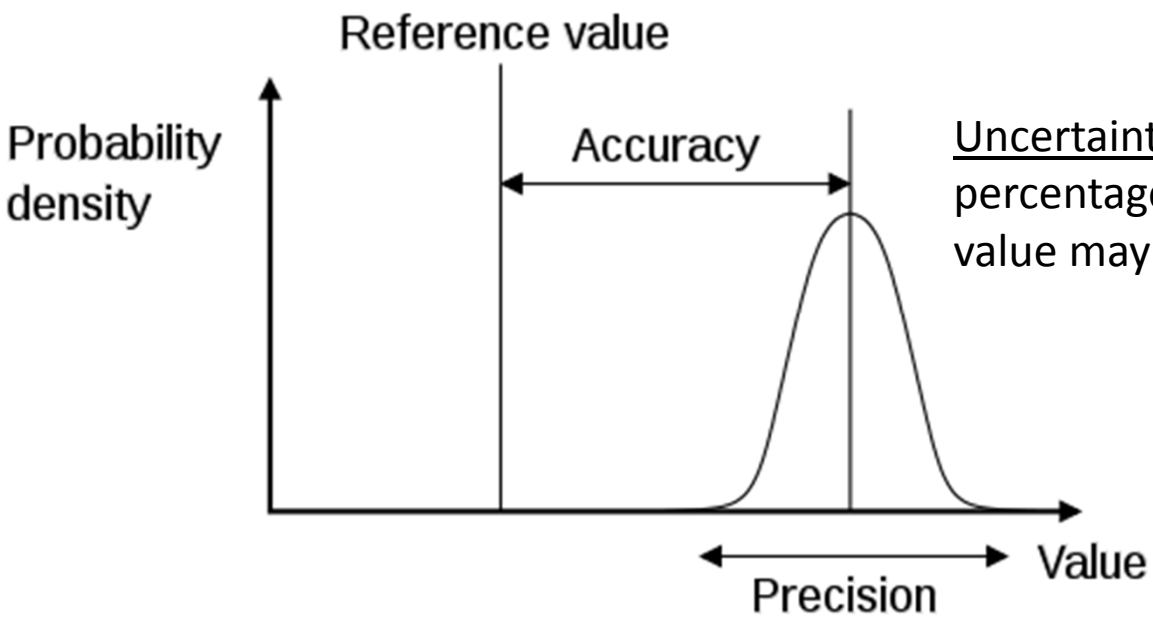
Overview of Soil Survey Database History with Uncertainty implications

Zamir Libohova, Skye Wills, Paul Finnell, Jon Hempel, Steve Peaslee

USDA-NRCS-National Soil Survey Center
Lincoln, Nebraska

Precision vs. Accuracy vs. Uncertainty

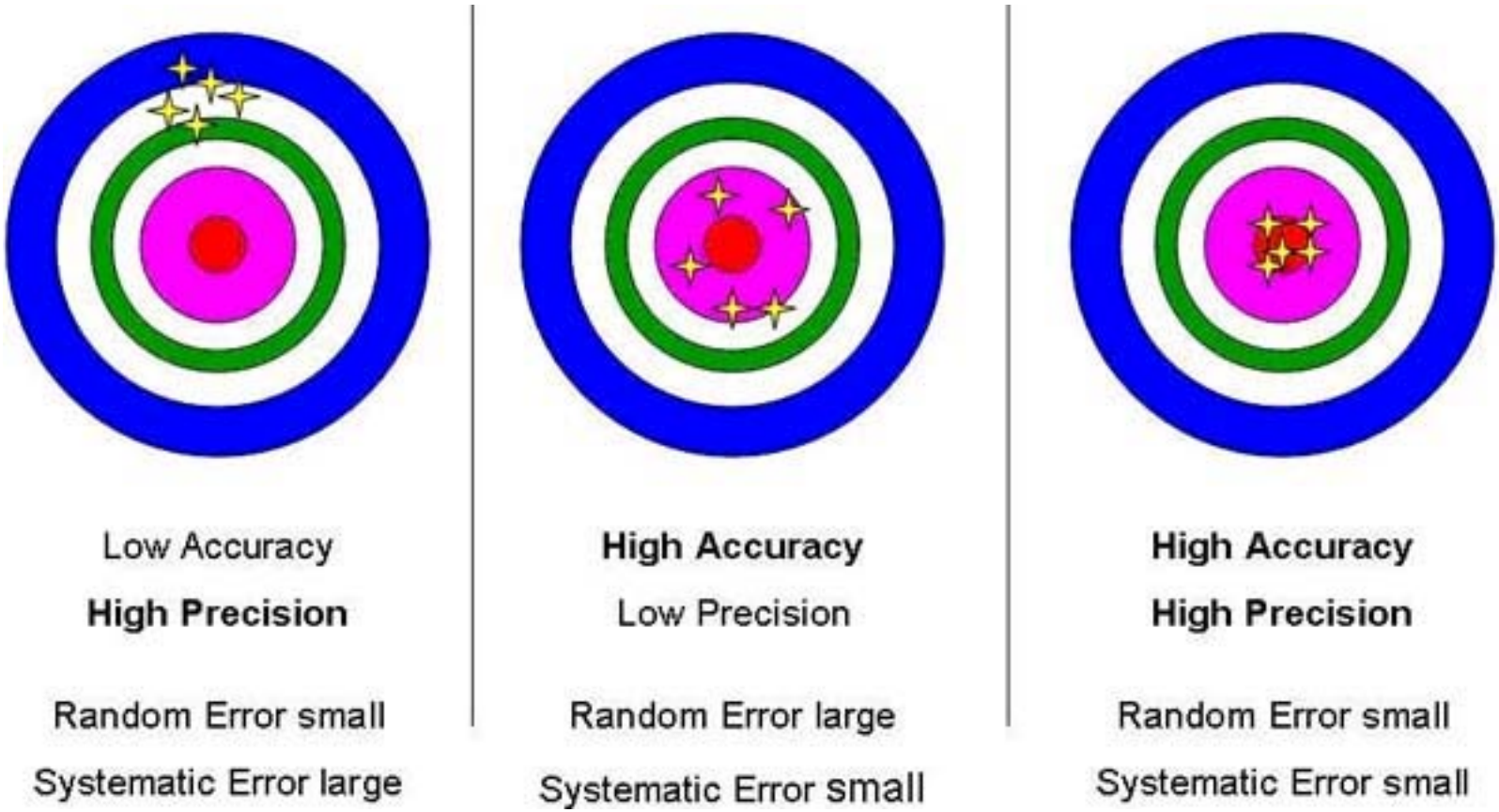
Accuracy: The ability of a measurement to match the actual value of the quantity being measured



Uncertainty: The *estimated* amount or percentage by which an observed or calculated value may differ from the true value

Precision: The ability of a measurement to be consistently reproduced

Error/Precision/Accuracy



Versioned *GlobalSoilMap.net* products
Release 2.2

For the purposes of these specifications, uncertainty is defined in terms of the 95% prediction interval (PI). The 95% PI reports the range of values within which the true value is expected to occur 19 times out of 20 (or 95% of the time). The 95 per cent (± 2.5%) confidence limit is often regarded as appropriate for range definition (IPCC, 1996).

There is no assumption that this prediction interval is necessarily symmetric around the predicted value.

Chasing the Errors/Uncertainty

- Possible sources of Errors/Uncertainty:
  - <u>Analytical methods (precision estimates):</u>
    - Between Laboratories Reproducibility (R);
    - Within Laboratory:
      - Reproducibility (R_L);
      - Repeatability (r).
  - Pedotransfer Functions (ptf);
  - Database Transactions;
  - Pedon Accuracy Locations (PLS vs GPS);
  - Other sources (ongoing).

Analytical Methods

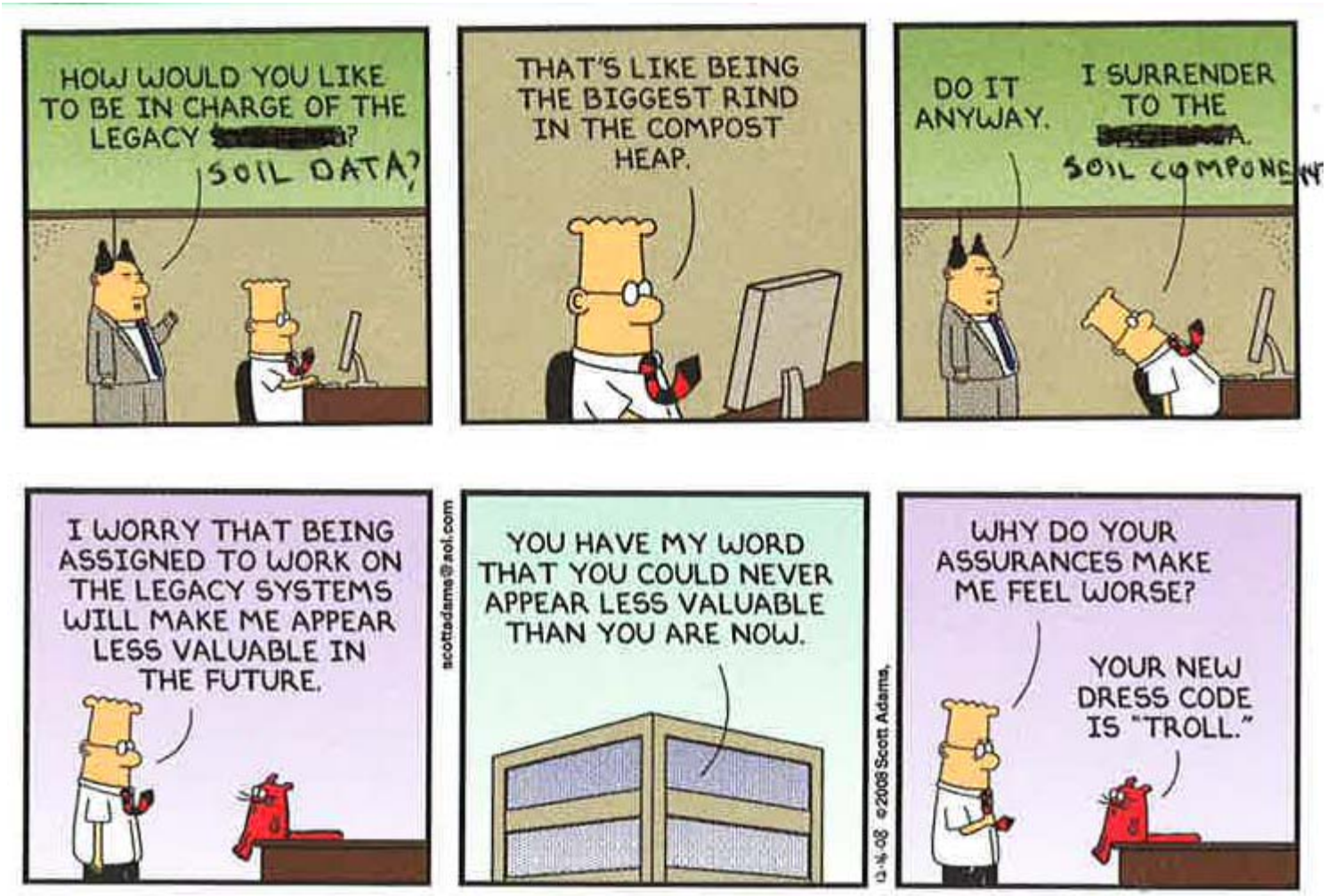
These three precision estimates are measures of the spread of results when a sample is analyzed repetitively under specified conditions, with 95% confidence that results would fall within ± (R, R_L, or r) of the mean:

- Between Laboratory Reproducibility(**R**) : is a measure of the agreement between results obtained by the same method on identical test materials under different conditions (e.g., different laboratories, different analysts, different equipment, etc.);
- Within Laboratory Reproducibility "**R_L**" : is a similar measure but within the same laboratory;
- Within Laboratory Repeatability "**r**" : measures the agreement between results obtained within the laboratory by the same method on identical test material under the same conditions (e.g., same analyst, same day, same equipment, etc.).

Database Transactions

- Many paths have been followed to populate the soil property attribute tables:
  - Measured laboratory data;
  - Field data estimates/tacit knowledge;
  - Class Limits (UL and LL);
  - Arithmetic Mean of UL and LL (for RV);
  - Other means.
- Poor documentation.

The Call to Paul



Source: Dilbert by Scott Adams at dilbert.com

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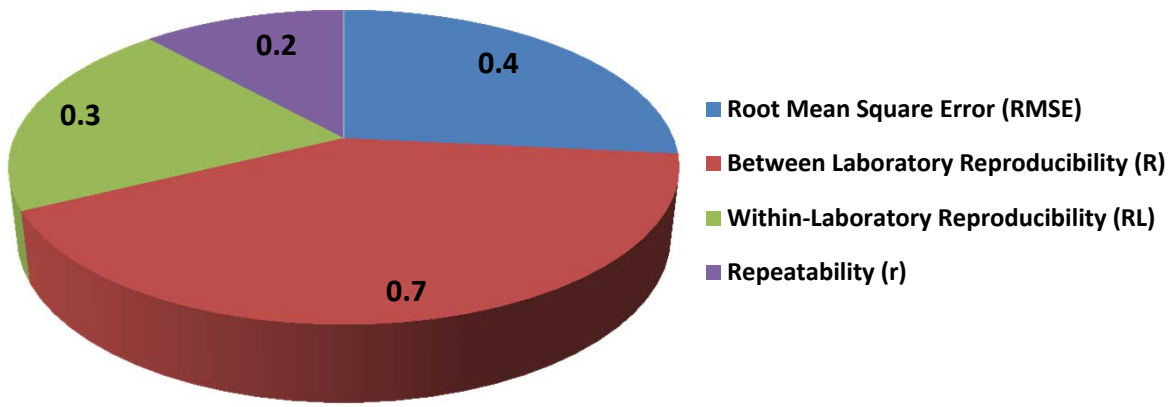
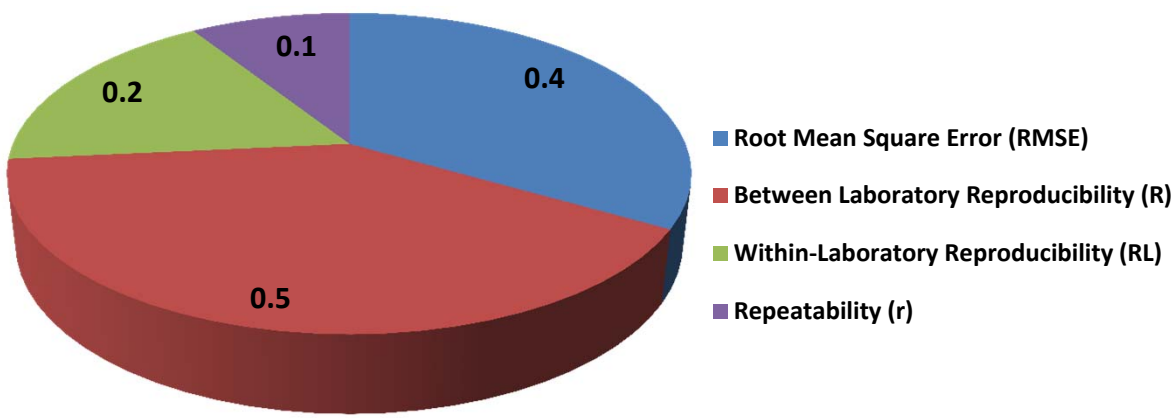
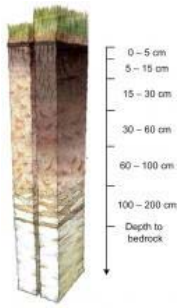
Error source and magnitude associated with analytical pH methods and pH $1{:}1_W$ and pH $1{:}2_{Ca}$ predictors (ptf)

pH $1{:}1_W$



pH $1{:}2_{Ca}$





NSSH Definitions

618.0 Definition and Purpose

The soil properties entered in the National Soil Information System (NASIS) must be representative of the soil and the dominant land use for which the *interpretations* are based

618.2 Collecting, Testing, and Populating Soil Property Data

Most data entries are developed by *aggregating information from point data* (pedons) to create low, high, and representative values for the component.

