USING COMPUTER TOOLS AND DATABASES TO DEVELOP SOIL RECONSTRUCTION PLANS FOLLOWING SURFACE COAL MINING[1]

H. Raymond Sinclair, Jr.[2] and Robert R. Dobos

Abstract. Passage of PL- 95-87 in 1977 (Surface Mining Control and Reclamation Act) confirmed the intentions of Congress regarding how soils disturbed during surface mining for coal will be reconstructed to achieve productivity levels approximating that of original soil. To achieve the legislation goals, land use managers are expected to use available technical information consistently across large and diverse geographic areas. Soil computer models and programs help people quickly and accurately evaluate characteristics of the selected land areas. Such models must put forward a reliable and integrated approach for using soil chemical and physical properties, landscape features, soil productivity information, and climate data and if needed, economic considerations. The models must also be flexible enough for selection of small to large geographical sites or tracts. The Soil Data Mart (SDM), Web Soil Survey (WSS), National Commodity Crop Productivity Index (NCCPI), and Land Evaluation and Site Assessment (LESA) are models and programs that generate information to assist in making wise land use decisions. The LESA and the NCCPI model compare the relative values for different soils or geographical areas. The LESA program requires significant user input and results vary based on the objective of the user. The objective is to reconstruct the original cropland, rangeland, woodland, hayland, or pastureland soils to their expected levels of productivity. The SDM, WSS, NCCPI, and LESA models and programs furnish numerical soil information to answer questions that land use managers of coal companies must defend or explain to government agencies and the general public during the development of the plan for soil reconstruction following surface mining for coal.

Additional Key Words: soil reconstruction, Farm and Ranch lands Protection Program, Farmland Protection Policy Act, SMCRA law, soil landscape, State Regulatory Authority (SRA), Prime Farmland, and Office of Surface Mining (OSM).

---

[1] Poster paper was presented at the 2010 National Meeting of the American Society of Mining and Reclamation, Pittsburgh, PA ***Bridging Reclamation, Science and the Community*** June 5 - 11, 2010. R.I. Barnhisel (Ed.) Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

[2] H. Raymond Sinclair, Jr. and Robert R. Dobos are Soil Scientists, National Soil Survey Center-Natural Resources Conservation Service, Lincoln, NE 68508.

Proceedings America Society of Mining and Reclamation, 2010 pp 1101-1134
DOI: 10.21000/JASMR10011101
http://dx.doi.org/10.21000JASMR10011101

Introduction

The passage of PL-95-87 in 1977 (Surface Mining Control and Reclamation Act) confirmed the intentions of Congress regarding how soils disturbed during surface mining for coal will be reconstructed to achieve productivity levels approximately that of original soil. To achieve the legislative goals, land use managers are expected to use available technical information consistently across large and diverse geographic areas (30CFR785.17, 2009). Soil computer models and programs help people quickly and accurately evaluate characteristics of the selected land areas. Such models and programs must put forward a reliable and integrated approach for using soil chemical and physical properties, landscape features, soil productivity information, and climate data and if needed, economic considerations. The models must also be flexible enough for selection of small to large geographical sites or tracts. The Soil Data Mart (SDM) (USDA, Natural Resources Conservation Service, 2009c), Web Soil Survey (WSS) (USDA, Natural Resources Conservation Service, 2009d), National Commodity Crop Productivity Index (NCCPI) (Dobos, 2008), and Land Evaluation and Site Assessment (LESA) (USDA, Natural Resources Conservation Service, 1983 and 2001) are computer-based models and programs that generate information to assist in making wise land use decisions. The LESA and the NCCPI can be used to compare the relative values for different soils or geographic areas.

Methods and Discussions

The National Cooperative Soil Survey (NCSS, 2009) developed the National Soil Information System (NASIS) to manage and maintain soil data from collection to dissemination. NASIS provides soil information for a wide range of public and scientific needs. NASIS supports three important areas: 1) collection of new information in compliance with standards, 2) PEDON Description Program is for point and site data collection, and 3) application of expert knowledge to make information usable for a variety of purposes. The information extracted from NASIS has a wide variety of users, one being the coal industry. The SDM, WSS, LESA, and NCCPI use NASIS-derived data during the generation of their products.

Figures 1 and 2 at a scale of 1:253,440 are General Soil Maps of Fulton (Suhl, 2003) and Peoria (Walker, 1992) Counties, Illinois. Their development requires expert knowledge by the soil scientist with proficiency taken to its highest level. Understanding of soil scientist's working knowledge and skill can make general soil maps usable for the land use decision maker

(Glaser, 1992). The general soil maps show the soil associations for Fulton and Peoria Counties, Illinois. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of major soils. Soils that occur in one association may occur in another association, but in a different pattern. A map showing soil associations is useful to land use decision makers who want a general idea of the soils in an area and who want to know the location of large tracts that are suitable for cropland, pastureland, rangeland, forestland, wetlands, and other land uses. A general soil map is not suitable for planning the management of a farm, ranch, or other enterprises. Soils in any one association ordinarily differ in slope, depth, texture, drainage, and other characteristics that affect their management.

In order to prepare first approximations for alternative mining sites, decision makers need generalized information concerning soil landscapes. The general soil map reveals landscape characteristics and provides adequate soil behavior predictions to formulate a plan. The general soil map is prepared for parish, county, region, state, or nation and can assist in making tentative land use decisions. On a general soil map, landscapes are delineated and described as soil associations. There is a degree of uniformity of soil pattern among the mapping units of the same association. The pattern may consist of only a few soils or many, and the soils may have similar or different soil properties and landscape features. Each soil map unit may be described as an important segment of the landscape, representing a geographic association of soils that are defined as phases of soil series. In comparison, the detailed soil map (Web soil survey) is an essential tool for the application of the plan after a specific tract of land has been selected (Bartelli, 1966).

The productivity indices in Table 1 were determined using the NCCPI model (Dobos et al., 2008) for soils that are represented in the soil associations. The indices are calculated by evaluating the soil properties (chemical and physical), landscape features, and climate information in terms of their impact on soil productivity. The least productive soils, for commodity crops, are given lower ratings and the more productive soils are given higher ratings.

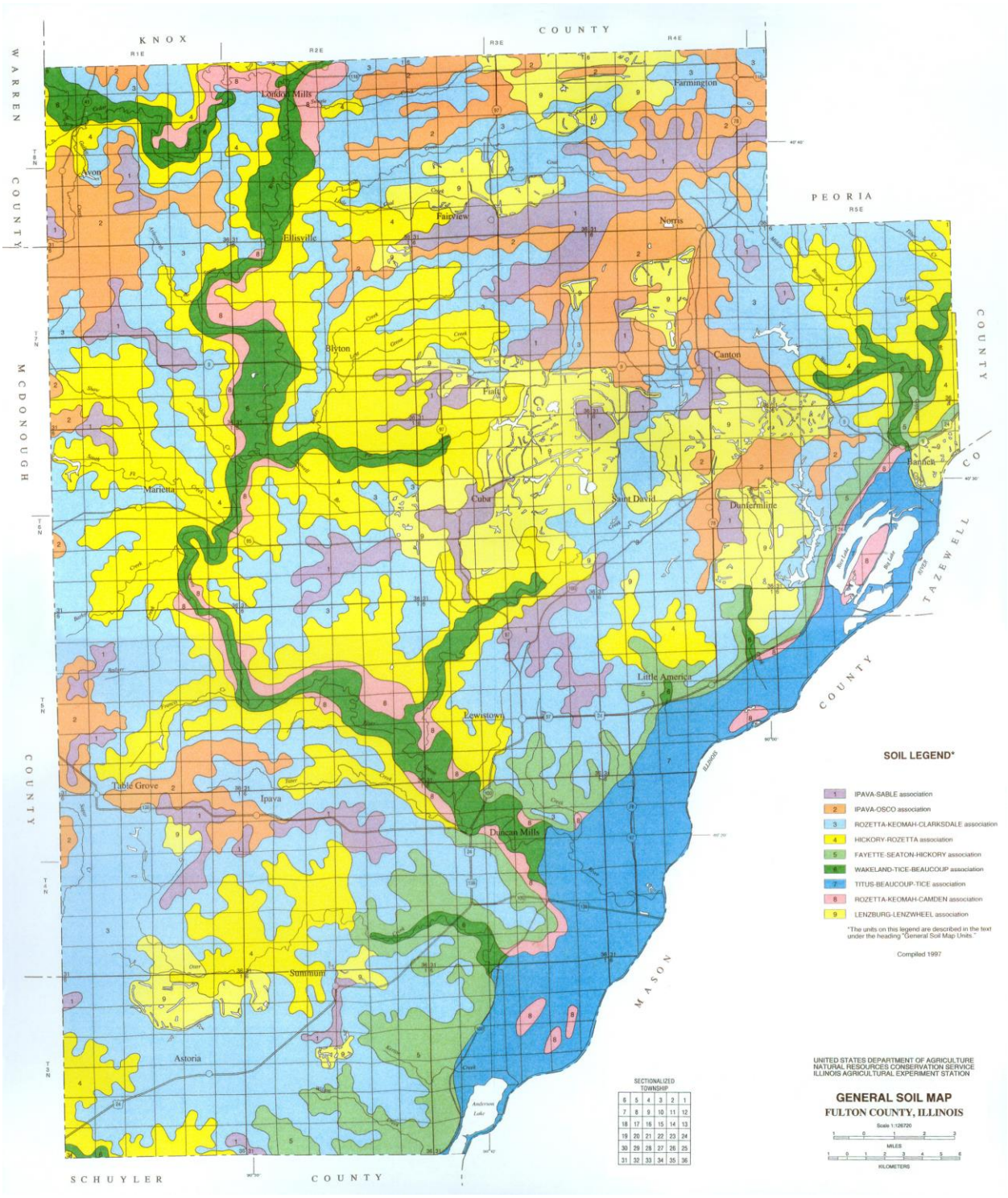

Figure 1. General soil map of Fulton County, Illinois (Suhl, 2003).

