 2594, 2607 (2006) (analyzing concurring and dissenting opinions in a prior case to identify a legal conclusion of a majority of the Court); Alexander v. Sandoval, 532 U.S. 275, 281-282 (2001) (same).

[16] 126 S. Ct. at 2265 (Stevens, J., dissenting) ("Given that all four justices who have joined this opinion would uphold the Corps' jurisdiction in both of these cases – and in all other cases in which either the plurality's or Justice Kennedy's test is satisfied – on remand each of the judgments should be reinstated *if either* of those tests is met.") (emphasis in original). The agencies recognize that the Eleventh Circuit, in United States v. McWane, Inc., et al., 505 F.3d 1208 (11th Cir. 2007), has concluded that the Kennedy standard is the sole method of determining CWA jurisdiction in that Circuit. The Supreme Court denied the government's petition for a writ of *certiorari* on December 1, 2008.

Agency Guidance[17]

To ensure that jurisdictional determinations, administrative enforcement actions, and other relevant agency actions are consistent with the Rapanos decision, the agencies in this guidance address which waters are subject to CWA § 404 jurisdiction.[18] Specifically, this guidance identifies those waters over which the agencies will assert jurisdiction categorically and on a case-by-case basis, based on the reasoning of the Rapanos opinions.[19] EPA and the Corps will continually assess and review the application of this guidance to ensure nationwide consistency, reliability, and predictability in our administration of the statute.

1. Traditional Navigable Waters (i.e., "(a)(1) Waters") and Their Adjacent Wetlands

Key Points

- **The agencies will assert jurisdiction over traditional navigable waters, which includes all the waters described in 33 C.F.R. § 328.3(a)(1), and 40 C.F.R. § 230.3 (s)(1).**
- **The agencies will assert jurisdiction over wetlands adjacent to traditional navigable waters, including over adjacent wetlands that do not have a continuous surface connection to traditional navigable waters.**

EPA and the Corps will continue to assert jurisdiction over "[a]ll waters which are currently used, or were used in the past, or may be susceptible to use in interstate or

[17] The CWA provisions and regulations described in this document contain legally binding requirements. This guidance does not substitute for those provisions or regulations, nor is it a regulation itself. It does not impose legally binding requirements on EPA, the Corps, or the regulated community, and may not apply to a particular situation depending on the circumstances. Any decisions regarding a particular water will be based on the applicable statutes, regulations, and case law. Therefore, interested persons are free to raise questions about the appropriateness of the application of this guidance to a particular situation, and EPA and/or the Corps will consider whether or not the recommendations or interpretations of this guidance are appropriate in that situation based on the statutes, regulations, and case law.

[18] This guidance focuses only on those provisions of the agencies' regulations at issue in Rapanos -- 33 C.F.R. §§ 328.3(a)(1), (a)(5), and (a)(7); 40 C.F.R. §§ 230.3(s)(1), (s)(5), and (s)(7). This guidance does not address or affect other subparts of the agencies' regulations, or response authorities, relevant to the scope of jurisdiction under the CWA. In addition, because this guidance is issued by both the Corps and EPA, which jointly administer CWA § 404, it does not discuss other provisions of the CWA, including §§ 311 and 402, that differ in certain respects from § 404 but share the definition of "waters of the United States." Indeed, the plurality opinion in Rapanos noted that "... there is no reason to suppose that our construction today significantly affects the enforcement of §1342 ... The Act does not forbid the 'addition of any pollutant *directly* to navigable waters from any point source,' but rather the 'addition of any pollutant *to* navigable waters.'" (emphasis in original) 126 S. Ct. 2208, 2227. EPA is considering whether to provide additional guidance on these and other provisions of the CWA that may be affected by the Rapanos decision.

[19] In 2001, the Supreme Court held that use of "isolated" non-navigable intrastate waters by migratory birds was not by itself a sufficient basis for the exercise of federal regulatory jurisdiction under the CWA. See Solid Waste Agency of Northern Cook County (SWANCC) v. U.S. Army Corps of Engineers, 531 U.S. 159 (2001). This guidance does not address SWANCC, nor does it affect the Joint Memorandum regarding that decision issued by the General Counsels of EPA and the Department of the Army on January 10, 2003. See 68 Fed. Reg. 1991, 1995 (Jan. 15, 2003).

foreign commerce, including all waters which are subject to the ebb and flow of the tide."[20] These waters are referred to in this guidance as traditional navigable waters.