618.3 Soil Properties and Soil Qualities

Ranges of soil properties and qualities that are posted in the NASIS database for map unit components may extend beyond the established limits of the taxon from which the component gets its name, *but only to the extent that interpretations do not change*. However, the representative value (rv) is within the range of the taxon.

Source: http://soils.usda.gov/technical/handbook/contents/part618.html#00

Chasing the Errors/Uncertainty

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  - Other sources (ongoing).

Official Series Descriptions (OSDs)

Contained typical soil profiles with genetic horizons (A/Ap, Bt…Cr, R and Laboratory Data)

Transferred to

National Guidelines (National Survey Handbook- NSH, 1983) developed to convert genetic horizons to similar layers (L1..L6) based on interpretations.
However, some states customized (fine tuned) the soil property ranges from the NSH to fill in Soil Interpretations Record (aka SOI-5).
Idaho example:
Liquid Limit/Plasticity Index and CEC

SOI 5 Forms

Examples:

OSD			SOI-5		
Horizon	Thickness	OM (%)	Layer	Thickness	OM (%)
Ap	0-5	4.4	L1	0-15	4.0
A1	5-15	3.6			
Ap	0-10	4.6	L1	0-200	4.6
…	…				
A6	170-200	n/a			

USDA NRCS
Natural Resources Conservation Service

How the SOI-5 were populated

Exhibit 618-7 Estimating LL and PI from Percent and Type of Clay. MINERAL SOILS

Table for Estimating LL and PI as Based on Kind and Percent of Clay

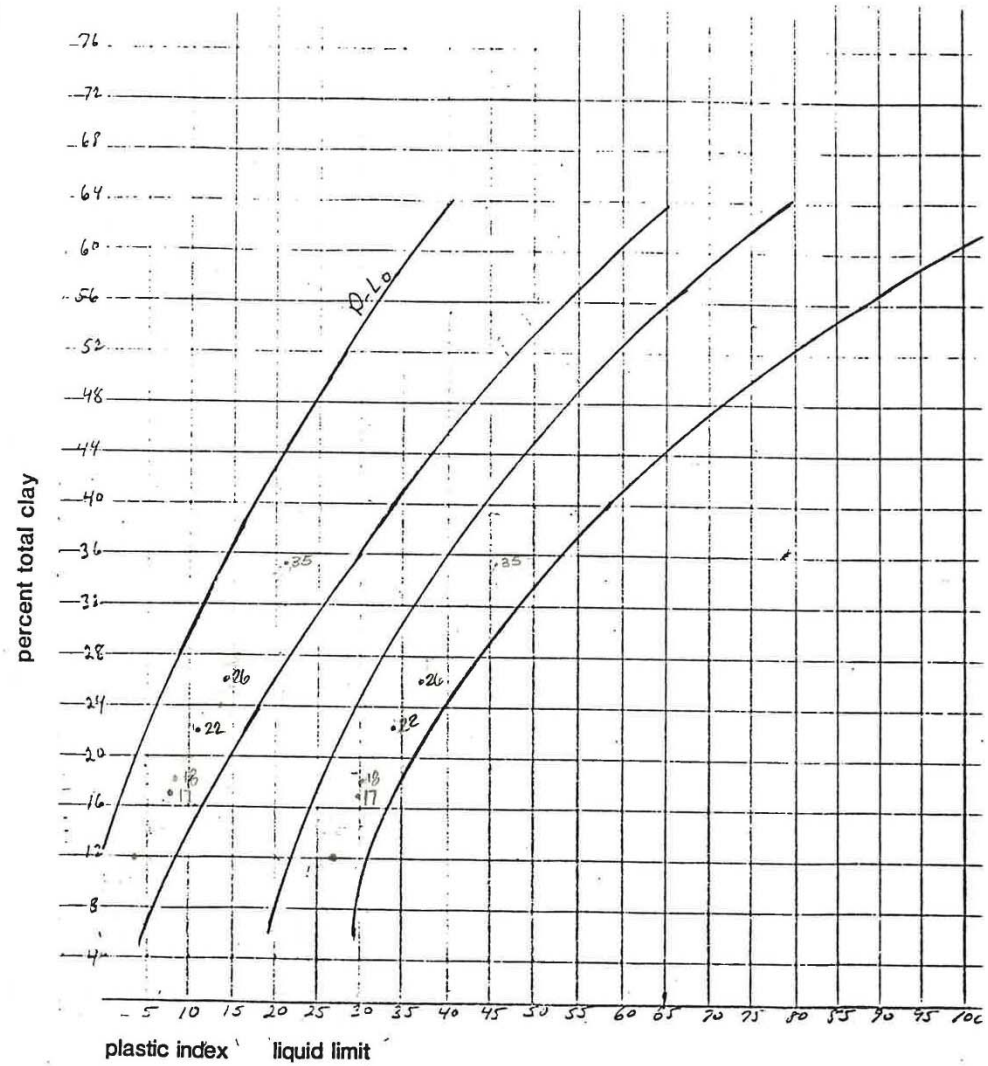
Percent of clay	Montmorillonitic 1/ class		Mixed class 2/ with considerable 2:1 clays		Mixed class 3/ with considerable 1:1 clays	
	LL	PI	LL	PI	LL	PI
10	26	9	21	4	16	3
12	28	11	23	6	18	4
14	30	12	25	7	20	5
16	32	14	26	8	21	6
18	34	15	28	9	23	7
20	36	17	30	11	25	8
22	38	19	32	13	27	9
24	40	20	34	14	29	10
26	42	22	35	15	30	11
28	44	23	37	16	32	12
30	46	25	39	18	34	13
32	48	27	41	20	36	14
34	50	28	43	21	38	15
36	52	30	44	22	39	16
38	54	31	46	23	41	17
40	56	33	48	25	43	18
42	58	35	50	27	45	19
44	60	36	52	28	47	20
46	62	38	53	29	48	21
48	64	39	55	30	50	22
50	66	41	57	32	52	23
52	68	43	59	34	54	24
54	70	44	61	35	56	25
56	72	46	62	36	57	26
58	74	47	64	37	59	27
60	76	49	66	39	61	28

1/ Based on the relationship of LL = 16 + 1.0 (clay) and PI = LL - [15 + 0.2 (clay)].
2/ Based on the relationship of LL = 12 + 0.9 (clay) and PI = LL - [15 + 0.2 (clay)].
3/ Based on the relationship of LL = 7 + 0.9 (clay) and PI = LL - [0 + 0.4 (clay)].

NOTE: Do not use this table for kaolinitic clays or oxidic or andic materials.

May :1984 HBM

LIQUID LIMITS AND PLASTICITY INDEX IDAHO



Graph number I

approximately 100 samples

Applies to most Idaho soils

CEC Example

Rules were developed based on laboratory data and research;
Many publications appeared in SSSJ and other Journals.
For example: Donald et al., 1993. Correlations Between Field and Laboratory Measurements of Soil Color. In SSSA Special Publication No. 31.

ed States
artment of
culture

Soil
Conservation
Service

West National Technical Center
511 N.W. Broadway, Rm. 248
Portland, Oregon 97209-3489

July 11, 1989

WEST NTC BULLETIN NO. W430-9-2

SUBJECT: SOI - SOIL INTERPRETAIONS - CEC ESTIMATION

Purpose. To provide information on how to estimate CEC for soil data base.

Expiration Date. September 30, 1989.

The National Soil Survey Laboratory has provided the following information to assist in estimating cation exchange capacity (CEC) for the soil data base (new entries for SCS-SOI-5). In the near future additional instructions will be included in the National Soil Handbook.

The work of Nettleton, Brasher, and Baumer, NSSL, has been assimilated to express "CEC of the clay in meq/100g as the clay activity times the percent clay". Clay activity is determined by the ratio of CEC (cation exchange capacity of the soil mineral fraction) to percent clay.

The attached map of the United States illustrates general geographical areas of clay activity. "In most cases, clay activity will not vary greatly in a geographic area and will generally be the same throughout a soil profile". (Baumer, Rice 1988)

By using the map, the following example demonstrates how CEC's can be estimated for the clay plus organic matter: a soil with 20% clay in clay activity class 5, [20% x (0.4 to 0.6) x 100], would have CEC 8 to 12 meq/100g for the clay fraction.

An over simplified method for determining the CEC of organic matter discussed in Buckman and Brady follows: CEC = % OM x (2) x 100, example: % OM = 1 to 2 thus CEC =0.01 to 0.02 x (2) x 100 or 2 to 4 meq/100g. These numbers are added to the CEC for the clay fraction. CEC for the layer would be 10 to 16 rounded to the nearest 5 m.e. the estimated CEC entry for the SCS-SOI-5 would be 10 to 15 meq/100g.

2 meq per % OM.

It is recommended that this method of determining CEC values be used to supplement existing laboratory data. This will provide a consistent and documented procedure.