(Zoom in for more detail)

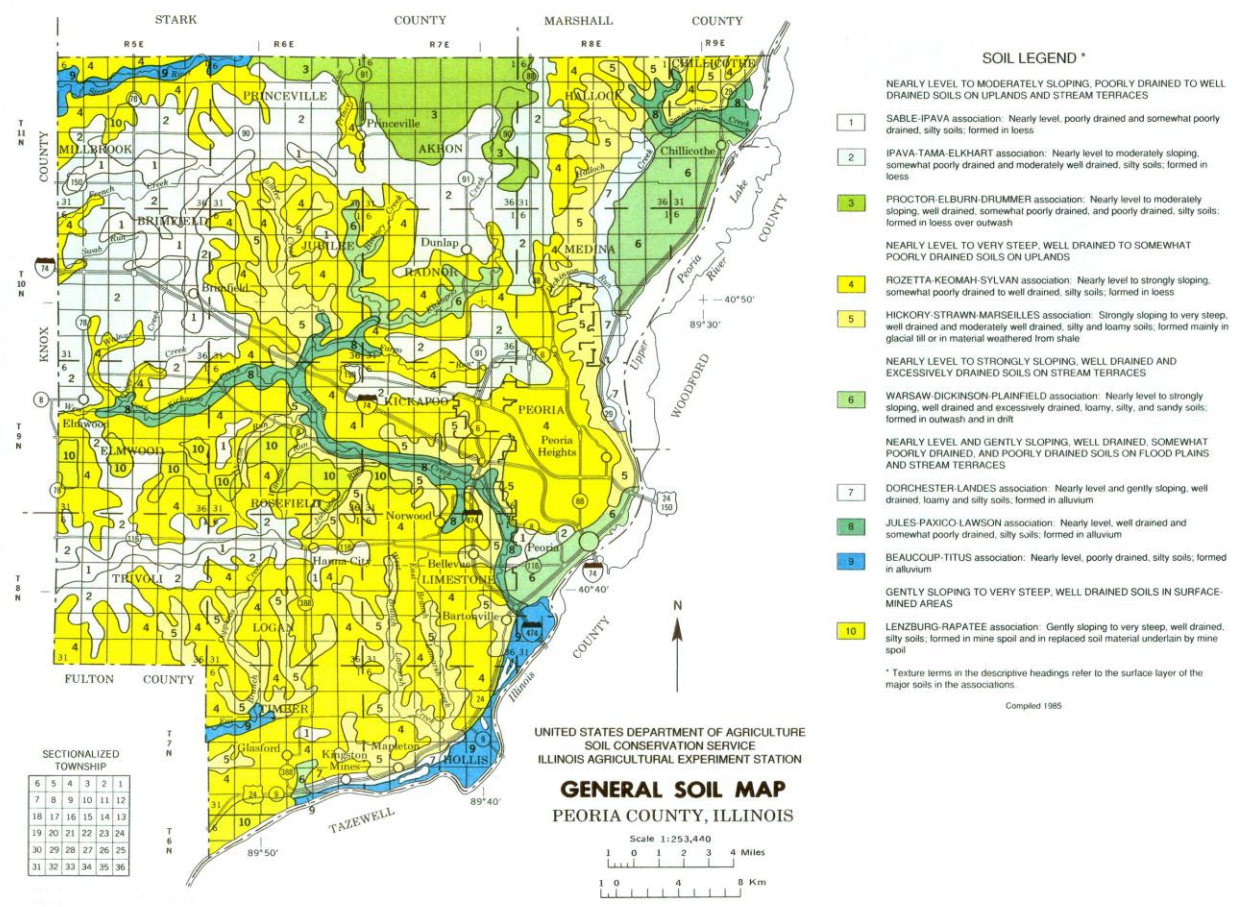

Figure 2. General soil map of Peoria County, Illinois.

Figure 2. General soil map of Peoria County, Illinois (Walker, 1992).

(Zoom in for more detail)

Table 1. Soil classification and NCCPI indices for soils in Figures 1 and 2.

Component	Classification	Suborder	Particle Size Class	NCCPI - National Commodity Crop Productivity Index (Ver. 1.0)
Beaucoup	fine-silty, mixed, superactive, mesic fluvaquentic endoaquolls	aquolls	fine-silty	0.89
Camden	fine-silty, mixed, superactive, mesic typic hapludalfs	udalfs	fine-silty	0.73
Clarksdale	udollic ochraqualfs, fine, montmorillonitic, mesic	aqualfs	fine	0.83
Dickinson	typic hapludolls, coarse-loamy, mixed, mesic	udolls	coarse-loamy	0.72
Dorchester	typic udifluvents, fine-silty, mixed (calcareous), mesic	fluvents	fine-silty	0.72
Drummer	typic haplaquolls, fine-silty, mixed, mesic	aquolls	fine-silty	0.82
Elburn	aquic argiudolls, fine-silty, mixed, mesic	udolls	fine-silty	0.88
Elkhart	typic argiudolls, fine-silty, mixed, mesic	udolls	fine-silty	0.67
Fayette	typic hapludalfs, fine-silty, mixed, mesic	udalfs	fine-silty	0.76
Hickory	fine-loamy, mixed, active, mesic typic hapludalfs	udalfs	fine-loamy	0.49
Ipava	fine, smectitic, mesic aquic argiudolls	udolls	fine	0.88
Jules	typic udifluvents, coarse-silty, mixed (calcareous), mesic	fluvents	coarse-silty	0.68
Keomah	fine, smectitic, mesic aeric endoaqualfs	aqualfs	fine	0.80
Landes	fluventic hapludolls, coarse-loamy, mixed, mesic	udolls	coarse-loamy	0.70
Lawson	cumulic hapludolls, fine-silty, mixed, mesic	udolls	fine-silty	0.85
Lenzburg	typic udorthents, fine-loamy, mixed (calcareous), mesic	orthents	fine-loamy	0.15
Lenzwheel	fine-loamy, mixed, active, calcareous, mesic alfic udarents	arents	fine-loamy	0.59
Marseilles	typic hapludalfs, fine-silty, mixed, mesic	udalfs	fine-silty	0.14
Osco	fine-silty, mixed, superactive, mesic typic argiudolls	udolls	fine-silty	0.84

Table 1, continued

Paxico	aeric fluvaquents, coarse-silty, mixed (calcareous), mesic	aquents	coarse-silty	0.68
Plainfield	typic udipsamments, mixed, mesic	psamments	not used	0.34
Proctor	typic argiudolls, fine-silty, mixed, mesic	udolls	fine-silty	0.83
Rapatee	typic udorthents, fine-silty, mixed, nonacid, mesic	orthents	fine-silty	0.61
Rozetta	fine-silty, mixed, superactive, mesic typic hapludalfs	udalfs	fine-silty	0.80
Sable	typic haplaquolls, fine-silty, mixed, mesic	aquolls	fine-silty	0.83
Seaton	fine-silty, mixed, superactive, mesic typic hapludalfs	udalfs	fine-silty	0.21
Strawn	typic hapludalfs, fine-loamy, mixed, mesic	udalfs	fine-loamy	0.40
Sylvan	typic hapludalfs, fine-silty, mixed, mesic	udalfs	fine-silty	0.64
Tama	typic argiudolls, fine-silty, mixed, mesic	udolls	fine-silty	0.90
Tice	fine-silty, mixed, superactive, mesic fluvaquentic hapludolls	udolls	fine-silty	0.82
Titus	fine, smectitic, mesic vertic endoaquolls	aquolls	fine	0.64
Wakeland	coarse-silty, mixed, superactive, nonacid, mesic aeric fluvaquents	aquents	coarse-silty	0.89
Warsaw	typic argiudolls, fine-loamy over sandy or sandy-skeletal, mixed, mesic	udolls	fine-loamy over sandy or sandy-skeletal	0.61

LE part of LESA is another tool for arraying the productivity of soils. Tables 2 and 3 array all the soils for Fulton and Peoria Counties, Illinois. The relative values in Tables 2 and 3 are assigned using corn for the index crop (U.S. Department of Agriculture, Natural Resources Conservation Service. 2001 and U.S. Department of Agriculture, Natural Resources Conservation Service. 1983). Table 2 is the adjusted weighted average yield for corn for the soils in each group. Table 3 arrays by relative values from highest to lowest for the groups in Table 2. It also calculates acres and percent of important farmland and farmable land and acres and accumulative acres for each group. Tables 2 and 3 indicate the hazard and/or limitation by assigning the land capability subclass (lc) to the soils and groups. Important farmlands (column

IF) in Table 2 and 3 are published in the Code of Federal Regulations, 7CFR657. The Web address is http://www.access.gpo.gov/nara/cfr/waisidx_00/7cfr657_00.html. The numerical designations for prime farmland are defined in Part 622.03 of the National Soil Survey handbook at Web address http://soils.usda.gov/technical/handbook/contents/part622.html#04.