The agencies will also continue to assert jurisdiction over wetlands "adjacent" to traditional navigable waters as defined in the agencies' regulations. Under EPA and Corps regulations and as used in this guidance, "adjacent" means "bordering, contiguous, or neighboring." Finding a continuous surface connection is not required to establish adjacency under this definition. The Rapanos decision does not affect the scope of jurisdiction over wetlands that are adjacent to traditional navigable waters because at least five justices agreed that such wetlands are "waters of the United States."[21]

The regulations define "adjacent" as follows: "The term *adjacent* means bordering, contiguous, or neighboring. Wetlands separated from other waters of the United States by man-made dikes or barriers, natural river berms, beach dunes and the like are 'adjacent wetlands.'"[22] Under this definition, the agencies consider wetlands adjacent if one of following three criteria is satisfied. First, there is an unbroken surface or shallow sub-surface connection to jurisdictional waters. This hydrologic connection may be intermittent. Second, they are physically separated from jurisdictional waters by man-made dikes or barriers, natural river berms, beach dunes, and the like. Or third, their proximity to a jurisdictional water is reasonably close, supporting the science-based

---

[20] 33 C.F.R. § 328.3(a)(1); 40 C.F.R. § 230.3(s)(1). The "(a)(1)" waters include all of the "navigable waters of the United States," defined in 33 C.F.R. Part 329 and by numerous decisions of the federal courts, plus all other waters that are navigable-in-fact (e.g., the Great Salt Lake, UT and Lake Minnetonka MN). For purposes of CWA jurisdiction and this guidance, waters will be considered traditional navigable waters if:

- They are subject to Section 9 or 10 of the Rivers and Harbors Act, or
- A federal court has determined that the water body is navigable-in-fact under federal law, or
- They are waters currently being used for commercial navigation, including commercial water-borne recreation (e.g., boat rentals, guided fishing trips, water ski tournaments, etc.), or
- They have historically been used for commercial navigation, including commercial water-borne recreation; or
- They are susceptible to being used in the future for commercial navigation, including commercial water-borne recreation. Susceptibility for future use may be determined by examining a number of factors, including the physical characteristics and capacity of the water (e.g., size, depth, and flow velocity, etc.) to be used in commercial navigation, including commercial recreational navigation, and the likelihood of future commercial navigation or commercial water-borne recreation. Evidence of future commercial navigation use, including commercial water-borne recreation (e.g., development plans, plans for water dependent events, etc.), must be clearly documented. Susceptibility to future commercial navigation, including commercial water-borne recreation, will not be supported when the evidence is insubstantial or speculative. Use of average flow statistics may not accurately represent streams with "flashy" flow characteristics. In such circumstances, daily gage data is more representative of flow characteristics.

[21] Id. at 2248 (Justice Kennedy, concurring) ("As applied to wetlands adjacent to navigable-in-fact waters, the Corps' conclusive standard for jurisdiction rests upon a reasonable inference of ecologic interconnection, and the assertion of jurisdiction for those wetlands is sustainable under the Act by showing adjacency alone.").

[22] 33 C.F.R. § 328.3(c).

inference that such wetlands have an ecological interconnection with jurisdictional waters.[23] Because of the scientific basis for this inference, determining whether a wetland is reasonably close to a jurisdictional water does not generally require a case-specific demonstration of an ecologic interconnection. In the case of a jurisdictional water and a reasonably close wetland, such implied ecological interconnectivity is neither speculative nor insubstantial. For example, species, such as amphibians or anadramous and catadramous fish, move between such waters for spawning and their life stage requirements. Migratory species, however, shall not be used to support an ecologic interconnection. In assessing whether a wetland is reasonably close to a jurisdictional water, the proximity of the wetland (including all parts of a single wetland that has been divided by road crossings, ditches, berms, etc.) in question will be evaluated and shall not be evaluated together with other wetlands in the area.