STANLEY N. HOBSON
Director

Attachment

- < 15% clay - round to nearest 1 meq
≥ 15% clay - round to nearest 5 meq

NP 3/16/92

WHEN LAB DATA IS AVAILABLE
pH < 5.5 USE BASE PLUS ALUMINUM CEC
pH > 5.5 USE NH_4 OAC CEC

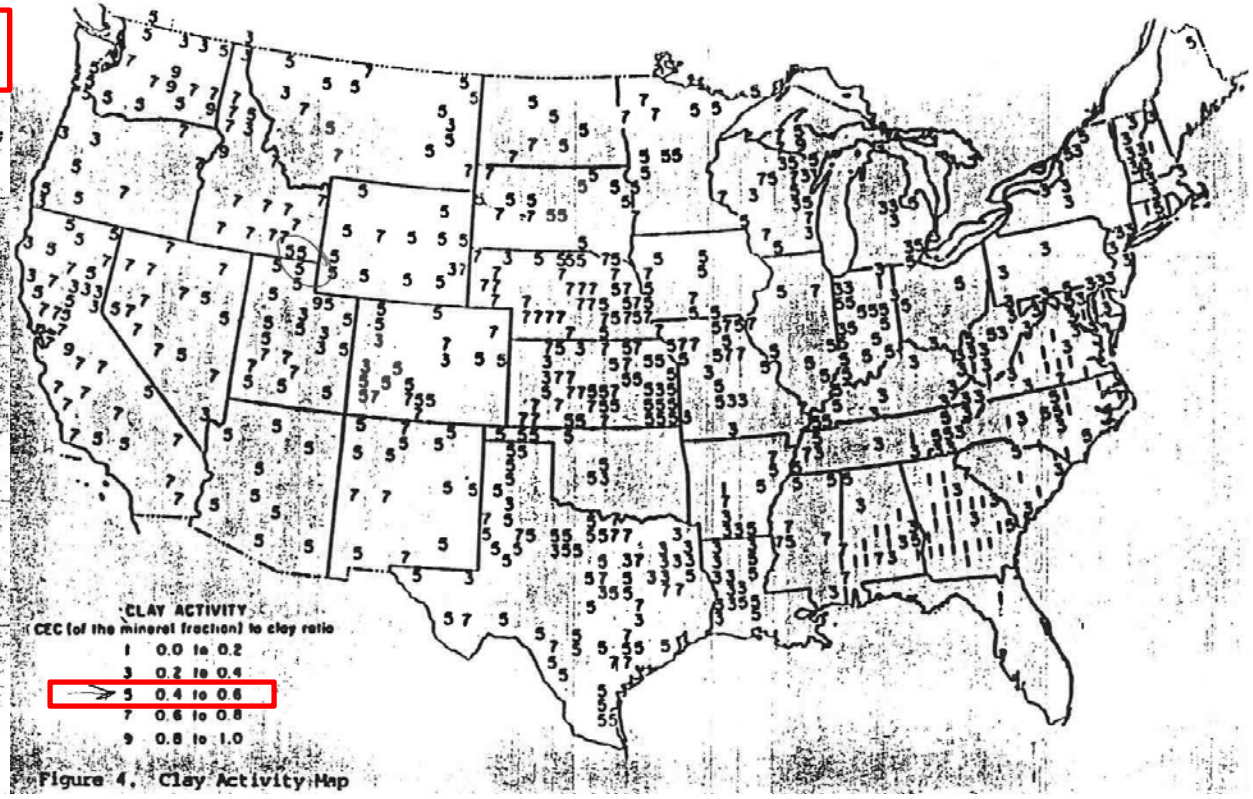


Figure 4. Clay Activity Map

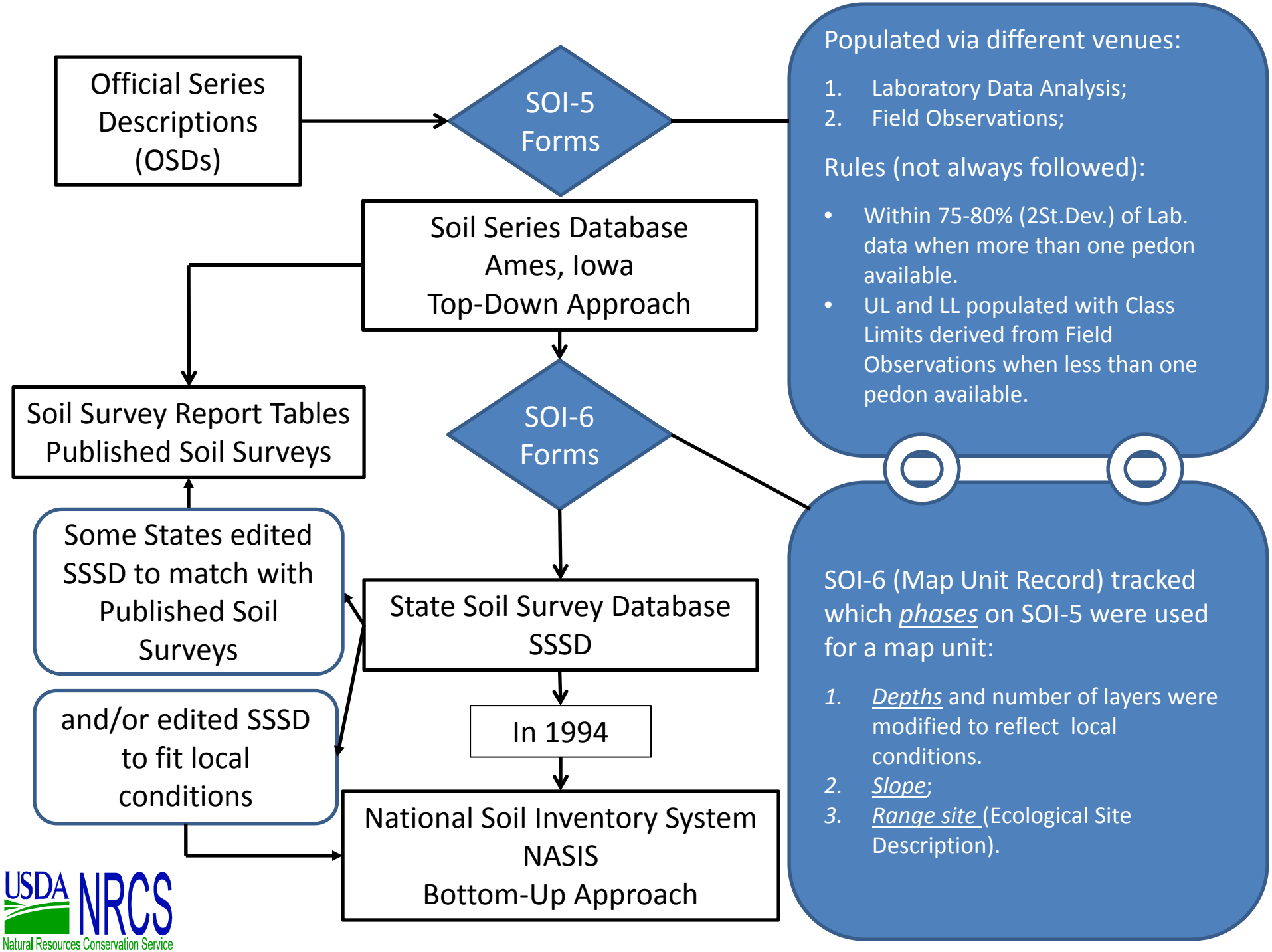

Official Series Descriptions (OSDs)
SOI-5 Forms
Soil Series Database Ames, Iowa Top-Down Approach
Soil Survey Report Tables Published Soil Surveys
SOI-6 Forms
Some States edited SSSD to match with Published Soil Surveys
State Soil Survey Database SSSD
and/or edited SSSD to fit local conditions
In 1994
National Soil Inventory System NASIS Bottom-Up Approach
Populated via different venues:
1. Laboratory Data Analysis;
2. Field Observations;
Rules (not always followed):
• Within 75-80% (2St.Dev.) of Lab. data when more than one pedon available.
• UL and LL populated with Class Limits derived from Field Observations when less than one pedon available.
SOI-6 (Map Unit Record) tracked which phases on SOI-5 were used for a map unit:
1. Depths and number of layers were modified to reflect local conditions.
2. Slope;
3. Range site (Ecological Site Description).
USDA NRCS
Natural Resources Conservation Service

Exhibit 603-18. Soil Interpretations Record (SCS-SOI-5).

SOI - 5

SOIL INTERPRETATIONS RECORD

Select:
the appropriate phases from SOI-5:

- *Surface texture*;
- *Slope*;
- *Range Site* (Ecological Site Description)

to populate SOI-6

SOI - 6

MAP UNIT RECORD

U.S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

NAME OF SOIL SURVEY AREA	SURVEY ACREAGE BY COUNTIES: COUNTY 1 IN AREA	COUNTY 1 TOTAL	COUNTY 2 IN AREA	COUNTY 2 TOTAL
VA FAIRFAX COUNTY, VIRGINIA	264960	264960		

FIELD SYMBOL	KIND	FIELD MAP UNIT NAME	MAP UNIT ACREAGE COUNTY 1	COUNTY 2
121C3	CS	APPLING GRITTY LOAM, ERODED UNDULATING PHASE	1994	

RECOM SYMBOL	MLRA	RECOMMENDED MAP UNIT NAME
AgB	153A	APPLING LOAM, 2 TO 7 PERCENT SLOPES

PUBLICA SYMBOL	DATE MO	DATE YR	APPROVED MAP UNIT NAME
Ag	06	92	APPLING SANDY LOAM 2 TO 7 PERCENT SLOPES

PER CENT OF UNIT	INTERPRETATION RECORD NUMBER	CRITICAL PHASE CRITERIA (use first line for single-taxon unit or first taxon of multi-taxa unit, second line for second unit, etc.) SLOPE	USDA TEXTURE	FLOODING	OTHER (growing season rainfall, erosion, aspect, etc.)
	NC0032	2-7	SL	NONE	X

ADDITIONAL SYMBOLS ON FIELD SHEETS (if more than 14, use second line)

1	2	3	4	5	6	7	8	9	10	11	12	13	14
121B	212	C2											

ADJUSTED LAYER DEPTH FOR MAP UNIT OR COMPONENTS OF MULTI-TAXA UNITS

MAP UNIT OR FIRST TAXON LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6	SECOND TAXON (use second line for third taxon) LAYER 1	LAYER 2	LAYER 3	LAYER 4	LAYER 5	LAYER 6
0-7	7-32	32-40									

RANGE SITE NAME (use first line for single-taxon unit or first taxon of multi-taxa unit, second line for second unit, etc.)

KEYPUNCH OPERATOR DUPLICATE FIELD SYMBOL ON ALL CARDS

USDA NRCS
Natural Resources Conservation Service

National Soil Inventory System
NASIS

Is under constant editing as data and/or observations become available

Soil Data Mart (SDM)
Published Snapshot of NASIS
http://soildatamart.nrcs.usda.gov/

Soil Survey Geographic Database SSURGO

State Soil Geographic Database STATSGO2

NASIS Rationale:

Interpretations developed based on actual soil properties;

Data capture at field level; ("bottom up" instead of "top down");

Multiple Components (SOI 6 limit was 3);

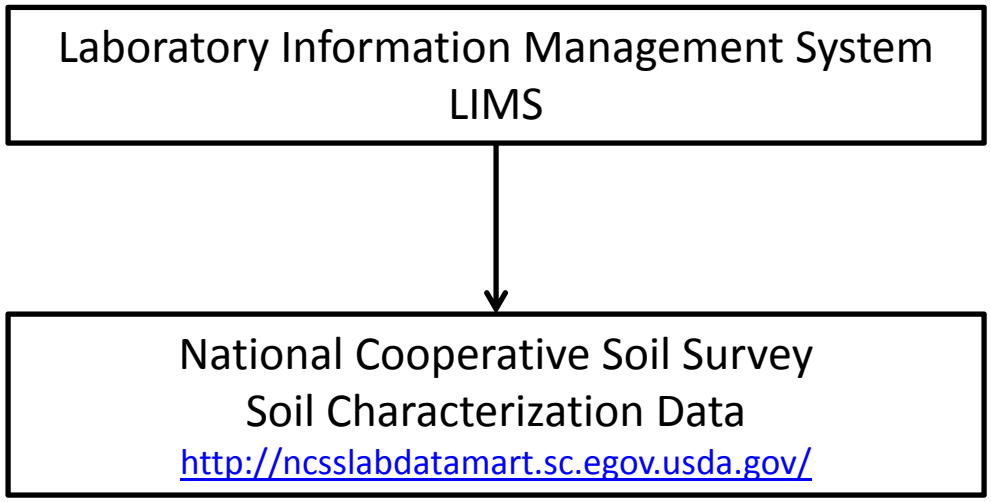
Multiple Horizons (SOI 5 limit was 6);

"RV"s - Representative Values for Modeling.

The end result: several sources are now available with different soil property values for the same soil map units.

http://soils.usda.gov/survey/geography/ssurgo/ http://soils.usda.gov/survey/geography/statsgo/

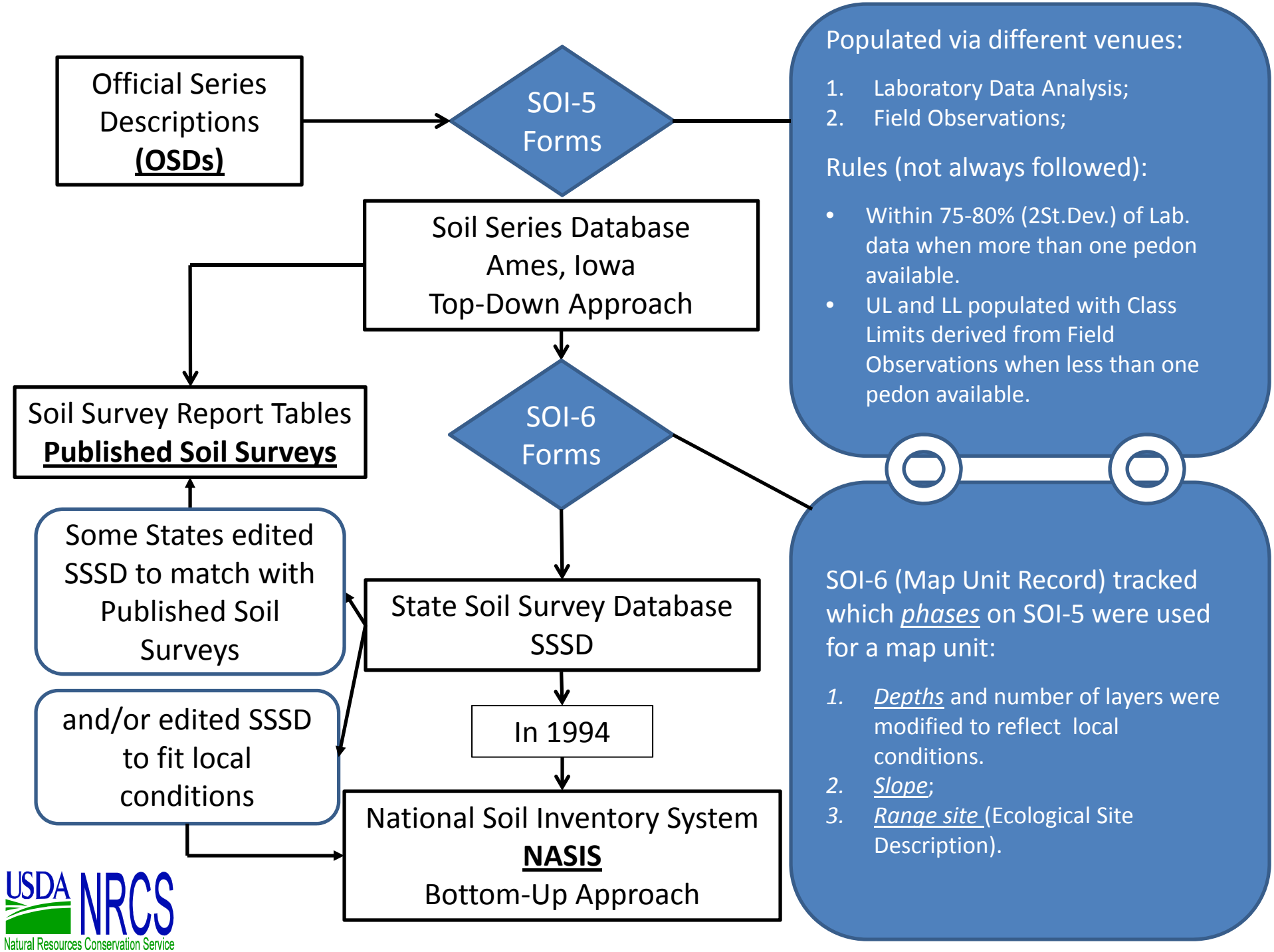
Laboratory Pedon Data



The NASIS/SDM/SSURGO are not directly linked with LIMS and can not be queried simultaneously;

Matching records between estimated and measured soil properties especially at horizon level is very difficult almost impossible for a 1:1 analysis ;

L1..L6 and/or H1..H6 and Genetic Horizons – Ap/A; Bt; C can not be disaggregated in a straightforward manner.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Dillon Creek Watershed Study Case