Table 2: Soil Map Units Grouped by Relative Values for Fulton and Peoria Counties, Illinois* (Data: U.S. Department of Agriculture, Natural Resources Conservation Service. 2006a and 2006b)

Group Number 1

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
198A	1	elburn sil	0-2	178	100	1	267	0.0	47,526		178	47,526
7081A	1	littleton	0-2	175	98	1	577	0.1	100,975		175	100,975
7037B	2e	worthen si	2-5	173	97	1	1,527	0.2	264,171		173	264,171
199B	2e	plano silt	2-5	173	97	1	632	0.1	109,336		173	109,336
68A	2w	sable silt	0-2	173	97	2	16,379	1.7	2,833,567		173	2,833,567
9068A	2w	sable silt	0-2	173	97	2	152	0.0	26,296		173	26,296
43A	1	ipava silt	0-2	172	97	1	46,271	4.8	7,958,612		172	7,958,612
86B	2e	osco silt	2-5	170	96	1	17,276	1.8	2,936,920		170	2,936,920
						TOTAL	83,081	8.6	14,277,403			14,277,403

Weighted Average Yield = 171.85 Adjusted Weighted Average Yield = 171.85

* (Relative Value Table is at end of this document)

Table 2, continued

Group Number 2

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
7430B	2e	raddle sil	2-5	168	94	1	1,723	0.2	289,464		168	289,464
8284A	2w	tice silty	0-2	166	93	1	3,237	0.3	537,342		166	537,342
104A	1	virgil sil	0-2	164	92	2	123	0.0	20,172		164	20,172
675B	2e	greenbush	2-5	164	92	1	9,679	1.0	1,587,356		164	1,587,356
43	1	ipava silt	0-2	163	92	1	48,105	5.0	7,841,115		163	7,841,115
8415A	3w	orion silt	0-2	162	91	2	1,694	0.2	274,428		162	274,428
198	1	elburn sil	0-2	161	90	1	1,500	0.2	241,500		161	241,500
149	1	brenton si	0-2	160	90	1	895	0.1	143,200		160	143,200
596B	2e	marbletown	2-5	160	90	1	578	0.1	92,480		160	92,480
						TOTAL	67,534	7.0	11,027,057			11,027,057

Weighted Average Yield = 163.28 Adjusted Weighted Average Yield = 163.28

Table 2, continued

Group Number 3

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
8070A	2w	beaucoup s	0-2	159	89	2	5,162	0.5	820,758		159	820,758
257A	1	clarksdale	0-2	157	88	2	16,785	1.7	2,635,245		157	2,635,245
9257A	1	clarksdale	0-2	157	88	2	321	0.0	50,397		157	50,397
3077A	2w	huntsville	0-2	157	88	3	2,024	0.2	317,768		157	317,768
8611A	2w	sepo silty	0-2	157	88	2	970	0.1	152,290		157	152,290
68	2w	sable silt	0-2	156	88	2	15,800	1.6	2,464,800		156	2,464,800
59	1	lisbon sil	0-2	155	87	1	835	0.1	129,425		155	129,425
242A	2w	kendall si	0-2	155	87	2	554	0.1	85,870		155	85,870
7075B	2e	drury silt	2-5	154	87	1	709	0.1	109,186		154	109,186
152	2w	drummer si	0-2	154	87	2	1,815	0.2	279,510		154	279,510
3451A	3w	lawson sil	0-2	154	87	5	11,652	1.2	1,794,408		154	1,794,408
36B	2e	tama silt	1-5	153	86	1	23,385	2.4	3,577,905		153	3,577,905
3107A	3w	sawmill si	0-2	153	86	5	3,151	0.3	482,103		153	482,103
77	2w	huntsville	0-2	152	85	1	1,740	0.2	264,480		152	264,480
105B2	2e	batavia si	2-5	151	85	1	86	0.0	12,986		151	12,986
199B	2e	plano silt	1-5	150	84	1	1,585	0.2	237,750		150	237,750
3074A	3w	radford si	0-2	150	84	2	573	0.1	85,950		150	85,950
243B	2e	st. charle	2-5	149	84	1	1,502	0.2	223,798		149	223,798
37B	2e	worthen si	1-5	149	84	1	1,325	0.1	197,425		149	197,425
3284A	3w	tice silty	0-2	149	84	3	8,851	0.9	1,318,799		149	1,318,799
					TOTAL		98,825	10.2	15,240,853			15,240,853

Weighted Average Yield = 154.22 Adjusted Weighted Average Yield = 154.22

Table 2, continued

Group Number 4

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
86C2	2e	osco silt	5-10	160	90	S	3,522	0.4	563,520		160	563,520
36C2	3e	tama silt	5-10	146	82	S	2,515	0.3	367,190		146	367,190
75C2	3e	drury silt	5-10	145	81	S	1,506	0.2	218,370		145	218,370
567C2	3e	elkhart si	5-10	143	80	S	159	0.0	22,737		143	22,737
9279C	3e	rozetta si	5-10	142	80	S	1,022	0.1	145,124		142	145,124
					TOTAL		8,724	0.9	1,316,941			1,316,941

Weighted Average Yield = 150.96 Adjusted Weighted Average Yield = 150.96

Table 2, continued

Group Number 5

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
104	1	virgil sil	0-2	148	83	2	1,005	0.1	148,740		148	148,740
279B	2e	rozetta si	2-5	147	83	1	75,995	7.9	11,171,265		147	11,171,265
386B	2e	downs silt	1-5	147	83	1	3,830	0.4	563,010		147	563,010
632A	2w	copperas	0-2	147	83	2	42	0.0	6,174		147	6,174
102A	1	la hogue l	0-2	146	82	1	196	0.0	28,616		146	28,616
9279B	2e	rozetta si	0-2	146	82	1	1,870	0.2	273,020		146	273,020
567B2	2e	elkhart	2-5	146	82	1	17	0.0	2,482		146	2,482
3415A	3w	orion silt	0-2	146	82	5	4,421	0.5	645,466		146	645,466
9017A	2w	keomah sil	0-2	145	81	2	590	0.1	85,550		145	85,550
451	3w	Lawson sil	0-2	145	81	3	3,925	0.4	569,125		145	569,125
171B2	2e	catlin sil	2-5	144	81	1	1,330	0.1	191,520		144	191,520
17B	2e	keomah sil	2-5	144	81	1	106	0.0	15,264		144	15,264
558A	1	breeds sil	0-2	143	80	1	116	0.0	16,588		143	16,588
280B2	2e	fayette si	2-5	143	80	1	4,416	0.5	631,488		143	631,488
148B	2e	proctor si	2-5	143	80	1	2,015	0.2	288,145		143	288,145
74	2w	radford si	0-2	143	80	1	925	0.1	132,275		143	132,275
8404A	3w	titus silt	0-2	143	80	2	11,759	1.2	1,681,537		143	1,681,537
3070A	3w	beaucoup s	0-2	143	80	5	7,231	0.7	1,034,033		143	1,034,033
45A	3w	denny silt	0-2	143	80	2	664	0.1	94,952		143	94,952
					TOTAL		120,453	12.4	17,579,250			17,579,250

Weighted Average Yield = 145.94 Adjusted Weighted Average Yield = 145.94

Table 2, continued

Group Number 6

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
171C2	3e	catlin sil	5-10	141	79	S	550	0.1	77,550		141	77,550
280C2	3e	fayette si	5-10	140	79	S	8,030	0.8	1,124,200		140	1,124,200
134C2	3e	camden sil	5-10	139	78	S	1,707	0.2	237,273		139	237,273
279C2	3e	rozetta si	5-10	138	78	S	45,494	4.7	6,278,172		138	6,278,172
259C2	3e	assumption	5-10	137	77	S	507	0.1	69,459		137	69,459
148C2	3e	proctor si	5-10	135	76	S	360	0.0	48,600		135	48,600
16A	3w	rushville	0-2	133	75	S	239	0.0	31,787		133	31,787
145C2	3e	saybrook s	5-10	131	74	S	740	0.1	96,940		131	96,940
280D2	3e	fayette si	10-18	130	73	S	9,437	1.0	1,226,810		130	1,226,810
134D2	3e	camden sil	10-18	129	72	S	1,250	0.1	161,250		129	161,250
279C3	4e	rozetta si	5-10	127	71	S	578	0.1	73,406		127	73,406
					TOTAL		68,892	7.1	9,425,447			9,425,447

Weighted Average Yield = 136.81 Adjusted Weighted Average Yield = 136.81

Table 2, continued

Group Number 7

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
3333A	2w	wakeland s	0-2	141	79	5	14,200	1.5	2,002,200		141	2,002,200
257	1	clarksdale	0-2	140	79	2	12,470	1.3	1,745,800		140	1,745,800
8183A	2w	shaffton c	0-2	140	79	1	254	0.0	35,560		140	35,560
570B	2e	martinsvil	2-5	139	78	1	374	0.0	51,986		139	51,986
3634A	2w	blyton sil	0-2	139	78	3	2,390	0.2	332,210		139	332,210
7070	2w	beaucoup s	0-2	138	78	2	1,970	0.2	271,860		138	271,860
8302A	2w	ambraw cla	0-2	138	78	2	563	0.1	77,694		138	77,694
439B	2e	jasper loa	1-4	137	77	1	2,350	0.2	321,950		137	321,950
67	2w	harpster s	0-2	136	76	2	460	0.0	62,560		136	62,560
379A	2s	dakota loa	0-2	135	76	1	205	0.0	27,675		135	27,675
379B	2e	dakota loa	2-5	134	75	1	438	0.0	58,692		134	58,692
145B2	2e	saybrook s	2-5	133	75	1	1,610	0.2	214,130		133	214,130
150B	2e	onarga fin	2-5	133	75	1	372	0.0	49,476		133	49,476
8595A	2s	coot loam	0-2	133	75	1	277	0.0	36,841		133	36,841
107	3w	sawmill si	0-2	132	74	5	1,600	0.2	211,200		132	211,200
344B	2e	harvard si	2-5	131	74	1	575	0.1	75,325		131	75,325
17	2w	keomah sil	0-2	131	74	2	21,240	2.2	2,782,440		131	2,782,440
					TOTAL		61,348	6.3	8,357,599			8,357,599