2. Relatively Permanent Non-navigable Tributaries of Traditional Navigable Waters and Wetlands with a Continuous Surface Connection with Such Tributaries

Key Points

- **The agencies will assert jurisdiction over non-navigable tributaries of traditional navigable waters that are relatively permanent where the tributaries typically flow year-round or have continuous flow at least seasonally (e.g., typically three months).**
- **The agencies will assert jurisdiction over those adjacent wetlands that have a continuous surface connection to such tributaries (e.g., they are not separated by uplands, a berm, dike, or similar feature.)**

A non-navigable tributary[24] of a traditional navigable water is a non-navigable water body whose waters flow into a traditional navigable water either directly or indirectly by means of other tributaries. Both the plurality opinion and the dissent would uphold CWA jurisdiction over non-navigable tributaries that are "relatively permanent" – waters that typically (e.g., except due to drought) flow year-round or waters that have a

[23] See e.g., United States v. Riverside Bayview Homes, Inc., 474 U.S. 121, 134 (1985) ("...the Corps' ecological judgment about the relationship between waters and their adjacent wetlands provides an adequate basis for a legal judgment that adjacent wetlands may be defined as waters under the Act.").

[24] A tributary includes natural, man-altered, or man-made water bodies that carry flow directly or indirectly into a traditional navigable water. Furthermore, a tributary, for the purposes of this guidance, is the entire reach of the stream that is of the same order (i.e., from the point of confluence, where two lower order streams meet to form the tributary, downstream to the point such tributary enters a higher order stream). The flow characteristics of a particular tributary generally will be evaluated at the farthest downstream limit of such tributary (i.e., the point the tributary enters a higher order stream). However, for purposes of determining whether the tributary is relatively permanent, where data indicates the flow regime at the downstream limit is not representative of the entire tributary (as described above) (e.g., where data indicates the tributary is relatively permanent at its downstream limit but not for the majority of its length, or vice versa), the flow regime that best characterizes the entire tributary should be used. A primary factor in making this determination is the relative lengths of segments with differing flow regimes. It is reasonable for the agencies to treat the entire tributary in light of the Supreme Court's observation that the phrase "navigable waters" generally refers to "rivers, streams, and other hydrographic features." 126 S. Ct. at 2222 (Justice Scalia, quoting Riverside Bayview, 474 U.S. at 131). The entire reach of a stream is a reasonably identifiable hydrographic feature. The agencies will also use this characterization of tributary when applying the significant nexus standard under Section 3 of this guidance.

continuous flow at least seasonally (e.g., typically three months).[25] Justice Scalia emphasizes that relatively permanent waters do not include tributaries "whose flow is 'coming and going at intervals ... broken, fitful.'"[26] Therefore, "relatively permanent" waters do not include ephemeral tributaries which flow only in response to precipitation and intermittent streams which do not typically flow year-round or have continuous flow at least seasonally. However, CWA jurisdiction over these waters will be evaluated under the significant nexus standard described below. The agencies will assert jurisdiction over relatively permanent non-navigable tributaries of traditional navigable waters without a legal obligation to make a significant nexus finding.

In addition, the agencies will assert jurisdiction over those adjacent wetlands that have a continuous surface connection with a relatively permanent, non-navigable tributary, without the legal obligation to make a significant nexus finding. As explained above, the plurality opinion and the dissent agree that such wetlands are jurisdictional.[27] The plurality opinion indicates that "continuous surface connection" is a "physical connection requirement."[28] Therefore, a continuous surface connection exists between a wetland and a relatively permanent tributary where the wetland directly abuts the tributary (e.g., they are not separated by uplands, a berm, dike, or similar feature).[29]

---

[25] See 126 S. Ct. at 2221 n. 5 (Justice Scalia, plurality opinion) (explaining that "relatively permanent" does not necessarily exclude waters "that might dry up in extraordinary circumstances such as drought" or "seasonal rivers, which contain continuous flow during some months of the year but no flow during dry months").

[26] Id. (internal citations omitted)

[27] Id. at 2226-27 (Justice Scalia, plurality opinion).