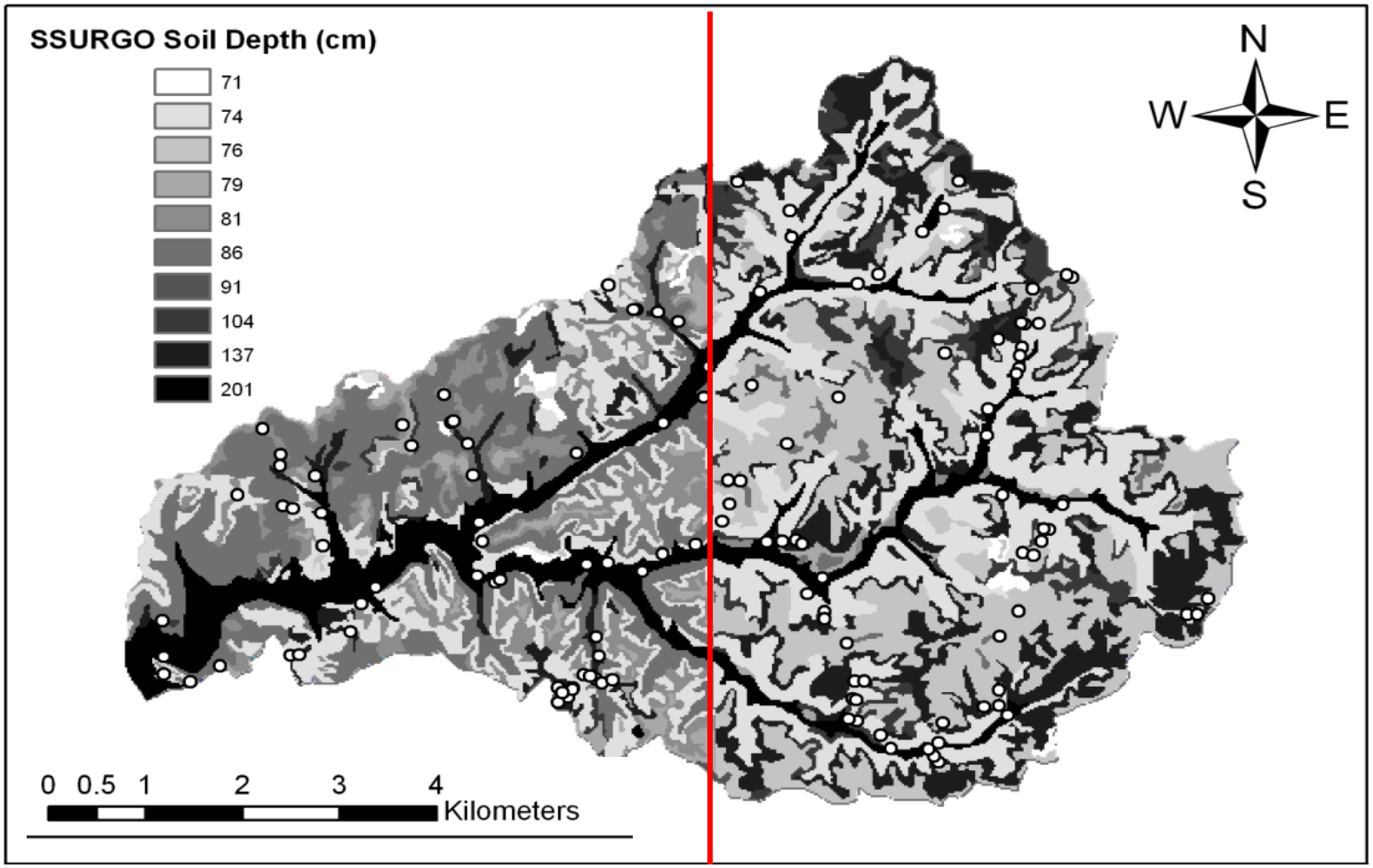
Soil depth to Lithic/Paralithic was measured for 127 georeferenced points stratified by major slope position (summit/shoulder, sideslope, and toeslope), but collected randomly within each slope position.

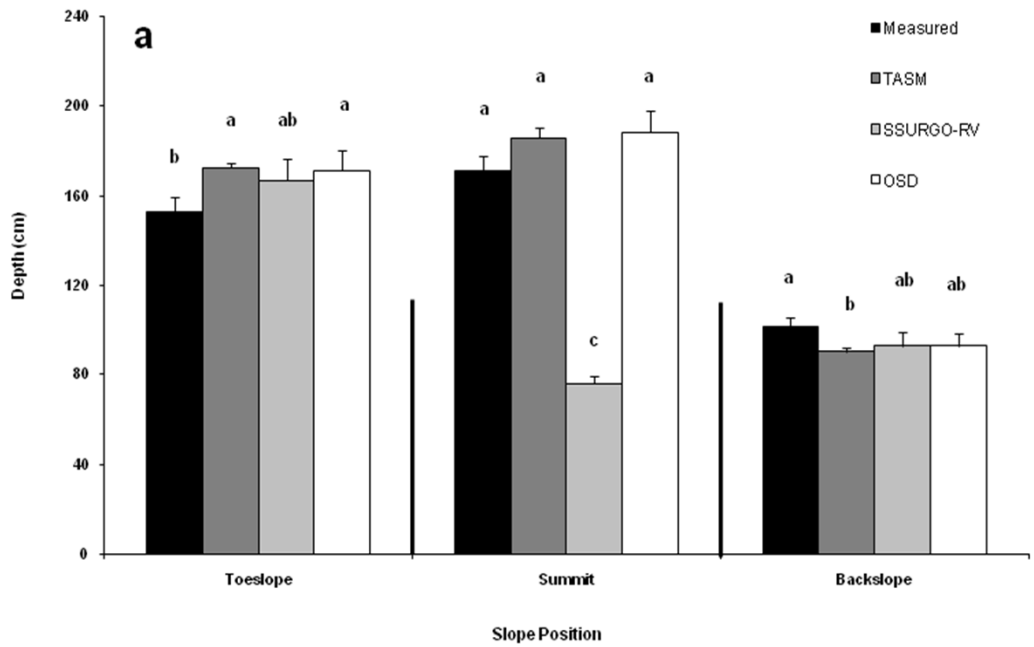
Slope Position	Soil Series	Depth to Lithic/Paralithic Contact (cm)		
		OSD†	SSURGO-RV‡	Published Soil Survey§
Summit/ shoulder	Tilsit, Bedford, Apalona, Johnsburg	198	201	178
	Tilsit, Bedford, Apalona	188	201	188
	Zanesville, Apalona, Wellston	165	173	155
Side slope	Gilpin, Wellston, Adyeville, Ebal	102	92	134
	Gilpin, Ebal, Berks	105	69	109
	Pekin, Bartle	126	201	119
Toeslope	Cuba	119	201	119
	Steff, Stendal, Burnside, Wakeland	200	201	200
	Rocky Outcrops, Steep Slopes	20	20	20

†- Official Series Descriptions.
‡- Soil Survey Geographic Database Representative Values.
§ - Published Soil Survey values were used.

Dillon Creek Watershed Study Case

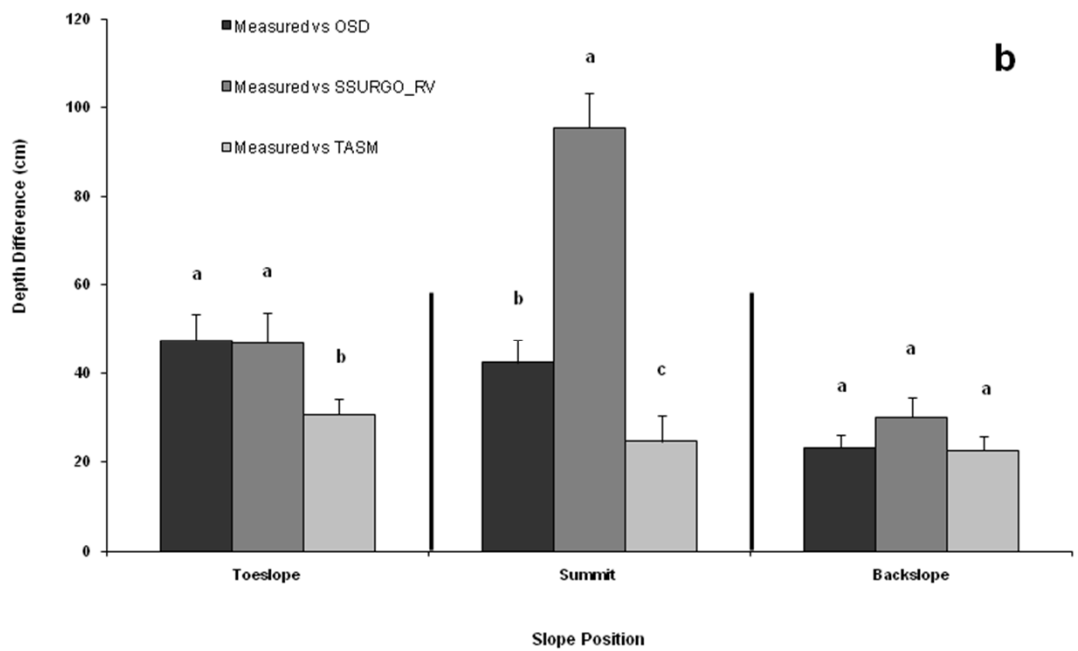
Dubois County **Orange County**





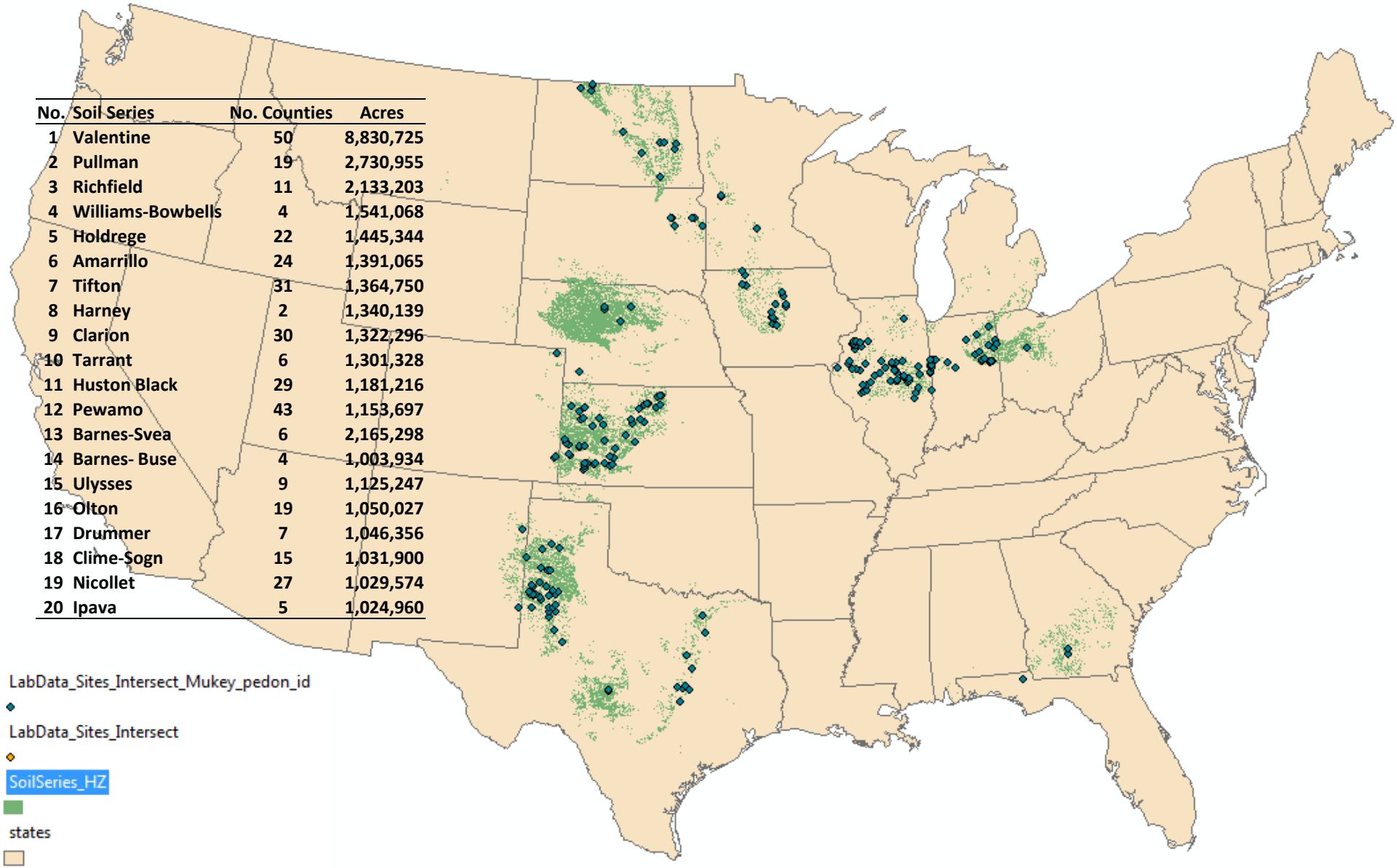
The Published Soil Survey predicted values for depth to lithic/paralithic contact were on average within 26 cm of measured values and were significantly closer to observations than SSURGO, which had a 57 cm mean difference from measured values.

Representative Values (RV) are the latest and most reliable source of expected soil properties, <u>but RV can be derived in a variety of ways</u>. For instance, the RV could be: (i) an average of the ranges (Min and Max); (ii) chosen within that range that would be the most likely to occur; (iii) chosen from the OSDs pedon ; (iv) or perhaps chosen from the representative pedon in a county, (v) but it could be a "virtual" pedon (M. Wigginton, personal communication).