Weighted Average Yield = 136.23 Adjusted Weighted Average Yield = 136.23

Table 2, continued

Group Number 8

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
279B	2e	rozetta si	1-5	130	73	1	34,295	3.5	4,458,350		130	4,458,350
8608A	2w	mudhen cla	0-2	130	73	2	179	0.0	23,270		130	23,270
567B2	2e	elkhart si	2-5	129	72	1	11,365	1.2	1,466,085		129	1,466,085
17A	2w	keomah sil	0-2	129	72	2	20,683	2.1	2,668,107		129	2,668,107
132	2w	starks sil	0-2	129	72	2	335	0.0	43,215		129	43,215
3404A	3w	titus silt	0-2	129	72	5	856	0.1	110,424		129	110,424
243B	2e	st. charle	2-5	126	71	1	815	0.1	102,690		126	102,690
872B	2e	rapatee si	2-5	125	70	1	1,770	0.2	221,250		125	221,250
404	3w	titus silt	0-2	125	70	2	1,405	0.1	175,625		125	175,625
134B	2e	camden sil	2-5	124	70	1	1,480	0.2	183,520		124	183,520
330	2w	peotone si	0-2	123	69	2	1,970	0.2	242,310		123	242,310
415	3w	orion silt	0-2	121	68	3	360	0.0	43,560		121	43,560
					TOTAL		75,513	7.8	9,738,406			9,738,406

Weighted Average Yield = 128.96 Adjusted Weighted Average Yield = 128.96

Table 2, continued

Group Number 9

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
279C2	3e	rozetta si	5-10	123	69	S	8,740	0.9	1,075,020		123	1,075,020
567C2	3e	elkhart si	5-10	123	69	S	6,305	0.7	775,515		123	775,515
280C2	3e	fayette si	5-10	121	68	S	10,585	1.1	1,280,785		121	1,280,785
271D2	3e	timula sil	10-18	121	68	S	441	0.0	53,361		121	53,361
259C2	3e	assumption	5-10	120	67	S	655	0.1	78,600		120	78,600
243C2	3e	st. charle	5-10	119	67	S	385	0.0	45,815		119	45,815
119D2	3e	elco silt	10-18	118	66	S	6,355	0.7	749,890		118	749,890
24C2	3e	dodge	5-10	118	66	S	2,430	0.3	286,740		118	286,740
134C2	3e	camden sil	5-10	117	66	S	1,025	0.1	119,925		117	119,925
279D3	4e	rozetta si	10-18	117	66	S	1,290	0.1	150,930		117	150,930
280D2	3e	fayette si	10-15	116	65	S	3,910	0.4	453,560		116	453,560
259D2	3e	assumption	10-15	116	65	S	280	0.0	32,480		116	32,480
16	3w	rushville	0-2	114	64	S	675	0.1	76,950		114	76,950
134D2	3e	camden sil	10-18	113	63	S	415	0.0	46,895		113	46,895
24D	4e	dodge silt	10-18	111	62	S	2,030	0.2	225,330		111	225,330
630C3	4e	navlys sil	5-10	108	61	S	11,689	1.2	1,262,412		108	1,262,412
					TOTAL		57,210	5.9	6,714,208			6,714,208

Weighted Average Yield = 117.36 Adjusted Weighted Average Yield = 117.36

Table 2, continued

Group Number 10

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
239	2w	dorchester	0-2	119	67	3	2,120	0.2	252,280		119	252,280
28	2w	jules silt	0-2	116	65	3	5,745	0.6	666,420		116	666,420
8875B	2e	lenzlo sil	1-7	115	65	1	1,031	0.1	118,565		115	118,565
290A	2s	warsaw sil	0-3	115	65	1	2,635	0.3	303,025		115	303,025
823B	2e	schuline s	1-7	114	64	1	1,719	0.2	195,966		114	195,966
45	3w	denny silt	0-2	113	63	2	355	0.0	40,115		113	40,115
709A	2w	osceola si	0-2	110	62	2	120	0.0	13,200		110	13,200
						TOTAL	13,725	1.4	1,589,571			1,589,571

Weighted Average Yield = 115.82 Adjusted Weighted Average Yield = 115.82

Table 2, continued

Group Number 11

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
19D3	4e	sylvan sil	10-18	107	60	S	7,365	0.8	788,055		107	788,055
119D2	3e	elco silt	8-15	101	57	S	4,260	0.4	430,260		101	430,260
						TOTAL	11,625	1.2	1,218,315			1,218,315

Weighted Average Yield = 104.80 Adjusted Weighted Average Yield = 104.80

Table 2, continued
Group Number 12

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
871B	2e	lenzburg s	1-7	107	60	1	13,860	1.4	1,483,020		107	1,483,020
88B	4s	sparta loa	1-7	106	60	1	203	0.0	21,518		106	21,518
709B2	2e	osceola si	2-5	105	59	2	1,040	0.1	109,200		105	109,200
872B	2e	rapatee si	1-5	100	56	1	925	0.1	92,500		100	92,500
406	3w	paxico sil	0-2	100	56	5	4,720	0.5	472,000		100	472,000
304B	2e	lands loa	1-5	99	56	1	1,565	0.2	154,935		99	154,935
87B	3e	dickinson	1-4	98	55	1	3,570	0.4	349,860		98	349,860
876B	2e	lenzwheel	1-7	97	54	1	4,879	0.5	473,263		97	473,263
					TOTAL		30,762	3.2	3,156,296			3,156,296

Weighted Average Yield = 102.60 Adjusted Weighted Average Yield = 102.60

Table 2, continued
Group Number 13

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
823D	3e	schuline s	7-20	109	61	0	277	0.0	30,193		109	30,193
119E	4e	elco silt	15-20	97	54	0	1,810	0.2	175,570		97	175,570
876D2	4e	lenzwheel	7-20	93	52	0	3,188	0.3	296,484		93	296,484
7C3	4e	atlas silt	5-10	78	44	0	255	0.0	19,890		78	19,890
					TOTAL		5,530	0.6	522,137			522,137

Weighted Average Yield = 94.42 Adjusted Weighted Average Yield = 94.42

Table 2, continued

Group Number 14

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
8092B	4s	sarpy sand	1-7	99	56	S	102	0.0	10,098		99	10,098
19C3	4e	sylvan sil	5-10	97	54	S	17,115	1.8	1,660,155		97	1,660,155
549C2	3e	marseilles	5-10	96	54	S	70	0.0	6,720		96	6,720
872C	3e	rapatee si	5-12	95	53	S	185	0.0	17,575		95	17,575
8D2	3e	hickory si	10-18	94	53	S	2,369	0.2	222,686		94	222,686
779B	4s	chelsea lo	1-7	94	53	S	233	0.0	21,902		94	21,902
19D3	4e	sylvan sil	10-15	93	52	S	3,475	0.4	323,175		93	323,175
131D2	3e	alvin fine	7-15	90	51	S	280	0.0	25,200		90	25,200
224D3	4e	strawn sil	8-15	90	51	S	1,325	0.1	119,250		90	119,250
8D	3e	hickory si	8-15	74	42	S	3,070	0.3	227,180		74	227,180
92A	4w	sarpy loam	0-3	71	40	S	1,100	0.1	78,100		71	78,100
54B	4s	plainfield	3-7	56	31	S	1,480	0.2	82,880		56	82,880
					TOTAL		30,804	3.2	2,794,921			2,794,921

Weighted Average Yield = 90.73 Adjusted Weighted Average Yield = 90.73

Table 2, continued

Group Number 15

map symbol	lc	soil name	slope	nir yld	prd ind	I F	acres number	pct	yield acres	x	adj yld	adjust product
2439B	8	jasper	1-7			0	1,905	0.2	0			0
801B	2e	orthents	1-7			0	1,388	0.1	0			0
2036B	8	tama-urban	1-5			0	870	0.1	0			0
2290A	8	warsaw-urb	0-3			0	1,380	0.1	0			0
2017	8	keomah-urb	0-2			0	1,245	0.1	0			0
2279B	8	rozetta-ur	3-8			0	7,235	0.7	0			0
2224D	8	strawn-urb	8-20			0	1,395	0.1	0			0
3641L	5w	quiver sil	0-2			0	2,396	0.2	0			0
3070	5w	beaucoup s	0-2			0	1,400	0.1	0			0
3406	5w	paxico sil	0-2			0	1,065	0.1	0			0
210	5w	lena muck	0-2			0	50	0.0	0			0
8E2	6e	hickory lo	18-25			0	20,458	2.1	0			0
8E	6e	hickory	15-30			0	10,915	1.1	0			0
871D	6e	lenzburg s	7-20			0	7,195	0.7	0			0
224E	6e	strawn sil	15-30			0	5,635	0.6	0			0
274E2	6e	seaton sil	18-25			0	5,064	0.5	0			0
119E2	6e	elco silt	18-25			0	4,839	0.5	0			0
871B	6e	lenzburg s	1-7			0	4,275	0.4	0			0
876G	6e	lenzwheel	20-60			0	2,538	0.3	0			0
280E2	6e	fayette si	18-25			0	2,289	0.2	0			0
280E	6e	fayette si	15-30			0	1,965	0.2	0			0
871D	6e	lenzburg s	7-20			0	1,870	0.2	0			0
19E3	6e	sylvan sil	15-20			0	1,335	0.1	0			0
134E2	6e	camden	18-25			0	863	0.1	0			0