[28] Id. at 2232 n.13 (referring to "our physical-connection requirement" and later stating that Riverside Bayview does not reject "the physical-connection requirement") and 2234 ("Wetlands are 'waters of the United States' if they bear the 'significant nexus' of physical connection, which makes them as a practical matter *indistinguishable* from waters of the United States.") (emphasis in original). See also 126 S. Ct. at 2230 ("adjacent" means "physically abutting") and 2229 (citing to Riverside Bayview as "confirm[ing] that the scope of ambiguity of 'the waters of the United States' is determined by a wetland's *physical connection* to covered waters...") (emphasis in original). A continuous surface connection does not require surface water to be continuously present between the wetland and the tributary. 33 C.F.R. § 328.3(b) and 40 C.F.R. § 232.2 (defining wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support ... a prevalence of vegetation typically adapted for life in saturated soil conditions").

[29] While all wetlands that meet the agencies' definitions are considered adjacent wetlands, only those adjacent wetlands that have a continuous surface connection because they directly abut the tributary (e.g., they are not separated by uplands, a berm, dike, or similar feature) are considered jurisdictional under the plurality standard.

3. Certain Adjacent Wetlands and Non-navigable Tributaries That Are Not Relatively Permanent

Key Points

- **The agencies will assert jurisdiction over non-navigable, not relatively permanent tributaries and their adjacent wetlands where such tributaries and wetlands have a significant nexus to a traditional navigable water.**
- **A significant nexus analysis will assess the flow characteristics and functions of the tributary itself and the functions performed by any wetlands adjacent to the tributary to determine if they significantly affect the chemical, physical and biological integrity of downstream traditional navigable waters.**
- **"Similarly situated" wetlands include all wetlands adjacent to the same tributary.**
- **Significant nexus includes consideration of hydrologic factors including the following:**
  - **volume, duration, and frequency of flow, including consideration of certain physical characteristics of the tributary**
  - **proximity to the traditional navigable water**
  - **size of the watershed**
  - **average annual rainfall**
  - **average annual winter snow pack**
- **Significant nexus also includes consideration of ecologic factors including the following:**
  - **potential of tributaries to carry pollutants and flood waters to traditional navigable waters**
  - **provision of aquatic habitat that supports a traditional navigable water**
  - **potential of wetlands to trap and filter pollutants or store flood waters**
  - **maintenance of water quality in traditional navigable waters**
- **The following geographic features generally are not jurisdictional waters:**
  - **swales or erosional features (e.g. gullies, small washes characterized by low volume, infrequent, or short duration flow)**
  - **ditches (including roadside ditches) excavated wholly in and draining only uplands and that do not carry a relatively permanent flow of water**

The agencies will assert jurisdiction over the following types of waters when they have a significant nexus with a traditional navigable water: (1) non-navigable tributaries that are not relatively permanent,[30] (2) wetlands adjacent to non-navigable tributaries that are not relatively permanent, and (3) wetlands adjacent to, but not directly abutting, a relatively permanent tributary (e.g., separated from it by uplands, a berm, dike or similar feature).[31] As described below, the agencies will assess the flow characteristics and functions of the tributary itself, together with the functions performed by any wetlands adjacent to that tributary, to determine whether collectively they have a significant nexus with traditional navigable waters.

[30] For simplicity, the term "tributary" when used alone in this section refers to non-navigable tributaries that are not relatively permanent.

[31] As described in Section 2 of this guidance, the agencies will assert jurisdiction, without the need for a significant nexus finding, over all wetlands that are both adjacent and have a continuous surface connection to relatively permanent tributaries. See pp. 6-7, supra.

The agencies' assertion of jurisdiction over non-navigable tributaries and adjacent wetlands that have a significant nexus to traditional navigable waters is supported by five justices. Justice Kennedy applied the significant nexus standard to the wetlands at issue in Rapanos and Carabell: "[W]etlands possess the requisite nexus, and thus come within the statutory phrase 'navigable waters,' if the wetlands, either alone or in combination with similarly situated lands in the region, significantly affect the chemical, physical, and biological integrity of other covered waters more readily understood as 'navigable.'"[32] While Justice Kennedy's opinion discusses the significant nexus standard primarily in the context of wetlands adjacent to non-navigable tributaries,[33] his opinion also addresses Clean Water Act jurisdiction over tributaries themselves. Justice Kennedy states that, based on the Supreme Court's decisions in Riverside Bayview and SWANCC, "the connection between a non-navigable water or wetland may be so close, or potentially so close, that the Corps may deem the water or wetland a 'navigable water' under the Act. ... Absent a significant nexus, jurisdiction under the Act is lacking."[34] Thus, Justice Kennedy would limit jurisdiction to those waters that have a significant nexus with traditional navigable waters, although his opinion focuses on the specific factors and functions the agencies should consider in evaluating significant nexus for adjacent wetlands, rather than for tributaries.