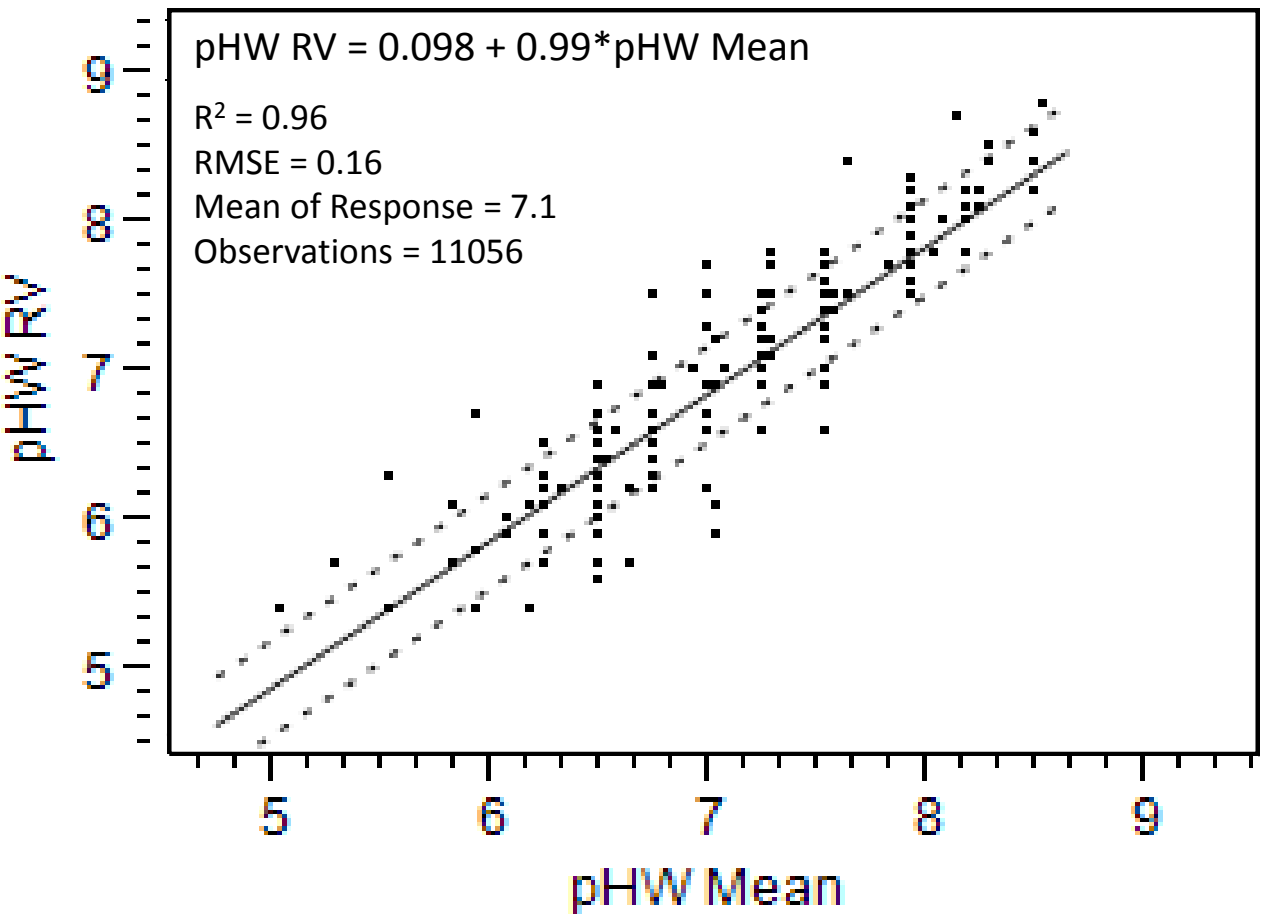
Mapped Soil Series with > 1 Million acres

No.	Soil Series	No. Counties	Acres
1	Valentine	50	8,830,725
2	Pullman	19	2,730,955
3	Richfield	11	2,133,203
4	Williams-Bowbells	4	1,541,068
5	Holdrege	22	1,445,344
6	Amarrillo	24	1,391,065
7	Tifton	31	1,364,750
8	Harney	2	1,340,139
9	Clarion	30	1,322,296
10	Tarrant	6	1,301,328
11	Huston Black	29	1,181,216
12	Pewamo	43	1,153,697
13	Barnes-Svea	6	2,165,298
14	Barnes- Buse	4	1,003,934
15	Ulysses	9	1,125,247
16	Olton	19	1,050,027
17	Drummer	7	1,046,356
18	Clime-Sogn	15	1,031,900
19	Nicollet	27	1,029,574
20	Ipava	5	1,024,960



Soil Series/Types

- pH RV. vs. Arithmetic Mean by Soil Series



pH RV. vs. Arithmetic Mean by

USDA NRCS
Natural Resources Conservation Service

Surface Horizons

Horizons	Mean	R^2	RMSE	Slope	Observations
Oe	5.8	na	0.00	0.00	5
Oi	6.7	1.00	0.00	1.00	30
A	6.8	0.78	0.17	0.85	1074
A1	7.2	0.99	0.02	0.95	12
A2	7.6	1.00	0.00	1.00	3
AB	7	1.00	na	0.80	2
AC	6.5	0.11	0.20	1.06	168
Ap	6.9	0.71	0.15	0.71	982
Ap,A	6.6	0.88	0.07	1.68	81
Ap1	7.2	0.89	0.07	1.00	3
Apc	5.3	0.34	0.05	-0.32	21
Au	6.55	1.00	na	0.60	2
E	5.9	0.27	0.38	0.48	14
Ec	5.4	0.00	0.21	0.00	10
	6.5	**0.69**	**0.11**	**0.70**	**2407**

B Horizons

Horizons	Mean	R^2	RMSE	Slope	Observations
B	7.7	0.99	0.02	0.99	52
BC	7.8	0.61	0.18	0.59	33
BCg	7.6	0.53	0.24	0.50	14
BCk	8.2	0.93	0.05	1.58	27
BCt	7.5	0.06	0.27	0.33	12
BCtg	7.5	0.00	0.12	0.00	5
BEc	5.2	1.00	0.00	0.80	4
Bk	7.9	0.66	0.05	1.06	909
Bk,C	7.9	1.00	0.00	1.00	52
Bk1	8.2	0.72	0.05	1.25	50
Bk2	8.2	0.00	0.04	0.02	50
Bt	7.3	0.85	0.20	0.74	261
Bt1	7.2	0.88	0.20	0.96	106
Bt1, Bt2	6.7	0.92	0.12	0.99	10
Bt2	7.3	0.91	0.15	0.98	104
Btc	5.3	1.00	0.00	1.20	14
Btg	6.9	0.34	0.22	0.55	15
Btg1	6.3	0.01	0.28	0.13	17
Btg1, Btg3	6.9	1.00	0.00	-0.80	3
Btg2	6.8	0.89	0.19	2.56	19
Btk1	8.1	0.96	0.05	0.95	34
Btk2	8.2	0.00	0.02	2.00	40
Btk3	8.2	1.00	0.00	0.00	27
Btkk	8.3	1.00	0.00	0.33	21
Btv1	5.2	1.00	0.00	1.20	4
Bw	7.1	0.84	0.14	0.96	994
Bw, BC	6.6	1.00	0.00	0.80	5
Bw1	7.3	1.00	0.00	1.20	50
Bw1, Bw2	6.7	0.15	0.09	1.10	96
Bw2	7.3	na	0.00	-0.40	48
	7.2	**0.70**	**0.09**	**0.79**	**3076**

C Horizons

Horizons	Mean	R^2	RMSE	Slope	Observations
C1	6.6	0.93	0.15	1.09	49
C1, C2	7.9	1.00	1.00	0.00	87
C2	7	0.98	0.09	0.98	37
C3	7.1	0.98	0.05	0.92	5
Cd	7.6	-0.02	0.05	-3.00	37
Cg	7.8	0.00	0.08	0.00	35
Ck	8.2	1.00	0.00	1.20	23
	7.5	**0.70**	**0.20**	**0.17**	**273**

H Layers

Horizons	Mean	R^2	RMSE	Slope	Observations
H1	6.6	0.97	0.12	0.99	1028
H2	6.6	0.96	0.18	0.99	968
H3	7.2	0.98	0.16	0.97	853
H4	7.1	0.98	0.18	0.97	469
H5	6.0	0.99	0.06	1.06	133
	6.7	**0.98**	**0.14**	**1.00**	**3451**

pH RV. vs. Arithmetic Mean by

State

Database	Mean	R^2	RMSE	Slope	Observations
Alabama	5.3	0.96	0.03	0.99	41
Colorado	7.7	0.99	0.04	1.04	115
Florida	5.3	0.18	0.18	0.67	48
Georgia	5.2	0.99	0.02	1.14	566
Iowa	6.9	0.99	0.03	0.91	300
Illinois	6.7	0.71	0.38	1.00	563
Indiana	7	0.90	0.22	0.96	338
Kansas	7.5	0.98	0.09	1.03	1194
Michigan	6.9	0.89	0.27	1.09	330
Minnesota	7.2	0.97	0.10	0.95	636
Montana	7.5	0.99	0.01	0.97	17
North Dakota	7.4	0.97	0.09	1.20	2850
Nebraska	6.7	0.86	0.17	0.99	1178
New Mexico	7.6	0.99	0.02	1.00	93
Ohio	6.9	0.94	0.21	0.98	558
Oklahoma	7.8	0.99	0.02	1.02	42
South Dakota	7.3	0.98	0.09	1.04	759
Texas	7.8	0.93	0.10	1.00	1016
Wisconsin	6.7	0.99	0.02	0.99	22
Wyoming	7.7	0.99	0.02	1.00	21
	7.0	**0.91**	**0.11**	**1.00**	**10687**

Soil DB

Database	Mean	R^2	RMSE	Slope	Observations
STATSGO2	**6.4**	**0.99**	**0.04**	**0.99**	**369**
SSURGO	**7.1**	**0.96**	**0.17**	**0.99**	**10687**
	6.8	**0.98**	**0.11**	**0.99**	**11056**

A more meaningful analysis would be based on genetic horizons or perhaps depth increments, recognizing that there are limitations to both approaches.

However, before getting there

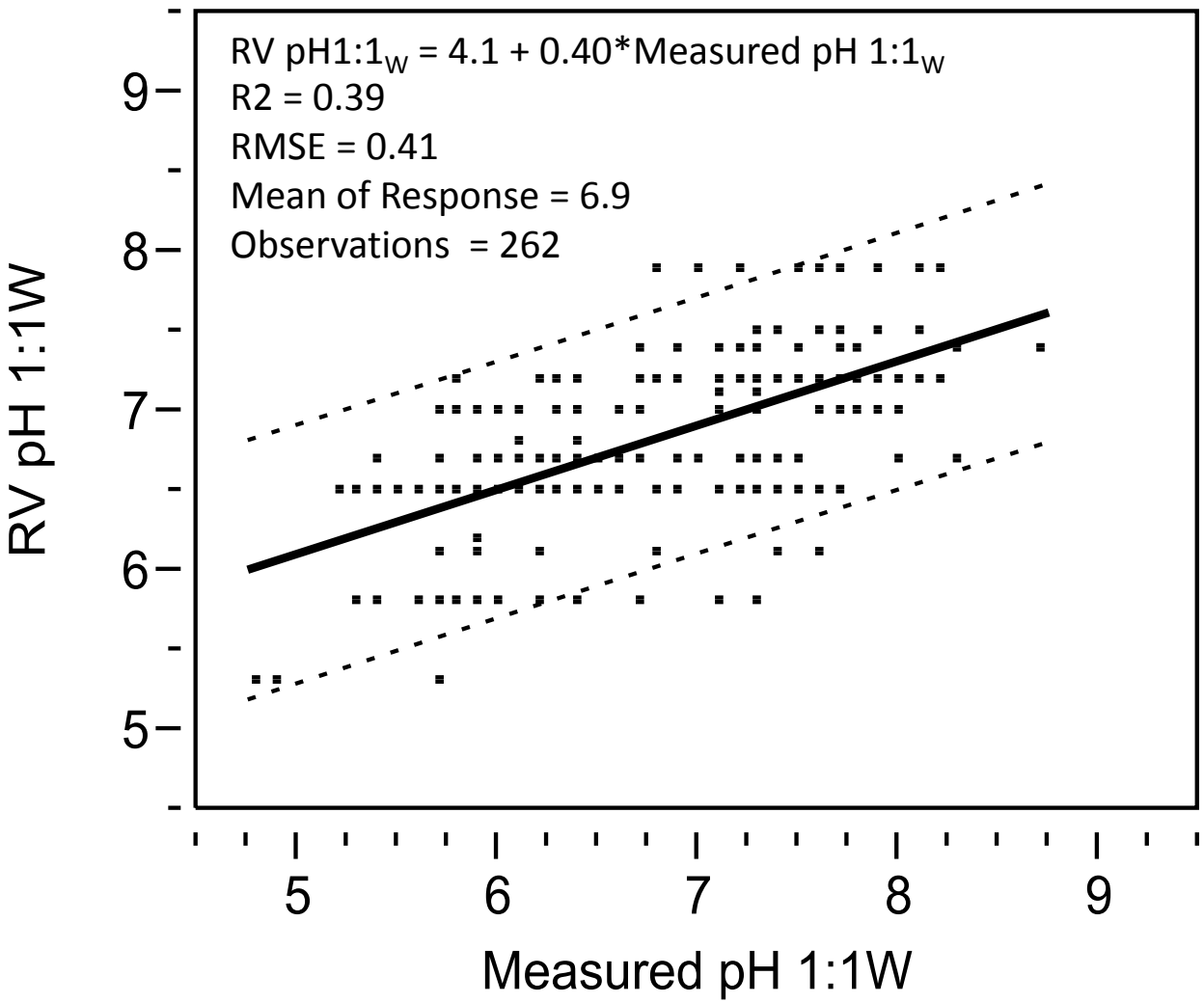
CEC Data Entry Method

Data Entry Method	Mean	R^2	RMSE	Slope	Observations
Mean of UL and LL	19.3	0.95	1.14	0.95	4215
Transferedfrom SOI-5/SOI-6 to SSSD	20.1	0.99	1.53	1.02	760
Manually Entered	16.1	0.99	0.63	0.99	5315
	18.5	**0.98**	**1.10**	**0.99**	**10290**

Can we address these questions consistently and in a statistical manner

- How close are the estimated RV to the measured mean?
- What about the UL and LL?
- How can we quantify the impact of database transactions to uncertainty, if at all?
- What does this means for predicted soil property maps?

Measured pH vs. RV pH $1:1_W$

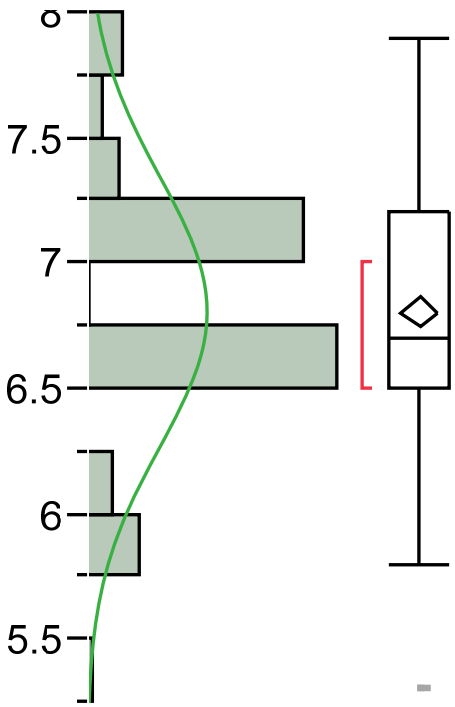


Surface Horizons

RV	Pedons
A	A1
Ap	Ap
H1	Ap1
	Ap/Btp
	AB
	Ap/BA
	Ap/AB
	A1
	A3
	No name

Estimated SSURGO pH RV vs. Mean Pedons

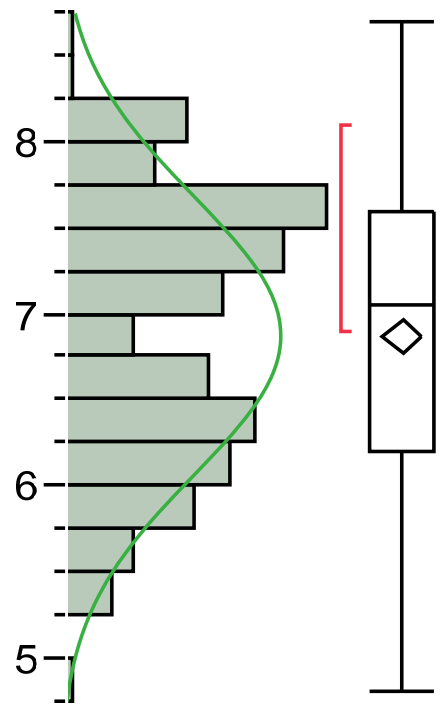
SSURGO_RV pH 1:1$_W$



100.0%	maximum	7.9
99.5%		7.9
97.5%		7.9
90.0%		7.4
75.0%	quartile	7.2
50.0%	median	6.7
25.0%	quartile	6.5
10.0%		6.1
2.5%		5.8
0.5%		5.3
0.0%	minimum	5.3
Mean		6.8
Std Dev		0.54
Std Err		0.03
N		306

Pedon_Mean pH 1:1$_W$

100.0%	maximum	8.7
99.5%		8.7
97.5%		8.1
90.0%		7.9
75.0%	quartile	7.6
50.0%	median	7.1
25.0%	quartile	6.2
10.0%		5.8
2.5%		5.4
0.5%		4.8
0.0%	minimum	4.8
Mean		6.9
Std Dev		0.81
Std Err		0.05
N		262



Where did/do the Upper and Lower values come from ?