Table 2, Group 15, continued

7D3	6e	atlas silt	10-18	0	543	0.1	0	0
779D	6s	chelsea lo	7-20	0	274	0.0	0	0
8F	7e	hickory si	25-35	0	36,708	3.8	0	0
8G	7e	hickory si	35-60	0	14,858	1.5	0	0
871G	7e	lenzburg s	20-60	0	13,509	1.4	0	0
857G	7e	strawn-hen	30-60	0	10,595	1.1	0	0
8G	7e	hickory lo	30-50	0	9,715	1.0	0	0
549G	7e	marseilles	30-60	0	7,630	0.8	0	0
549E	7e	marseilles	15-30	0	4,670	0.5	0	0
274F	7e	seaton sil	18-35	0	4,020	0.4	0	0
549G	7e	marseilles	35-60	0	2,229	0.2	0	0
871G	7e	lenzburg s	20-60	0	2,185	0.2	0	0
549F	7e	marseilles	18-35	0	1,706	0.2	0	0
274G	7e	seaton sil	35-60	0	1,184	0.1	0	0
282F	7s	chute loam	18-35	0	1,440	0.1	0	0
54D	7s	plainfield	7-18	0	730	0.1	0	0
W	8	water	0-0	0	9,905	1.0	0	0
W	8	water	0-0	0	9,245	1.0	0	0
2802B	8	orthents-u	0-6	0	6,235	0.6	0	0
533	8	urban land	0-0	0	3,250	0.3	0	0
536	8	dumps	0-0	0	1,366	0.1	0	0
865	8	pits	0-0	0	940	0.1	0	0
865	8	pits	0-0	0	522	0.1	0	0
864	8	pits	0-0	0	345	0.0	0	0
536	8	dumps	0-0	0	280	0.0	0	0
				TOTAL	233,654	24.1	0	0

Weighted Average Yield = 0.00 Adjusted Weighted Average Yield = 0.00

Table 3: Relative Values for Fulton and Peoria Counties, Illinois (Data : U.S. Department of Agriculture, Natural Resources Conservation Service. 2006a and 2006b)

group	lc	important farmland	potential or productivity	%	cumulative %	acres	cumulative acres	relative value
1	1-2w	prime	96-100	8.6	8.6	83,081	83,081	100
2	1-3w	prime	90-94	7.0	15.6	67,534	150,615	95
3	1-3w	prime	84-89	10.2	25.8	98,825	249,440	90
4	2e-3e	state	80-90	0.9	26.7	8,724	258,164	88
5	1-3w	prime	80-83	12.4	39.1	120,453	378,617	85
6	3e-4e	state	71-79	7.1	46.2	68,892	447,509	80
7	1-3w	prime	74-79	6.3	52.6	61,348	508,857	79
8	2e-3w	prime	68-73	7.8	60.4	75,513	584,370	75
9	3e-4e	state	61-69	5.9	66.3	57,210	641,580	68
10	2e-4s	prime	62-67	1.4	67.7	13,725	655,305	67
11	2e-4s	state	57-60	1.2	68.9	11,625	666,930	61
12	2e-4s	prime	54-60	3.2	72.1	30,762	697,692	60
13	3e-4s	other	44-61	0.6	72.7	5,530	703,222	55
14	3e-4s	state	31-56	3.2	75.9	30,804	734,026	53
15	2e-8	other	-------	-24.1	100.0	233,654	967,680	0

FPPA acres: 728,496 (75.3% of county) Farmable acres: 734,026 (75.9% of county)
Grouped acres: 967,680 Total acres: 967,680

Note: LESA is for NRCS and others responsible for the Land Evaluation portion of a Land Evaluation and Site Assessment (LESA) system. LESA requires significant user input and results vary based upon user knowledge and emphasis. Official NRCS Land Evaluation results to be used for the Farmland Protection Policy Act (FPPA) are approved by the NRCS State Conservationist and placed in the Field Office Technical Guide (FOTG). For more information contact your local or state NRCS office.

Figures 3 through 13 are information produced by WSS (U.S. Department of Agriculture, Natural Resources Conservation Service, accessed October 26, 2009d). They are in Peoria County, Illinois located in all or parts of sections 15, 16, 17, 20, 21, 22, 27, 28, and 29, T. 9 N., R. 6 E, Fourth Principal Meridian. **Figures 3 through 13 can be printed** (available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm) and are worth a thousand words. A detailed soil map which is used to make a thematic map is suitable for planning the management for a farm, ranch, or other enterprises. The interpretive information and soil chemical and physical properties differ among the undisturbed soils and the reconstructed soils (Lenzburg and Rapatee soils). The soil map symbol, soil map unit name, land capability subclass, soil classification, and acres for the soils in Figures 3 through 13 are in Table 4. Figures 3 through 13 and Tables 2, 3, and 4 meet the requirements in 30CFR785.17 (2009) and 30CFR823 (2009) for surface mining of coal.

Table 4. Soil Information for Figures 3 through 13.

Soil Map Symbol	Soil Map unit name	Capability subclass
8D	Hickory silt loam, 8 to 15 percent slopes	3e
8E	Hickory silt loam, 15 to 30 percent slopes	6e
8G	Hickory loam, 30 to 50 percent slopes	7e
17	Keomah silt loam	2w
19C3	Sylvan silty clay loam, 5 to 10 percent slopes, severely eroded	4e
19E3	Sylvan silty clay loam, 15 to 20 percent slopes, severely eroded	6e
77	Huntsville silt loam	2w
119D2	Elco silt loam, 8 to 15 percent slopes, eroded	3e
257	Clarksdale silt loam	1
279B	Rozetta silt loam, 1 to 5 percent slopes	2e
280C2	Fayette silt loam, 5 to 10 percent slopes, eroded	3e
280D2	Fayette silt loam, 10 to 15 percent slopes, eroded	3e
280E	Fayette silt loam, 15 to 30 percent slopes	6e
549E	Marseilles silt loam, 15 to 30 percent slopes	7e
549G	Marseilles silt loam, 30 to 60 percent slopes	7e
871B	Lenzburg silt loam, 1 to 7 percent slopes, stony	6e
871D	Lenzburg silt loam, 7 to 20 percent slopes, stony	6e
871G	Lenzburg silt loam, 20 to 60 percent slopes, stony	7e
872B	Rapatee silt loam, 1 to 5 percent slopes	2e
872C	Rapatee silty clay loam, 5 to 12 percent slopes	3e
W	Water	

Table 4. Continued.

Soil Map Symbol	Soil Classification	Acres
8D	Typic Hapludalfs, fine-loamy, mixed, mesic	5.9
8E	Typic Hapludalfs, fine-loamy, mixed, mesic	30.9
8G	Typic Hapludalfs, fine-loamy, mixed, mesic	53.9
17	Aeric Ochraqualfs, fine, montmorillonitic, mesic	102.2
19C3	Typic Hapludalfs, fine-silty, mixed, mesic	46.9
19E3	Typic Halpudalfs, fine-silty, mixed, mesic	4.2
77	Cumulic Hapludolls, fine-silty, mixed, mesic	19.7
119D2	Typic Halpudalfs, fine-silty, mixed, mesic	2.7
257	Udollic Ochraqulalfs, fine, montmorillitic,mesic	20.9
279B	Typic Hapludalfs, fine-silty, mixed, mesic	52.2
280C2	Typic Hapludalfs, fine-silty, mixed, mesic	20.3
280D2	Typic Hapludalfs, fine-silty, mixed, mesic	7.6
280E	Typic Hapludalfs, fine-silty, mixed, mesic	7
549E	Typic Hapludalfs, fine-silty, mixed, mesic	11.8
549G	Typic Hapludalfs, fine-silty, mixed, mesic	17.3
871B	Typic Udorthents, fine-loamy, mixed, (calareous), mesic	267.9
871D	Typic Udorthents, fine-loamy, mixed, (calareous), mesic	110
871G	Typic Udorthents, fine-loamy, mixed, (calareous), mesic	143.6
872B	Typic Udorthents, fine-silty, mixed, nonacid, mesic	121.9
872C	Typic Udorthents, fine-silty, mixed, nonacid, mesic	22.4
W		84.7

Figure 3: Soil map for a tract of land in Peoria County, Illinois (Zoom in for more detail)

Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

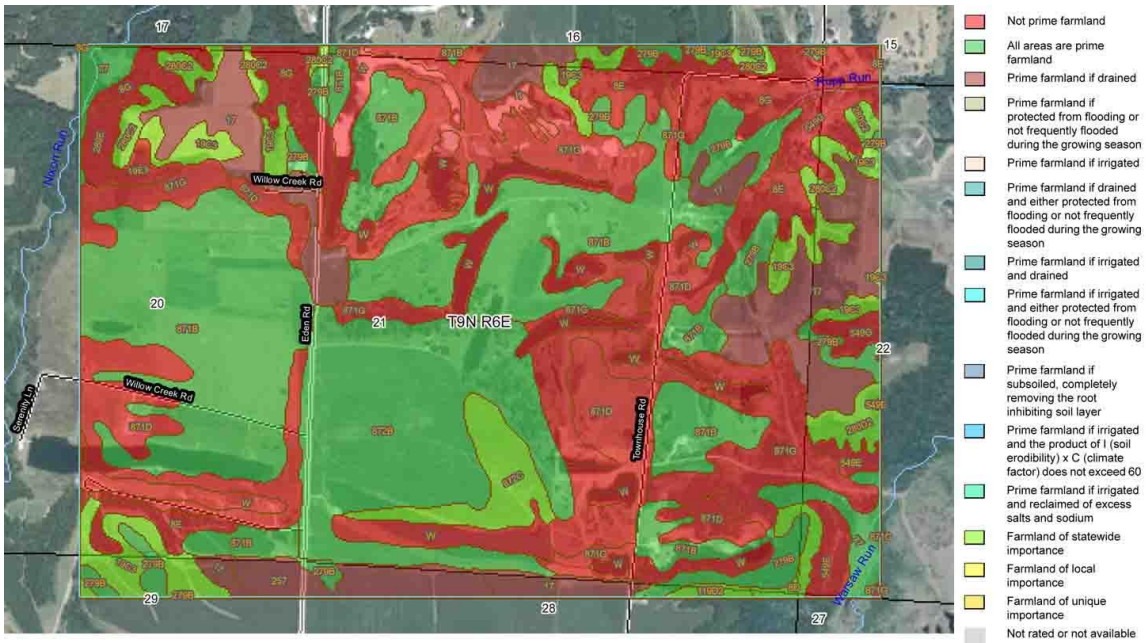

Figure 4. Important farmland for a tract of land in Peoria County, Illinois.

Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

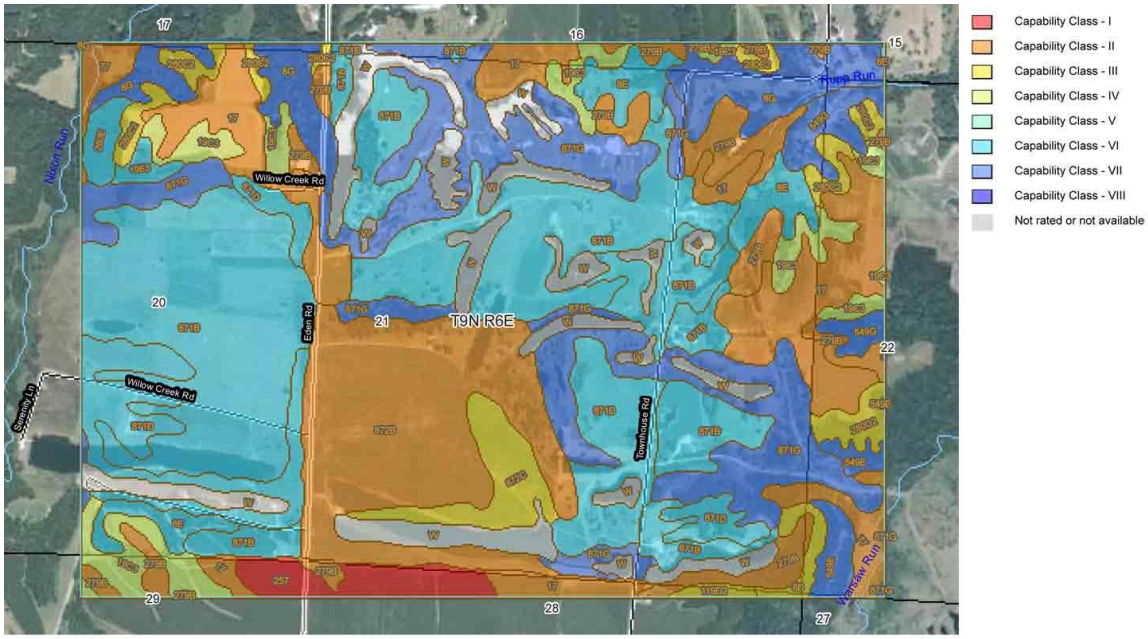

Figure 5. Nonirrigated capability class for a tract of land in Peoria County, Illinois.
Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

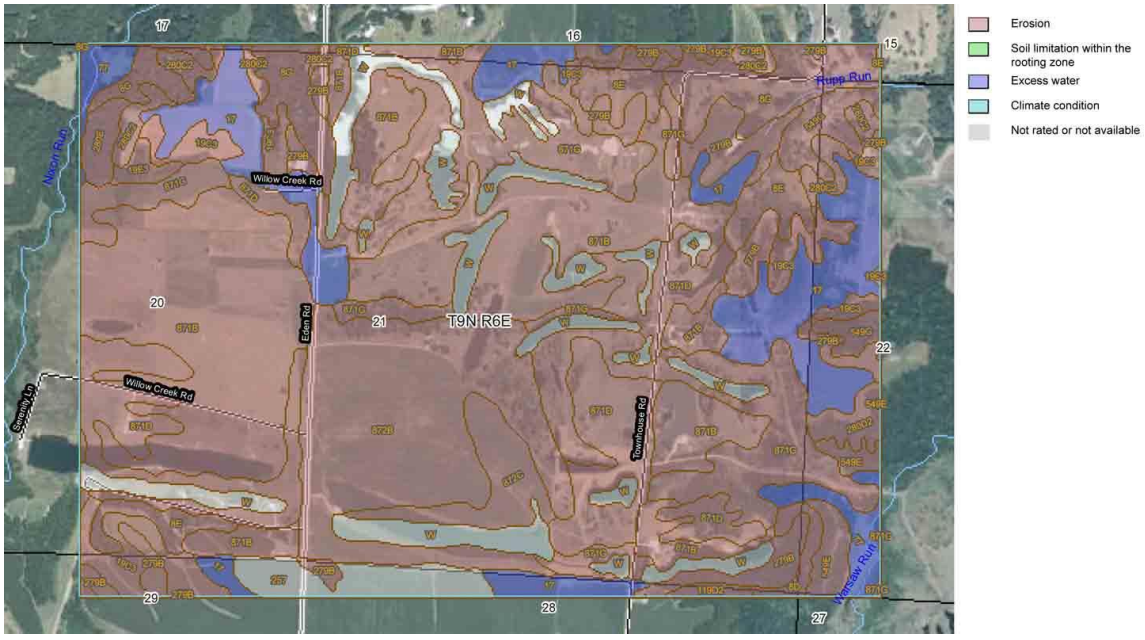

Figure 6. Nonirrigated capability subclass for a tract of land in Peoria County, Illinois. (Zoom in for more detail)
Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

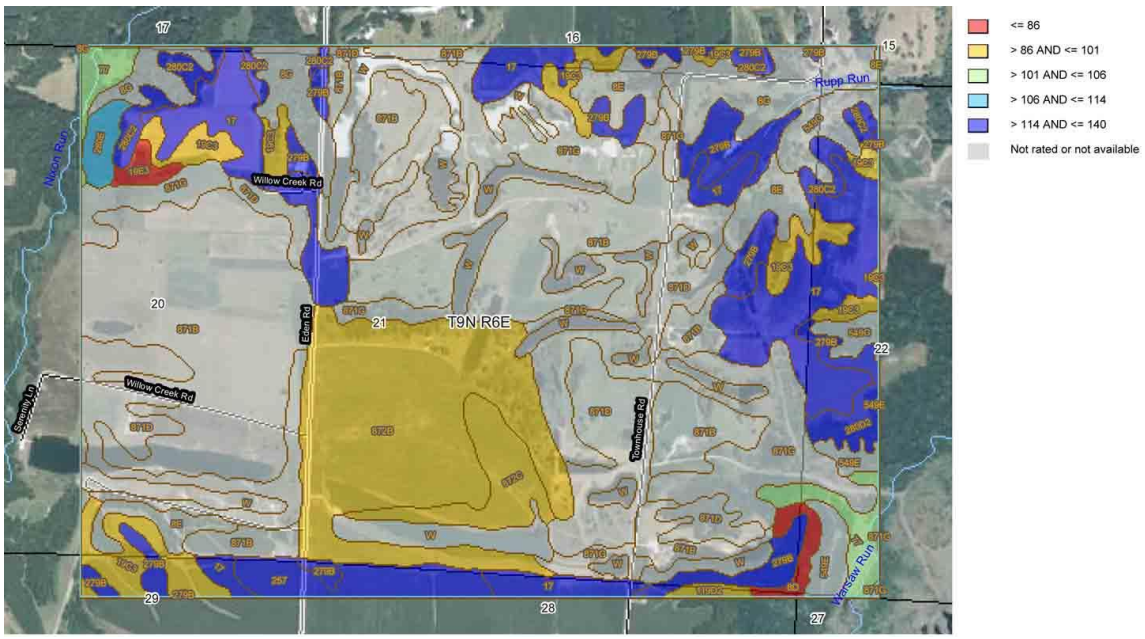

Figure 7. Corn yields of a nonirrigated tract of land in Peoria County, Illinois.

Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

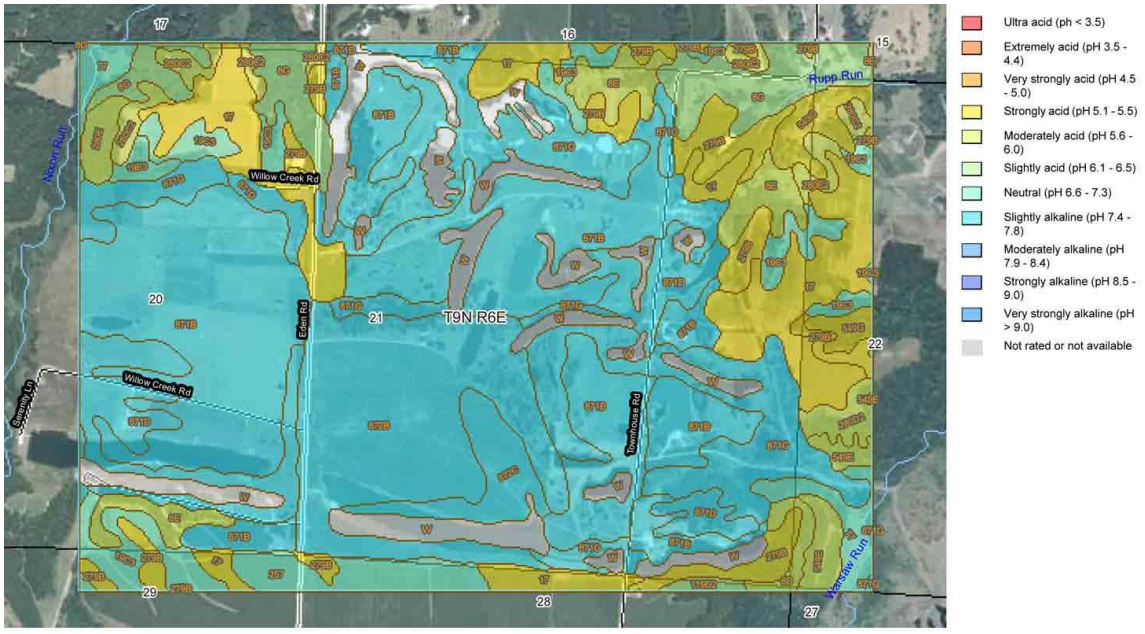

Figure 8. The pH of soils for a tract of land in Peoria County, Illinois.

(Zoom in for more detail)

Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

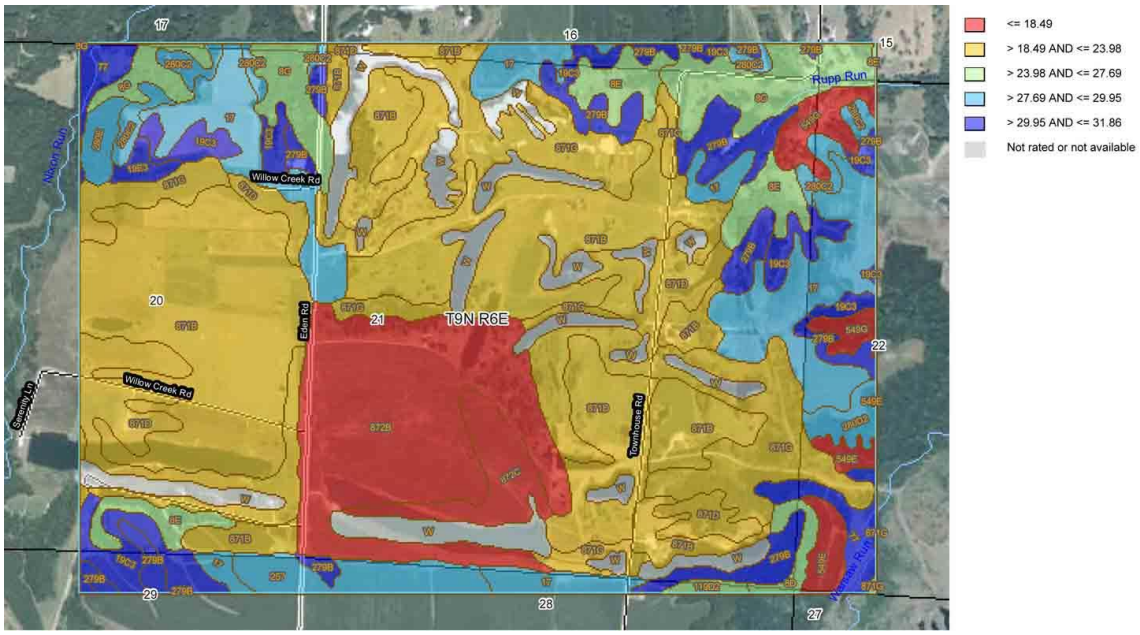

Figure 9. Available water capacity (0-150cm) of soils for a tract of land in Peoria County, Illinois. (Zoom in for more detail)
Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

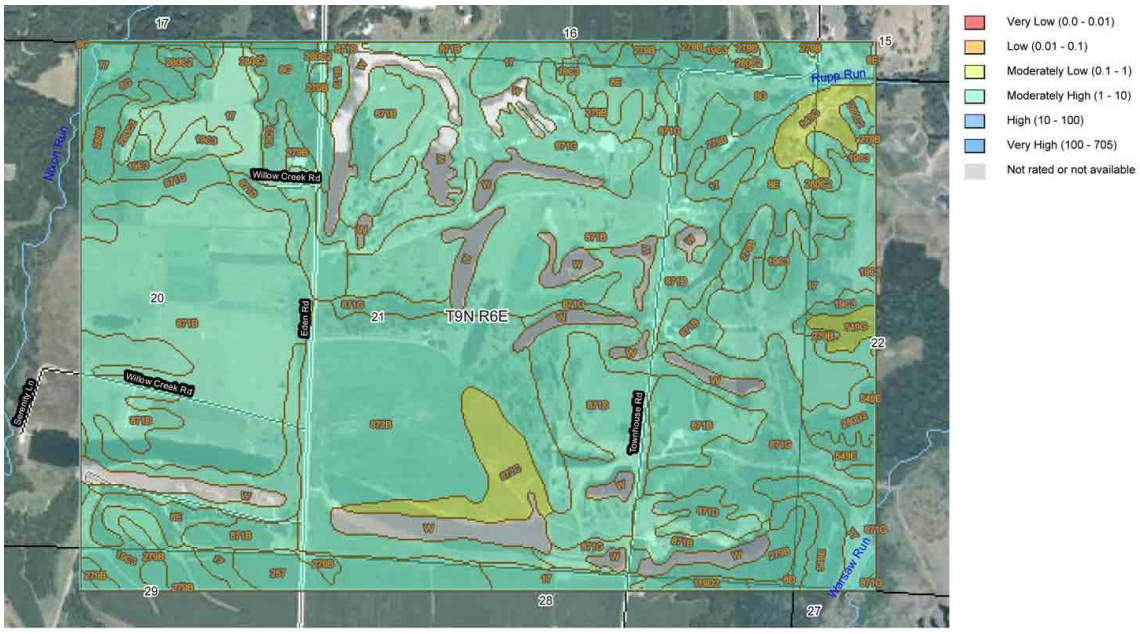

Figure 10. Saturated hydraulic conductivity (Ksat) for a tract of land in Peoria County, Illinois. (Zoom in for more detail)
Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

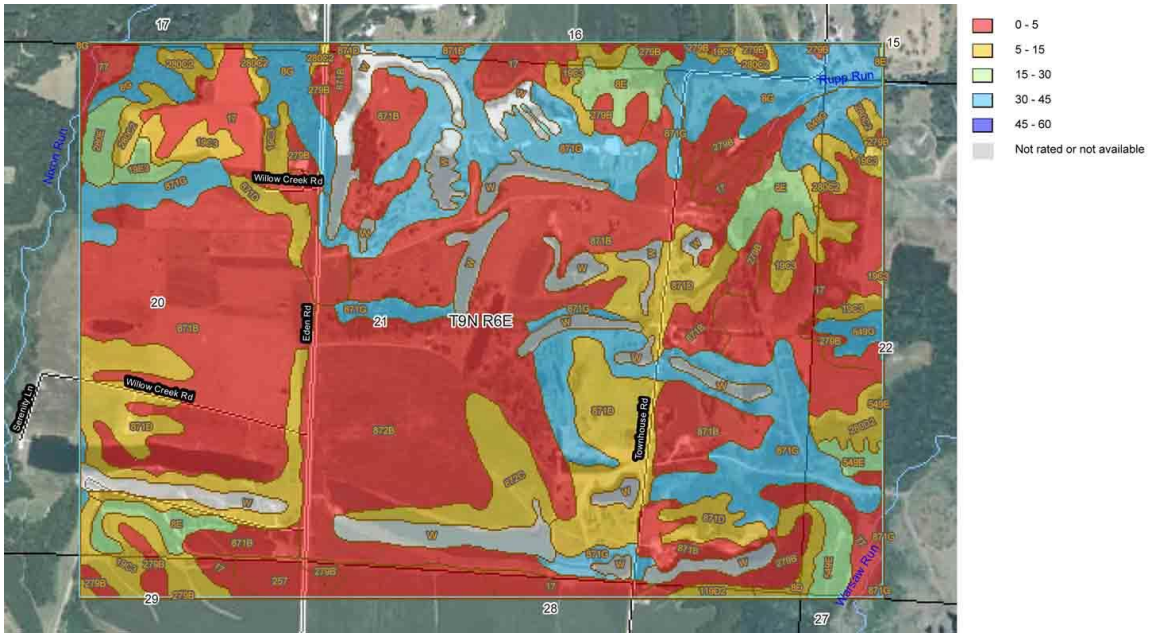

Figure 11. Slope of soils for a tract of land in Peoria County, Illinois.

Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

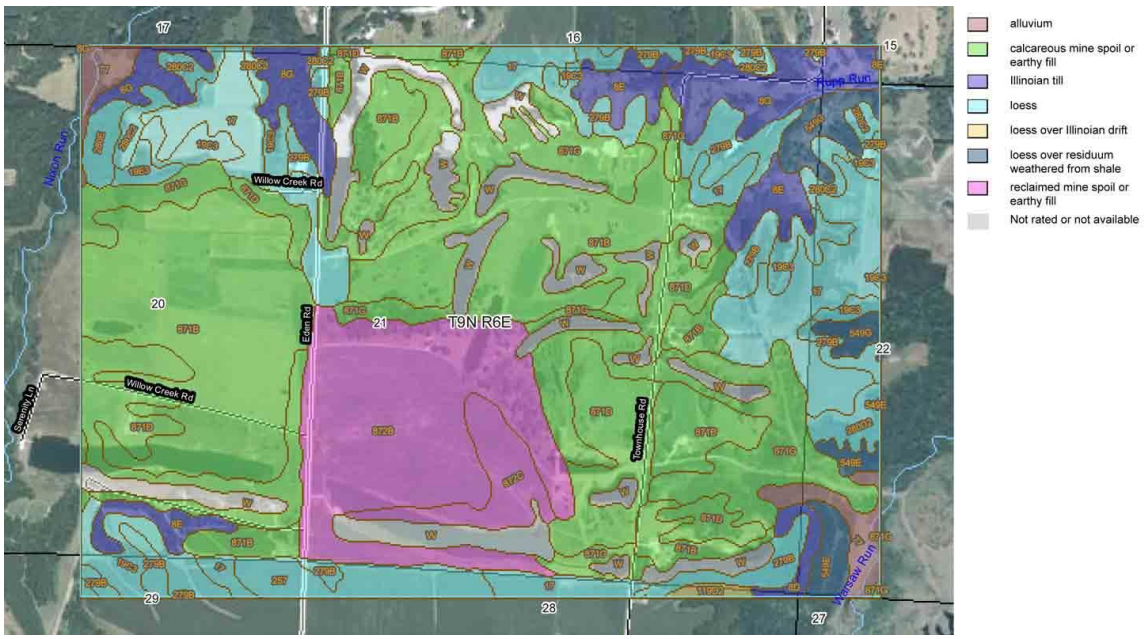

Figure 12. Parent material name for a tract of land in Peoria County, Illinois.

(Zoom in for more detail)

Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

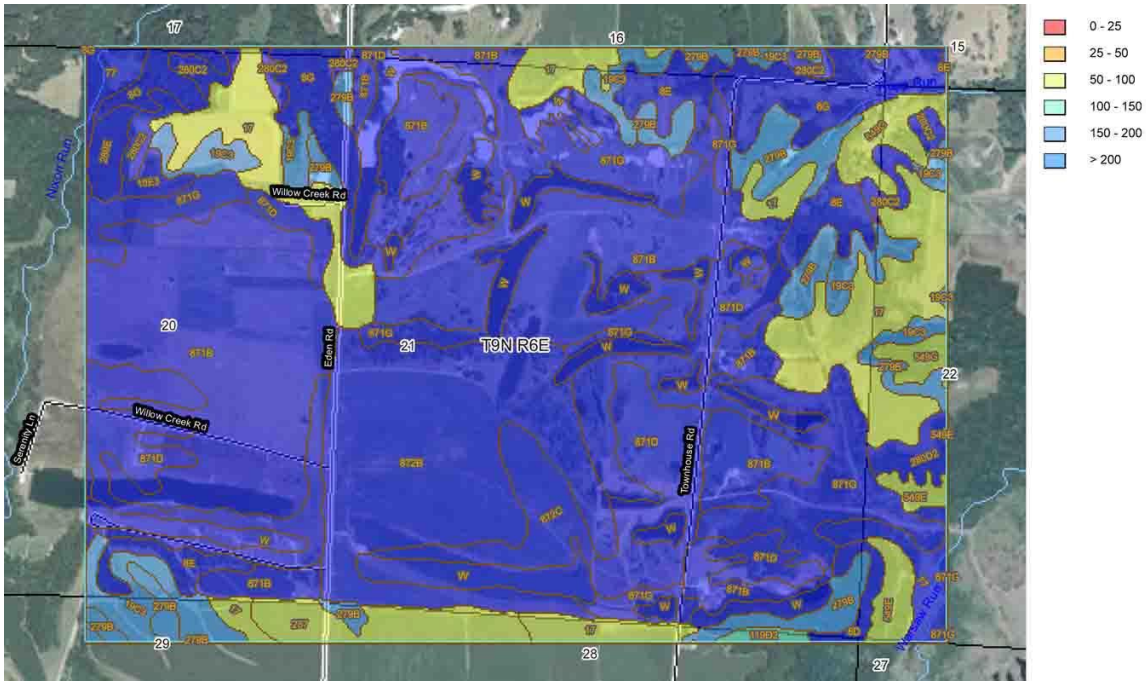

Figure 13. Depth of water table of soils for a tract of land in Peoria County, Illinois. (Zoom in for more detail)
Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Summary

The objective of using soil information is to assist in reconstructing the mined soils to the approximate level of productivity the cropland, rangeland, woodland, hayland, or pastureland had before the mining occurred. The SDM, WSS, NCCPI, and LESA furnish objective, quantitative soil information to answer questions that land use managers of coal companies can defend or explain to government agencies and the general public during the development of the plan for soil reconstruction following surface mining for coal. The LESA program requires significant user input and results vary based on the objective of the user.

SDM, WSS, LESA, and NCCPI are helpful to learn more about soils in an area where a person may or may not have ever worked. The information from SDM, WSS, and NCCPI computer tools and LESA program is useful in 1) understanding some of the soil limitations, hazards, and conditions of performance under a specific use, 2) evaluating areas for specific uses or alternative uses for specific area, and 3) determining treatments required for good soil and water conservation under a given use.

Most people who use SDM, WSS, LESA, and NCCPI find them useful in 1) assessing the soils of a specific area, 2) foreseeing problems and evaluating the feasibility of corrective measures, 3) determining the need for additional expert study, 4) determining what additional soil sampling, testing, and interpreting must be done, and 5) meeting the requirements in 30CFR785.17, 2009 and 30CFR823, 2009.

It is beyond the scope of this paper to discuss the overall progress made in the solution of soil and revegetation challenges (soil removal, storage, and reconstruction and restoration of original productivity) for surface mined land for coal. Substantial progress apparently has been made. Probably the best evidence of this is the fact that original soil productivity is being documented for soil reconstructed after surface mining and bonds are being released for mined lands. This situation is believed to be due to better techniques being used during surface mining for coal, and a more earnest desire on the part of everyone to reconstruct a soil similar to the original soil as described in the Web soil survey and using agronomic management learned to date on mined lands.

References

Bartetti, L.J. 1966. General soil map – a study of landscapes. J. Soil Water Conserv. 21 (1):3-6.

Dobos, R.R., H.R. Sinclair, Jr., and K.W. Hipple. 2008. National Commodity Crop Productivity Index. Version 1.0. pp. 70 United States Department of Agriculture, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, Nebraska. Available online at: ftp://ftp-fc.sc.egov.usda.gov/NSSC/NCCPI/NCCPI_user_guide.pdf accessed October 26, 2009.

Glaser, R. 1992. Expert knowledge and processes of thinking. *In* D.F.Halpern (Ed.), Enhancing thinking skills in the sciences and mathematics (pp. 63–75). Lawrence Erlbaum Associates, Publishers. Hillsdale, NJ and Hove and London, England. ix, 155 pp.

National Cooperative Soil Survey (NCSS). 2009. National Soil Information System. U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey Division. Lincoln, NE. Available online at: http://soils.usda.gov/technical/nasis/

Suhl, S.E. 2003. Soil Survey of Fulton County, Illinois. USDA-Natural Resources Conservation Service. Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1983. National Agricultural Land Evaluation and Site Assessment Handbook, title 310-VI-NLESAH (issue 1). Washington, DC.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2001. User Manual for LESA-CALES: Computer-Assisted Land Evaluation System. NSSC. Lincoln, NE

U.S. Department of Agriculture, Natural Resources Conservation Service. 2006a. National Soil Information System (NASIS) database for Fulton County, Illinois. USDA- Natural Resources Conservation Service.

U.S. Department of Agriculture, Natural Resources Conservation Service. 2006b. National Soil Information System (NASIS) database for Peoria County, Illinois. USDA- Natural Resources Conservation Service.

U.S. Department of Agriculture, Natural Resources Conservation Service. Soil Data Mart. Available online at: http://soildatamart.nrcs.usda.gov/ accessed October 26, 2009c.

U.S. Department of Agriculture, Natural Resources Conservation Service. Web Soil Survey. Available online at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm accessed October 26, 2009d.

Walker, B.W. 1992. Soil Survey of Peoria County, Illinois. USDA-Natural Resources Conservation Service. Washington, DC.

30CFR785.17. 2009. Requirements for Permits for Special Categories of Mining of Prime Farmland. Office of Surface Mining Reclamation and Enforcement. Department of Interior. Washington, D.C.

Available online at: http://edocket.access.gpo.gov/cfr_2009/julqtr/30cfr785.17.htm

30CFR823. 2009. Special Permanent Program Performance Standards_Operations on Prime Farmland. Office of Surface Mining Reclamation and Enforcement. Department of Interior. Washington, D.C. Available online at: http://www.access.gpo.gov/nara/cfr/waisidx_09/30cfr823_09.html