In considering how to apply the significant nexus standard, the agencies have focused on the integral relationship between the ecological characteristics of tributaries and those of their adjacent wetlands, which determines in part their contribution to restoring and maintaining the chemical, physical and biological integrity of the Nation's traditional navigable waters. The ecological relationship between tributaries and their adjacent wetlands is well documented in the scientific literature and reflects their physical proximity as well as shared hydrological and biological characteristics. The flow parameters and ecological functions that Justice Kennedy describes as most relevant to an evaluation of significant nexus result from the ecological inter-relationship between tributaries and their adjacent wetlands. For example, the duration, frequency, and volume of flow in a tributary, and subsequently the flow in downstream navigable waters, is directly affected by the presence of adjacent wetlands that hold floodwaters, intercept sheet flow from uplands, and then release waters to tributaries in a more even and constant manner. Wetlands may also help to maintain more consistent water temperature in tributaries, which is important for some aquatic species. Adjacent wetlands trap and hold pollutants that may otherwise reach tributaries (and downstream navigable waters) including sediments, chemicals, and other pollutants. Tributaries and their adjacent wetlands provide habitat (e.g., feeding, nesting, spawning, or rearing young) for many aquatic species that also live in traditional navigable waters.

---

[32] Id. at 2248. When applying the significant nexus standard to tributaries and wetlands, it is important to apply it within the limits of jurisdiction articulated in SWANCC. Justice Kennedy cites SWANCC with approval and asserts that the significant nexus standard, rather than being articulated for the first time in Rapanos, was established in SWANCC. 126 S. Ct. at 2246 (describing SWANCC as "interpreting the Act to require a significant nexus with navigable waters"). It is clear, therefore, that Justice Kennedy did not intend for the significant nexus standard to be applied in a manner that would result in assertion of jurisdiction over waters that he and the other justices determined were not jurisdictional in SWANCC. Nothing in this guidance should be interpreted as providing authority to assert jurisdiction over waters deemed non-jurisdictional by SWANCC.

[33] 126 S. Ct. at 2247-50.

[34] Id. at 2241 (emphasis added).

When performing a significant nexus analysis,[35] the first step is to determine if the tributary has any adjacent wetlands. Where a tributary has no adjacent wetlands, the agencies will consider the flow characteristics and functions of only the tributary itself in determining whether such tributary has a significant effect on the chemical, physical and biological integrity of downstream traditional navigable waters. A tributary, as characterized in Section 2 above, is the entire reach of the stream that is of the same order (i.e., from the point of confluence, where two lower order streams meet to form the tributary, downstream to the point such tributary enters a higher order stream). For purposes of demonstrating a connection to traditional navigable waters, it is appropriate and reasonable to assess the flow characteristics of the tributary at the point at which water is in fact being contributed to a higher order tributary or to a traditional navigable water. If the tributary has adjacent wetlands, the significant nexus evaluation needs to recognize the ecological relationship between tributaries and their adjacent wetlands, and their closely linked role in protecting the chemical, physical, and biological integrity of downstream traditional navigable waters.

Therefore, the agencies will consider the flow and functions of the tributary together with the functions performed by all the wetlands adjacent to that tributary in evaluating whether a significant nexus is present. Similarly, where evaluating significant nexus for an adjacent wetland, the agencies will consider the flow characteristics and functions performed by the tributary to which the wetland is adjacent along with the functions performed by the wetland and all other wetlands adjacent to that tributary. This approach reflects the agencies' interpretation of Justice Kennedy's term "similarly situated" to include all wetlands adjacent to the same tributary. Where it is determined that a tributary and its adjacent wetlands collectively have a significant nexus with traditional navigable waters, the tributary and all of its adjacent wetlands are jurisdictional. Application of the significant nexus standard in this way is reasonable because of its strong scientific foundation – that is, the integral ecological relationship between a tributary and its adjacent wetlands. Interpreting the phrase "similarly situated" to include all wetlands adjacent to the same tributary is reasonable because such wetlands are physically located in a like manner (i.e., lying adjacent to the same tributary).