[14] Soil reaction (pH)--See 603.02-1 for definition.
Enter the range of pH (1:1 water, except Histosols which are measured in 0.0lM CaCl2).
Use the following classes:
<3.5,
3.5-4.4,
4.5-5.0,
5.1-5.5,
5.6-6.0,
6.1-6.5,
6.6-7.3,
7.4-7.8,
7.9-8.4,
8.5-9.0,
>9.0, or
a combination of classes, e.g., 4.5-5.5.

Source: NSH, 1984

Enter the high, low, and representative values of the appropriate estimated pH range for each horizon. The high and low values must correspond with the class limits.

Reaction Class	Range in pH
Ultra acid	1.8-3.4
Extremely acid	3.5-4.4
Very strongly acid	4.5-5.0
Strongly acid	5.1-5.5
Moderately acid	5.6-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Slightly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	9.1-11.0

Source: U.S. Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. Available online at http://soils.usda.gov/technical/handbook/. Accessed [09/24/2012].

Laboratory Measured vs. NASIS

Soil Series	Laboratory Measured					NASIS															Observations	
						Lower Limits (LL)					Representative Values (RV)					Upper Limits (UL)						
	Min	0.5	Mean	99.5	Max	Min	0.5	Mean	99.5	Max	Min	0.5	Mean	99.5	Max	Min	0.5	Mean	99.5	Max	Laboratory	NASIS
Amarillo	5.8	6.1	7.9	8.9	9.0	6.6	6.6	7.4	7.9	7.9	7.0	7.0	7.8	8.3	8.3	7.3	7.3	8.3	9.0	9.0	383	315
Barnes	5.7	5.7	7.8	9.1	9.1	5.6	5.6	6.9	7.4	7.9	6.5	6.7	7.4	8.2	8.2	7.3	7.3	8.1	8.4	8.4	167	3697
Blount																						
Clarion	5.0	5.1	6.8	8.3	8.4	5.6	5.6	6.2	7.6	7.6	6.5	6.5	6.9	7.9	7.9	7.3	7.3	7.7	8.4	8.4	384	645
Drummer	5.5	5.6	7.3	8.5	8.6	5.6	5.6	6.1	7.9	7.9	6.0	6.0	7.0	8.2	8.2	7.3	7.3	7.9	8.4	8.4	350	416
Harney	5.4	5.4	7.4	8.8	8.8	5.6	5.6	6.4	7.4	7.4	6.7	6.7	7.3	7.9	7.9	7.8	7.8	8.2	8.4	8.4	255	662
Huston Black	7.1	7.1	8.0	8.6	8.6	7.4	7.4	7.4	7.4	7.4	7.9	7.9	7.9	7.9	7.9	8.4	8.4	8.4	8.4	8.4	110	217
Ipava	5.0	5.1	6.3	8.2	8.3	5.6	5.6	5.9	7.4	7.4	5.8	5.8	6.8	8.2	8.2	6.5	6.6	7.7	8.4	8.4	761	230
Olton	5.7	5.7	7.9	8.5	8.5	6.6	6.6	7.4	7.9	7.9	6.7	6.8	7.7	8.3	8.3	7.3	7.3	8.0	8.4	8.4	56	241
Pewamo	5.8	5.8	7.2	8.3	8.3	5.6	5.6	6.4	7.9	7.9	6.3	6.3	7.1	8.2	8.2	7.0	7.0	7.8	8.4	8.4	119	429
Pullman	5.9	5.9	7.8	8.5	8.5	6.6	6.6	7.4	7.9	7.9	7.0	7.0	7.7	8.3	8.3	7.3	7.3	8.1	8.4	8.4	92	180
Richfield	5.7	5.8	8.1	9.1	9.1	6.1	6.1	7.0	8.2	8.3	6.7	6.9	7.7	9.0	9.0	6.9	7.4	8.3	9.0	9.0	240	305
Tarrant	7.6	7.6	7.6	7.7	7.7	7.4	7.4	7.4	7.4	7.4	7.9	7.9	7.9	7.9	7.9	8.4	8.4	8.4	8.4	8.4	4 (1 pedon)	174
Tifton	4.5	4.5	5.0	6.0	6.0	4.0	4.0	4.5	5.1	5.1	4.8	4.8	5.2	6.2	6.2	5.5	5.5	5.8	7.3	7.3	98	760
Ulysses	6.6	6.6	8.1	8.9	8.9	6.6	6.6	7.3	7.9	7.9	7.0	7.0	7.8	8.6	8.6	7.3	7.3	8.2	8.6	9.0	254	576
Valentine	5.8	5.8	6.2	6.8	6.8	5.1	5.6	5.6	6.6	7.9	5.3	5.8	6.5	7.2	8.2	7.3	7.3	7.3	7.8	8.4	20	1231

NASIS UL/LL vs. Lab Max/Min for pH

NASIS vs. Laboratory Measured	Mean	R^2	RMSE	Equation
Lower Limits vs Lab_Min	6.6	0.51	0.62	NASIS_LL = 2.1 + 0.8*Lab_Min
Lower Limits vs Lab_0.5%	6.6	0.54	0.60	NASIS_LL = 1.9 + 0.8*Lab_0.5%
Lower Limits_0.5% vs Lab_0.5%	6.0	0.80	0.40	NASIS_0.5% = 0.25 + 0.99*Lab_0.5%
Upper Limits vs Lab_Max	7.9	0.72	0.36	NASIS_UL = 2.6 + 0.6*Lab_Max
Upper Limits vs Lab_95.5%	7.9	0.73	0.34	NASIS_UL = 2.5 + 0.6*Lab_95.5%
Upper Limits_95.5% vs Lab_95.5%	8.4	0.80	0.19	NASIS_95.5% = 4.8 + 0.42*Lab_95.5%

Class vs. Confidence Limits
pH example

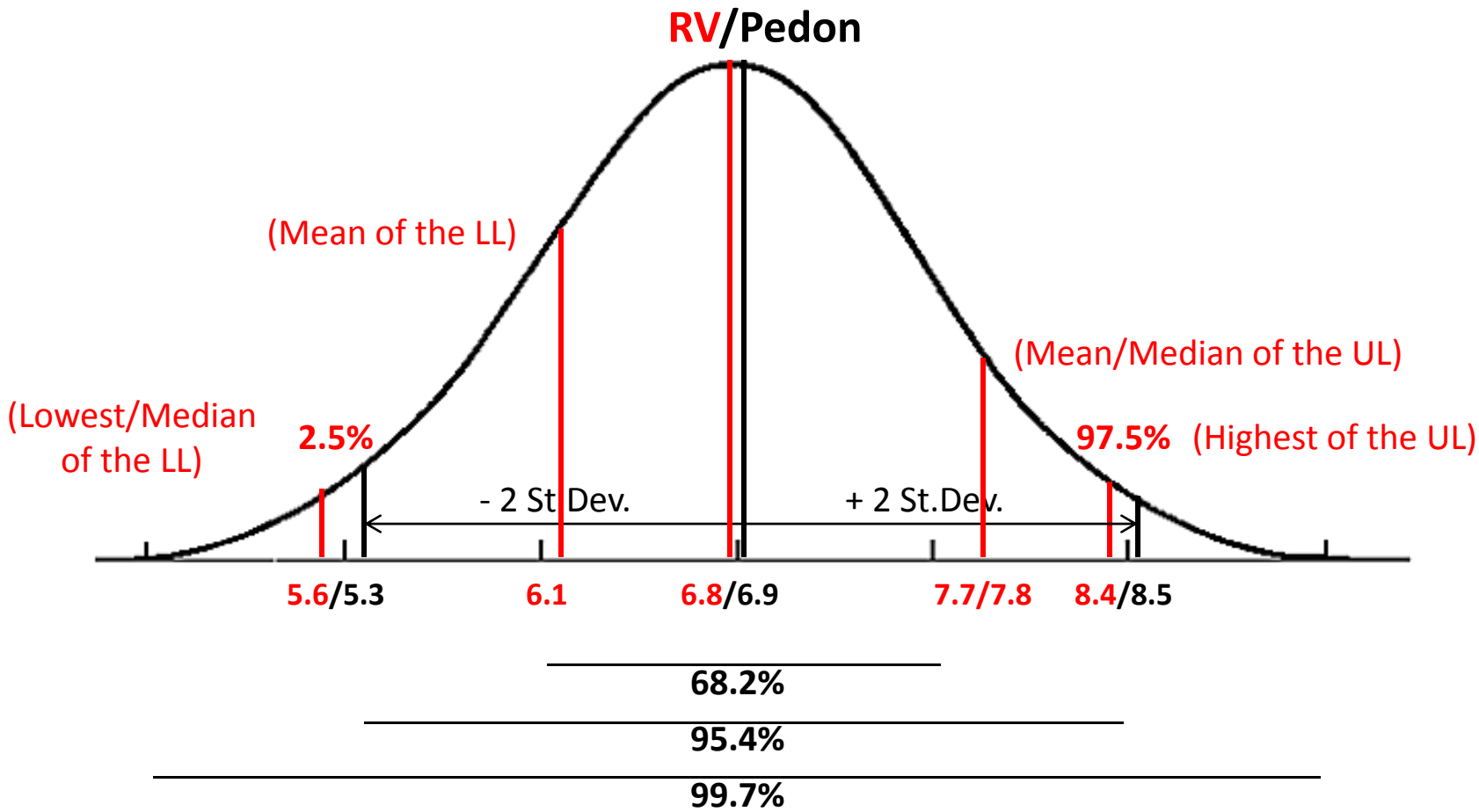
[14] Soil reaction (pH)--See 603.02-1 for definition.

Enter the range of pH (1:1 water, except Histosols which are measured in 0.0lM CaCl2).

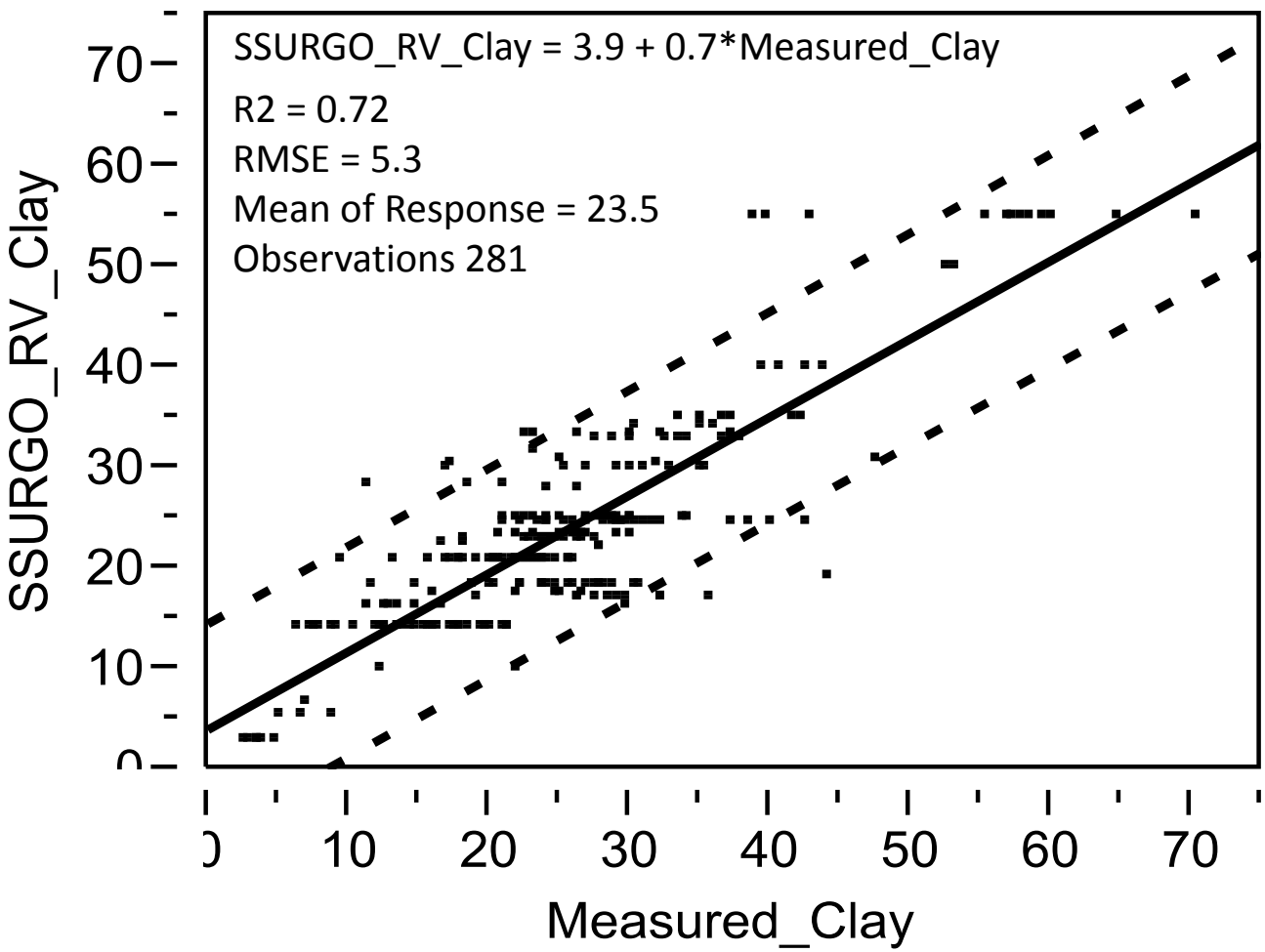
Use the following classes:

<3.5,
3.5-4.4,
4.5-5.0,
5.1-5.5,
5.6-6.0,
6.1-6.5,
6.6-7.3,
7.4-7.8,
7.9-8.4,
8.5-9.0,
>9.0, or
a combination of classes, e.g., 4.5-5.5.

Class vs. Confidence Limits
pH example



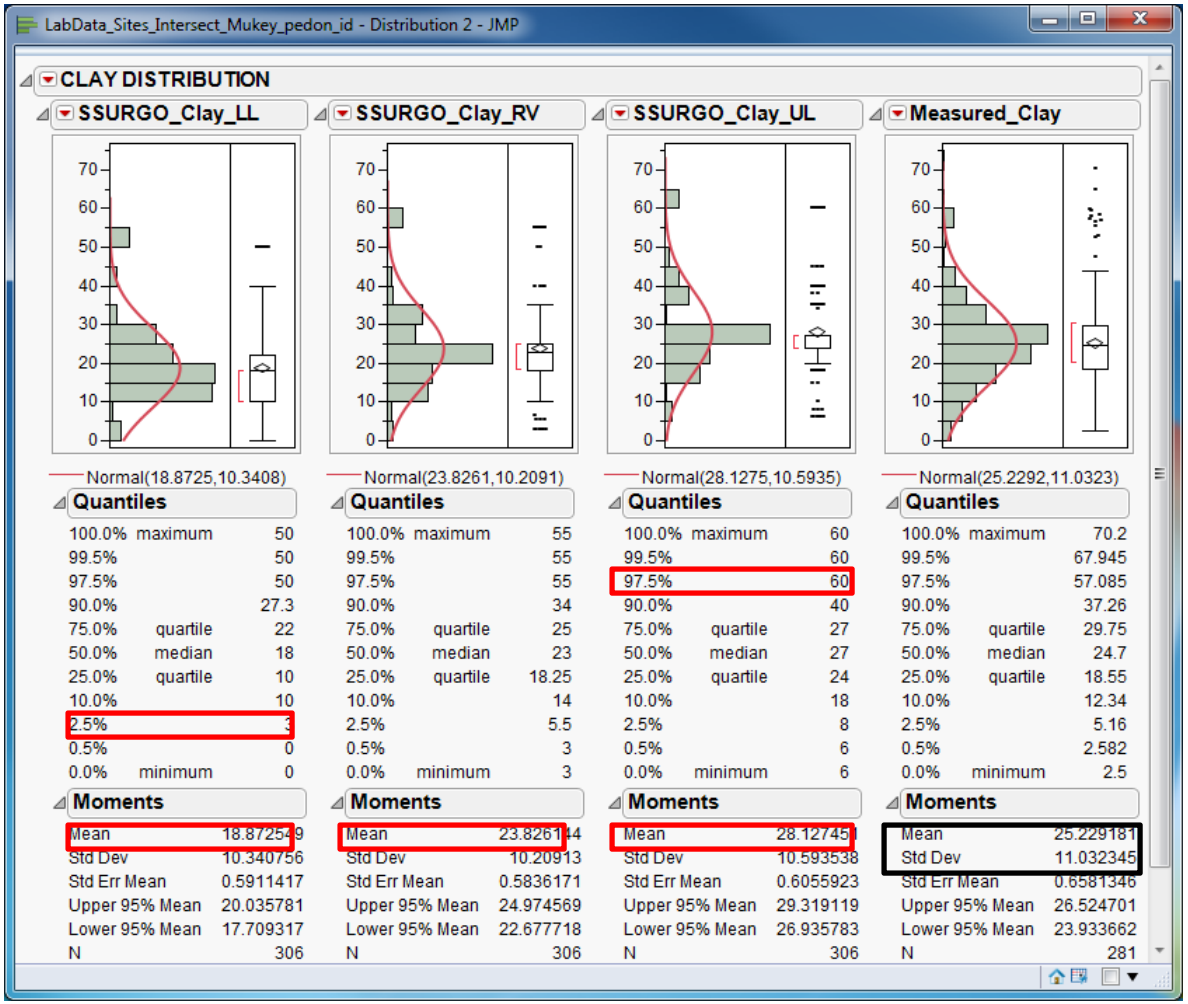
SSURGO_RV_Clay vs. Measured Clay



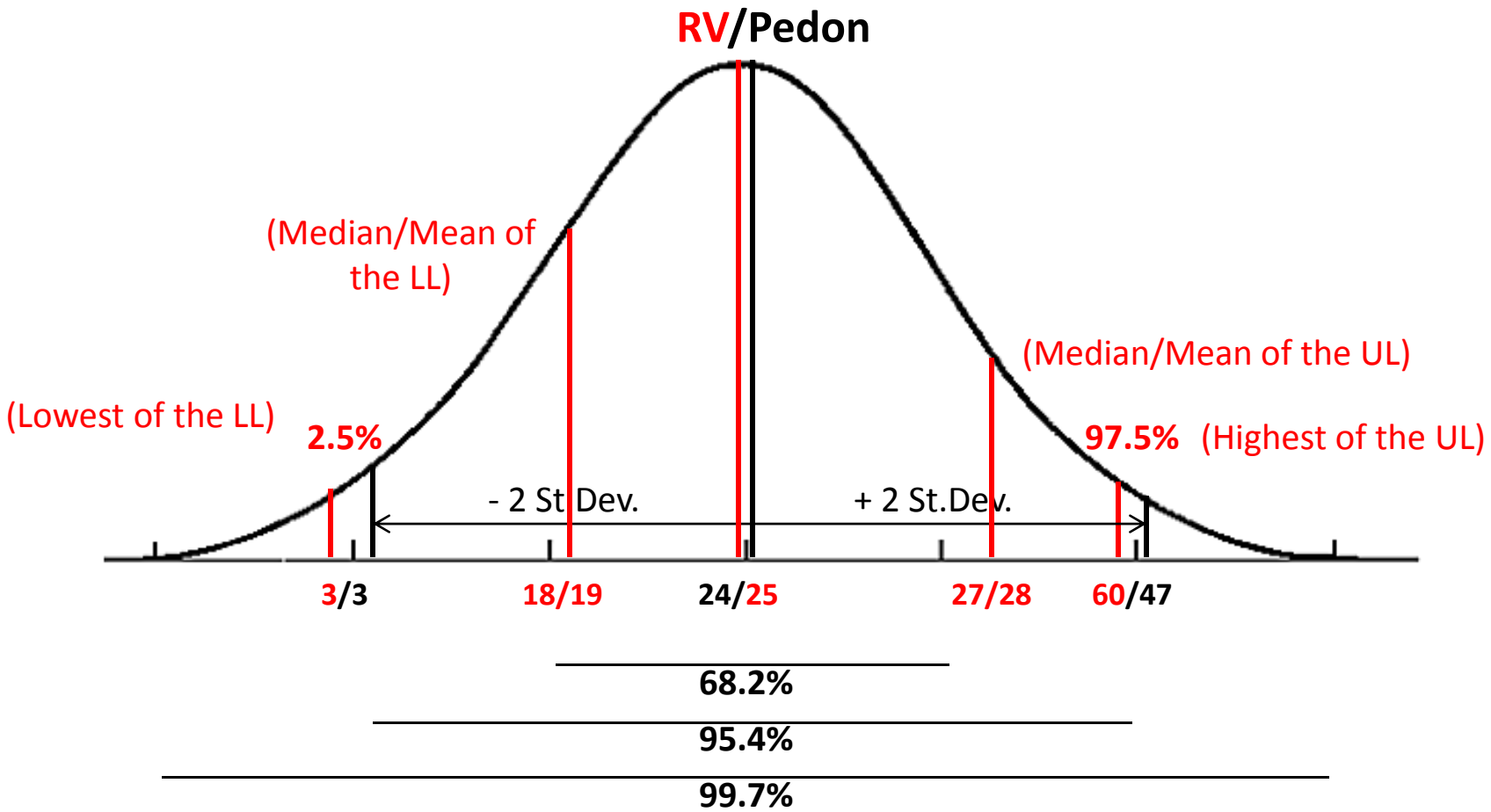
Surface Horizons

RV	Pedons
A	A1
Ap	Ap
H1	Ap1
	Ap/Btp
	AB
	Ap/BA
	Ap/AB
	A1
	A3
	No name

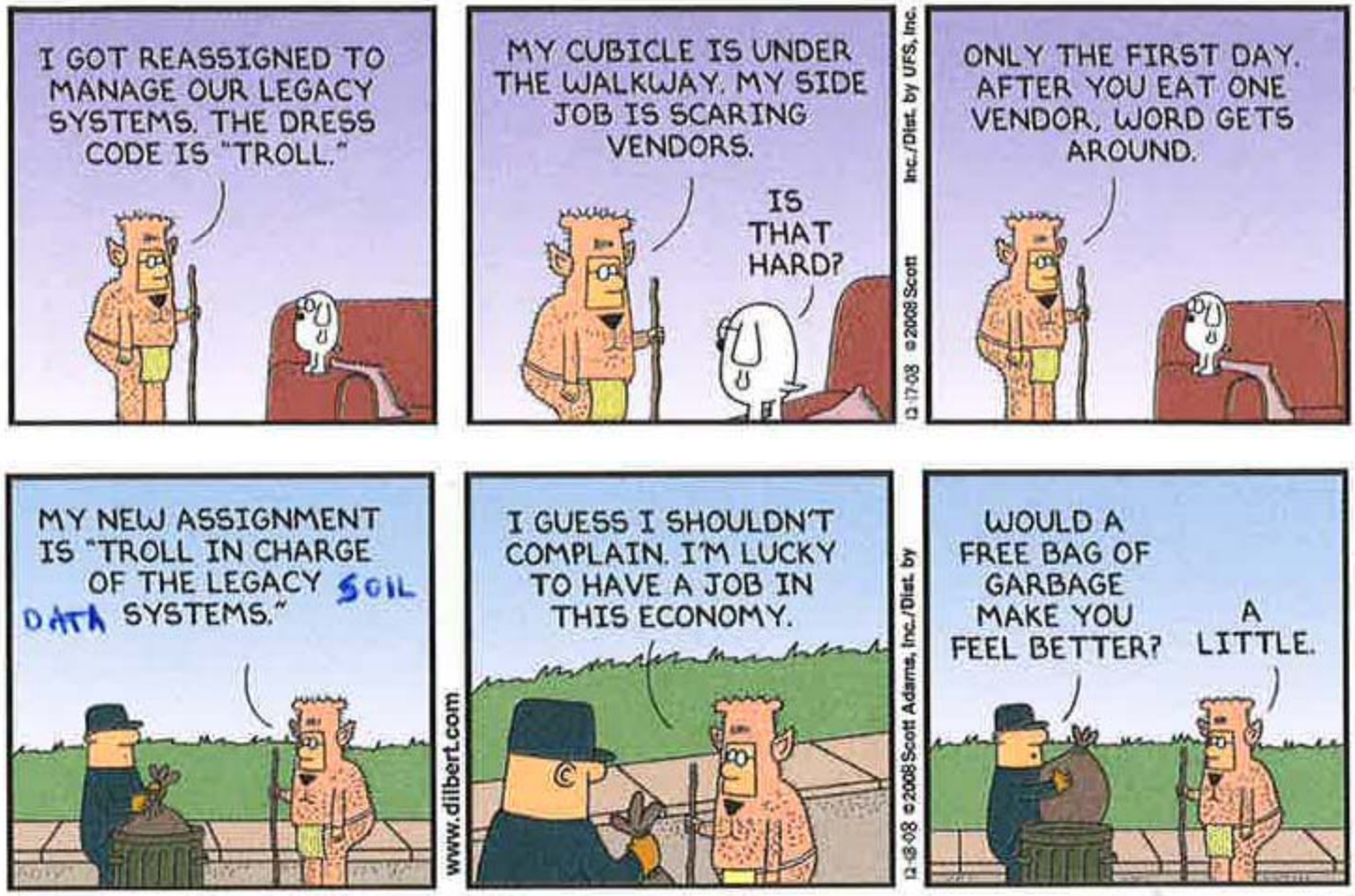
Class vs. Confidence Limits
Clay example