Principal considerations when evaluating significant nexus include the volume, duration, and frequency of the flow of water in the tributary and the proximity of the tributary to a traditional navigable water. In addition to any available hydrologic information (e.g., gauge data, flood predictions, historic records of water flow, statistical data, personal observations/records, etc.), the agencies may reasonably consider certain physical characteristics of the tributary to characterize its flow, and thus help to inform the determination of whether or not a significant nexus is present between the tributary and downstream traditional navigable waters. Physical indicators of flow may include the presence and characteristics of a reliable ordinary high water mark (OHWM) with a channel defined by bed and banks.[36] Other physical indicators of flow may include

[35] In discussing the significant nexus standard, Justice Kennedy stated: "The required nexus must be assessed in terms of the statute's goals and purposes. Congress enacted the [CWA] to 'restore and maintain the chemical, physical, and biological integrity of the Nation's waters' ..." 126 S. Ct. at 2248. Consistent with Justice Kennedy's instruction, EPA and the Corps will apply the significant nexus standard in a manner that restores and maintains any of these three attributes of traditional navigable waters.

[36] See 33 C.F.R. § 328.3(e). The OHWM also serves to define the lateral limit of jurisdiction in a non-navigable tributary where there are no adjacent wetlands. See 33 C.F.R. § 328.4(c). While EPA regions

shelving, wracking, water staining, sediment sorting, and scour.[37] Consideration will also be given to certain relevant contextual factors that directly influence the hydrology of tributaries including the size of the tributary's watershed, average annual rainfall, average annual winter snow pack, slope, and channel dimensions.

In addition, the agencies will consider other relevant factors, including the functions performed by the tributary together with the functions performed by any adjacent wetlands. One such factor is the extent to which the tributary and adjacent wetlands have the capacity to carry pollutants (e.g., petroleum wastes, toxic wastes, sediment) or flood waters to traditional navigable waters, or to reduce the amount of pollutants or flood waters that would otherwise enter traditional navigable waters.[38] The agencies will also evaluate ecological functions performed by the tributary and any adjacent wetlands which affect downstream traditional navigable waters, such as the capacity to transfer nutrients and organic carbon vital to support downstream foodwebs (e.g., macroinvertebrates present in headwater streams convert carbon in leaf litter making it available to species downstream), habitat services such as providing spawning areas for recreationally or commercially important species in downstream waters, and the extent to which the tributary and adjacent wetlands perform functions related to maintenance of downstream water quality such as sediment trapping.

After assessing the flow characteristics and functions of the tributary and its adjacent wetlands, the agencies will evaluate whether the tributary and its adjacent wetlands are likely to have an effect that is more than speculative or insubstantial on the chemical, physical, and biological integrity of a traditional navigable water. As the distance from the tributary to the navigable water increases, it will become increasingly important to document whether the tributary and its adjacent wetlands have a significant nexus rather than a speculative or insubstantial nexus with a traditional navigable water.

Accordingly, Corps districts and EPA regions shall document in the administrative record the available information regarding whether a tributary and its adjacent wetlands have a significant nexus with a traditional navigable water, including the physical indicators of flow in a particular case and available information regarding the functions of the tributary and any adjacent wetlands. The agencies will explain their basis for concluding whether or not the tributary and its adjacent wetlands, when considered together, have a more than speculative or insubstantial effect on the chemical, physical, and biological integrity of a traditional navigable water.

Swales or erosional features (e.g., gullies, small washes characterized by low volume, infrequent, or short duration flow) are generally not waters of the United States

---

and Corps districts must exercise judgment to identify the OHWM on a case-by-case basis, the Corps' regulations identify the factors to be applied. These regulations have recently been further explained in Regulatory Guidance Letter (RGL) 05-05 (Dec. 7, 2005). The agencies will apply the regulations and the RGL and take other steps as needed to ensure that the OHWM identification factors are applied consistently nationwide.

[37] See Justice Kennedy's discussion of "physical characteristics," 126 S. Ct. at 2248-2249.

[38] See, generally, 126 S. Ct. at 2248-53; see also 126 S. Ct. at 2249 ("Just as control over the non-navigable parts of a river may be essential or desirable in the interests of the navigable portions, so may the key to flood control on a navigable stream be found in whole or in part in flood control on its tributaries....") (citing to Oklahoma ex rel. Phillips v. Guy F. Atkinson Co., 313 U.S. 508, 524-25(1941)).

because they are not tributaries or they do not have a significant nexus to downstream traditional navigable waters. In addition, ditches (including roadside ditches) excavated wholly in and draining only uplands and that do not carry a relatively permanent flow of water are generally not waters of the United States because they are not tributaries or they do not have a significant nexus to downstream traditional navigable waters.[39] Even when not jurisdictional waters subject to CWA §404, these geographic features (e.g., swales, ditches) may still contribute to a surface hydrologic connection between an adjacent wetland and a traditional navigable water. In addition, these geographic features may function as point sources (i.e., "discernible, confined, and discrete conveyances"), such that discharges of pollutants to other waters through these features could be subject to other CWA regulations (e.g., CWA §§ 311 and 402).[40]

Certain ephemeral waters in the arid west are distinguishable from the geographic features described above where such ephemeral waters are tributaries and they have a significant nexus to downstream traditional navigable waters. For example, in some cases these ephemeral tributaries may serve as a transitional area between the upland environment and the traditional navigable waters. During and following precipitation events, ephemeral tributaries collect and transport water and sometimes sediment from the upper reaches of the landscape downstream to the traditional navigable waters. These ephemeral tributaries may provide habitat for wildlife and aquatic organisms in downstream traditional navigable waters. These biological and physical processes may further support nutrient cycling, sediment retention and transport, pollutant trapping and filtration, and improvement of water quality, functions that may significantly affect the chemical, physical, and biological integrity of downstream traditional navigable waters.

Documentation

As described above, the agencies will assert CWA jurisdiction over the following waters without the legal obligation to make a significant nexus determination: traditional navigable waters and wetlands adjacent thereto, non-navigable tributaries that are relatively permanent waters, and wetlands with a continuous surface connection with such tributaries. The agencies will also decide CWA jurisdiction over other non-navigable tributaries and over other wetlands adjacent to non-navigable tributaries based on a fact-specific analysis to determine whether they have a significant nexus with traditional navigable waters. For purposes of CWA §404 determinations by the Corps, the Corps and EPA are developing a revised form to be used by field regulators for documenting the assertion or declination of CWA jurisdiction.

Corps districts and EPA regions will ensure that the information in the record adequately supports any jurisdictional determination. The record shall, to the maximum extent practicable, explain the rationale for the determination, disclose the data and information relied upon, and, if applicable, explain what data or information received greater or lesser weight, and what professional judgment or assumptions were used in reaching the determination. The Corps districts and EPA regions will also demonstrate and document in the record that a particular water either fits within a class identified above as not requiring a significant nexus determination, or that the water has a

[39] See 51 Fed. Reg. 41206, 41217 (Nov. 13, 1986).
[40] 33 U.S.C. § 1362(14).

significant nexus with a traditional navigable water. As a matter of policy, Corps districts and EPA regions will include in the record any available information that documents the existence of a significant nexus between a relatively permanent tributary that is not perennial (and its adjacent wetlands if any) and a traditional navigable water, even though a significant nexus finding is not required as a matter of law.

All pertinent documentation and analyses for a given jurisdictional determination (including the revised form) shall be adequately reflected in the record and clearly demonstrate the basis for asserting or declining CWA jurisdiction.[41] Maps, aerial photography, soil surveys, watershed studies, local development plans, literature citations, and references from studies pertinent to the parameters being reviewed are examples of information that will assist staff in completing accurate jurisdictional determinations. The level of documentation may vary among projects. For example, jurisdictional determinations for complex projects may require additional documentation by the project manager.

Benjamin H. Grumbles
Assistant Administrator for Water
U.S. Environmental Protection Agency

John Paul Woodley, Jr.
Assistant Secretary of the Army
(Civil Works)
Department of the Army

[41] For jurisdictional determinations and permitting decisions, such information shall be posted on the appropriate Corps website for public and interagency information.