Class vs. Confidence Limits
Clay example



Soil Legacy Data

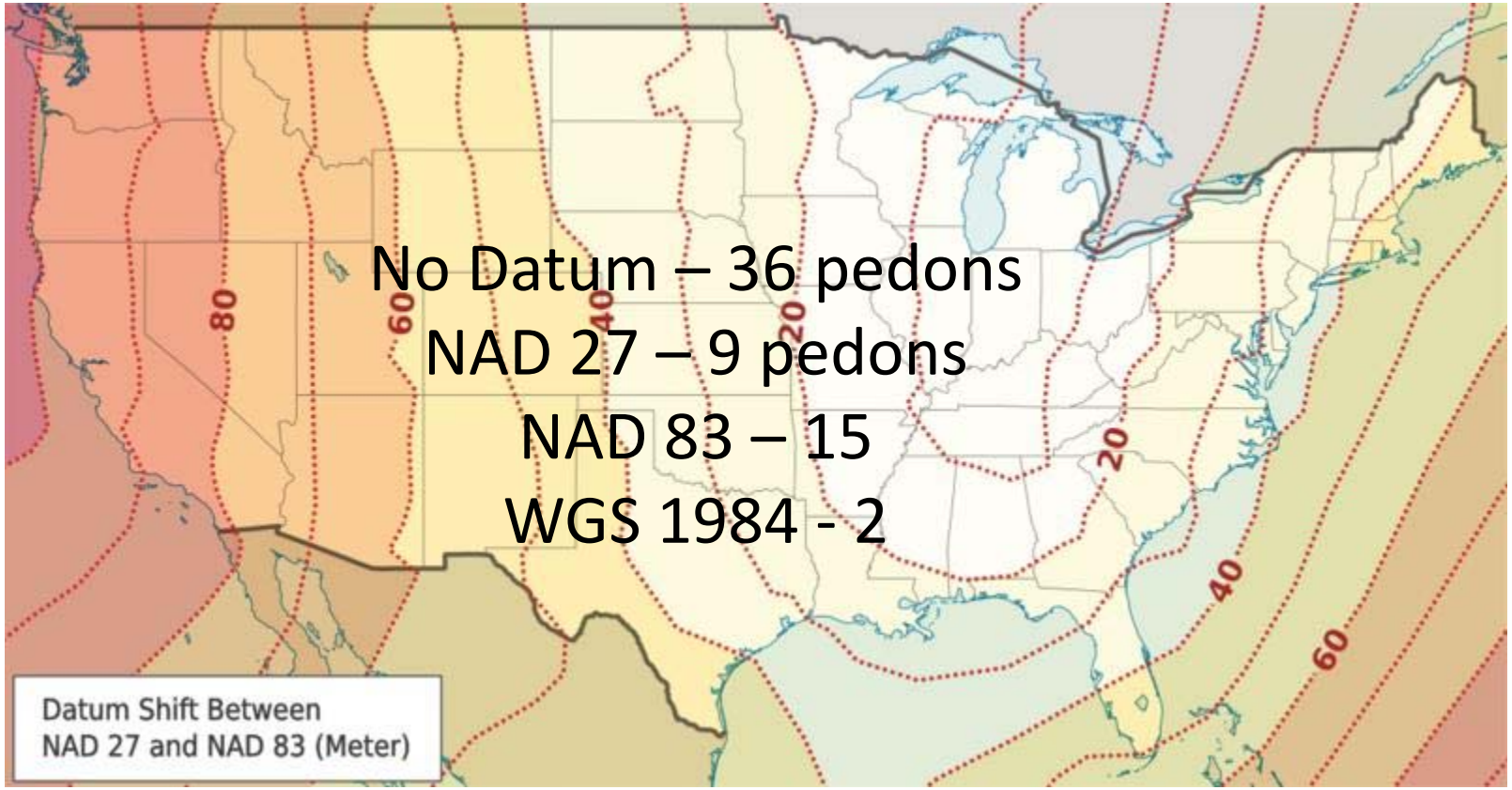


Source: Dilbert by Scott Adams at dilbert.com

Chasing the Errors/Uncertainty

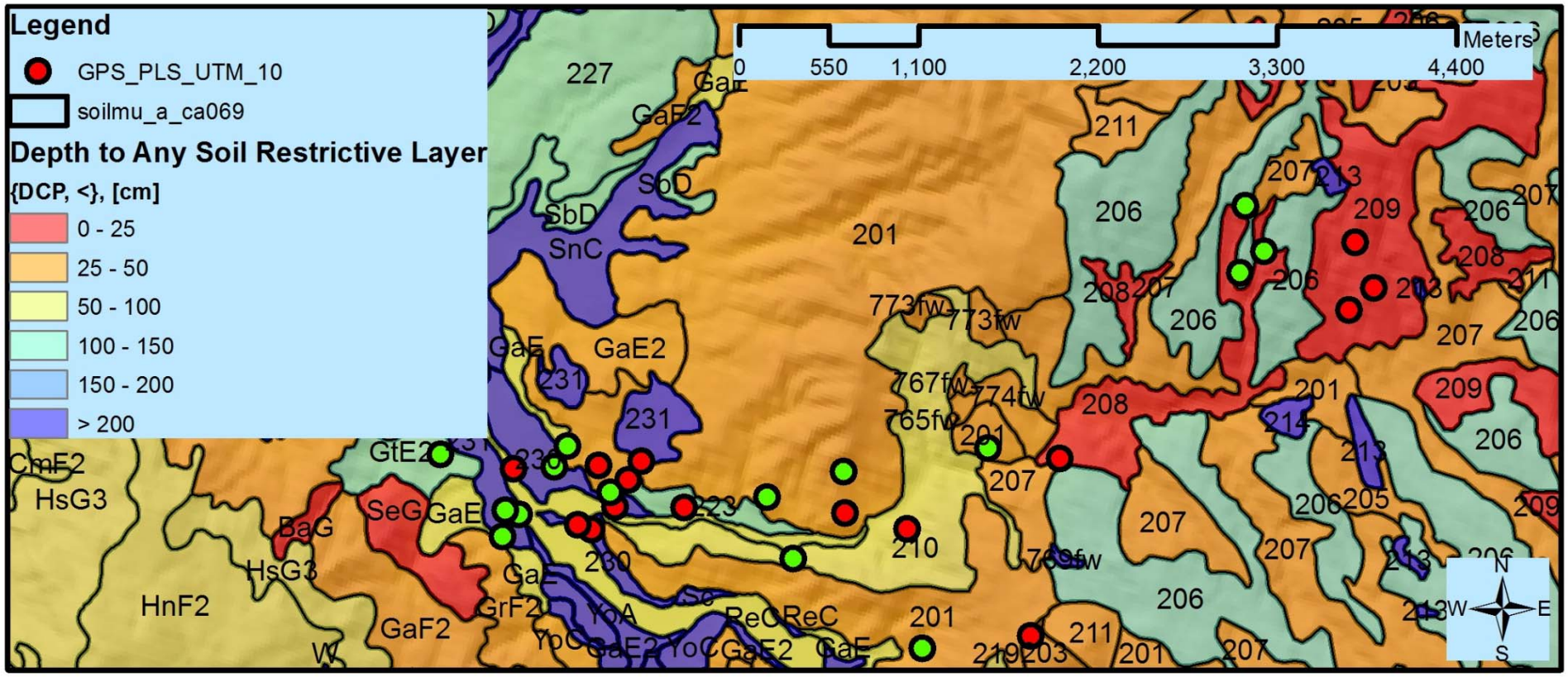
- Possible sources of Errors/Uncertainty:
  - Analytical methods (precision estimates):
    - Between Laboratories Reproducibility (R);
    - Within Laboratory:
      - Reproducibility (R_L);
      - Repeatability (r).
  - Pedotransfer Functions (ptf);
  - Database Transactions;
  - <u>Pedon Accuracy Locations (PLS vs GPS);</u>
  - Other sources (ongoing).

A point having a given latitude and longitude in NAD27 may be displaced on the order of many tens of meters from another point having the identical latitude and longitude in NAD83



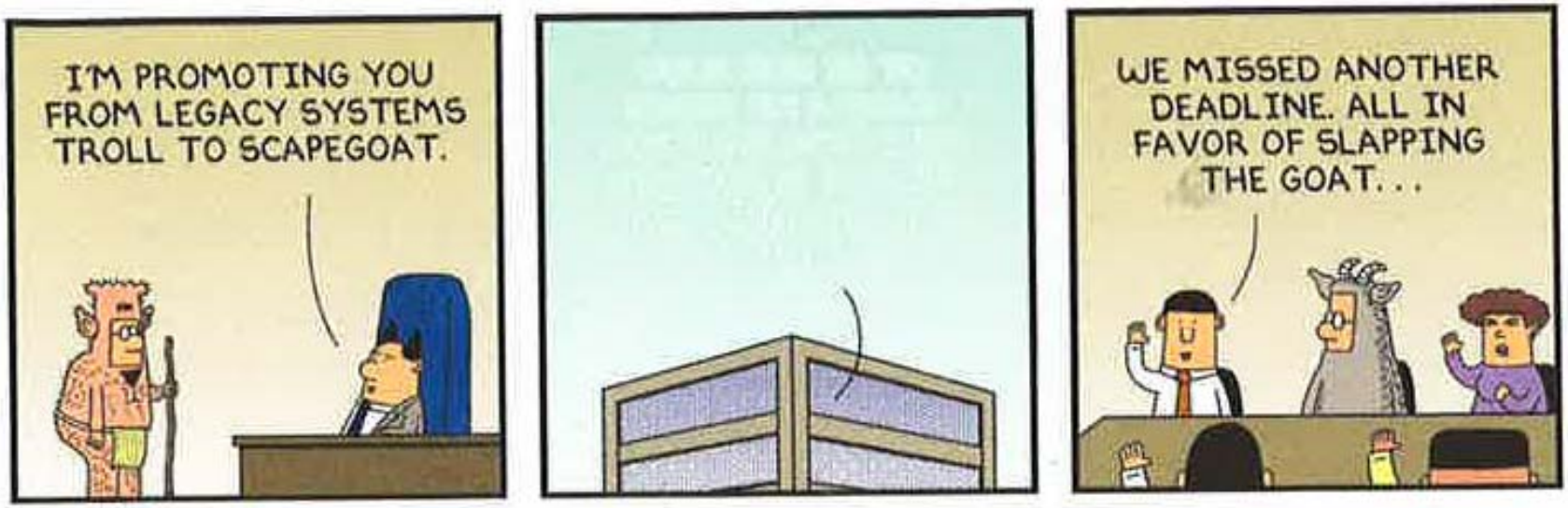
Conversion from NAD27 to NAD83 does not affect vertical data; any conversion needs only be concerned with the horizontal positioning of the data

Pedon Accuracy Locations



Soil Legacy Data

- Due to many vintages the current SSURGO inherits many consistencies;
- Can we asses in a meaningful manner the impact of inconsistencies on uncertainty error prediction and confidence limits?



Source: Dilbert by Scott Adams at dilbert.com

So, Let's Talk

Source: Dilbert by Scott Adams at dilbert.com

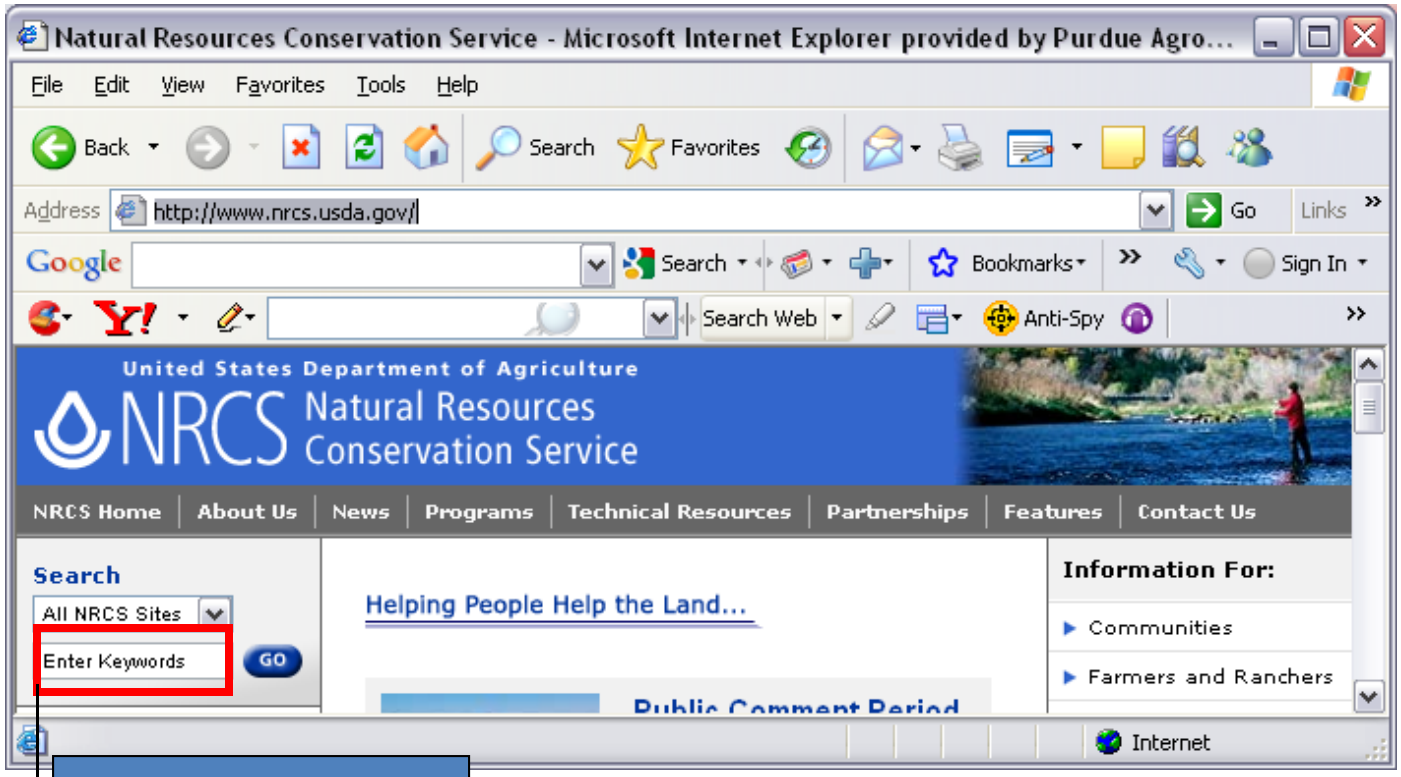
On-Line sources for Soil Data available to the general public

Web Soil Survey (more...)	Indiana Online Soil Surveys
Soil Data Mart	Indiana Major Land Resource Areas Major Land Resource Area Map Tool
Geospatial Data Gateway	State Soil Geographic Database (STATSGO) Indiana STATSGO (map) STATSGO-Download
Soil Data Viewer (Version 5.2)	MLRA Project Offices Indiana Resource Soil Scientist (map)
Official Soil Series Descriptions (OSD)	State Soils World Soil Resources Indiana University Spatial Data Server
National Soil Survey Laboratory	Information for Soil Scientists Information For Teachers and Students
National Soil Information System (NASIS)	Indiana Correlation Amendments Indiana Correlation Documents
Indiana eFOTG	Indiana Highly Erodible Land (HEL) Indiana Hydric Soils List
NRCS Soils National Soil Survey Handbook	Soil Science Society of America Indiana Registry of Soil Scientists

http://www.in.nrcs.usda.gov/mlra11/soils.html

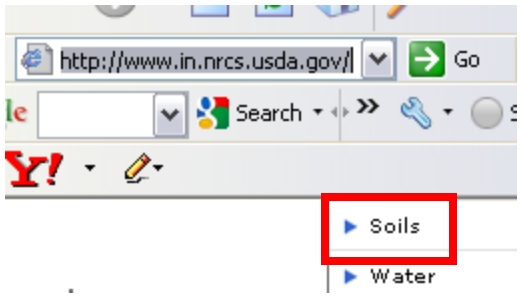
Published Soil Survey (paper copy, or on-line pdf format)

http://www.nrcs.usda.gov/



Indiana

http://www.in.nrcs.usda.gov/



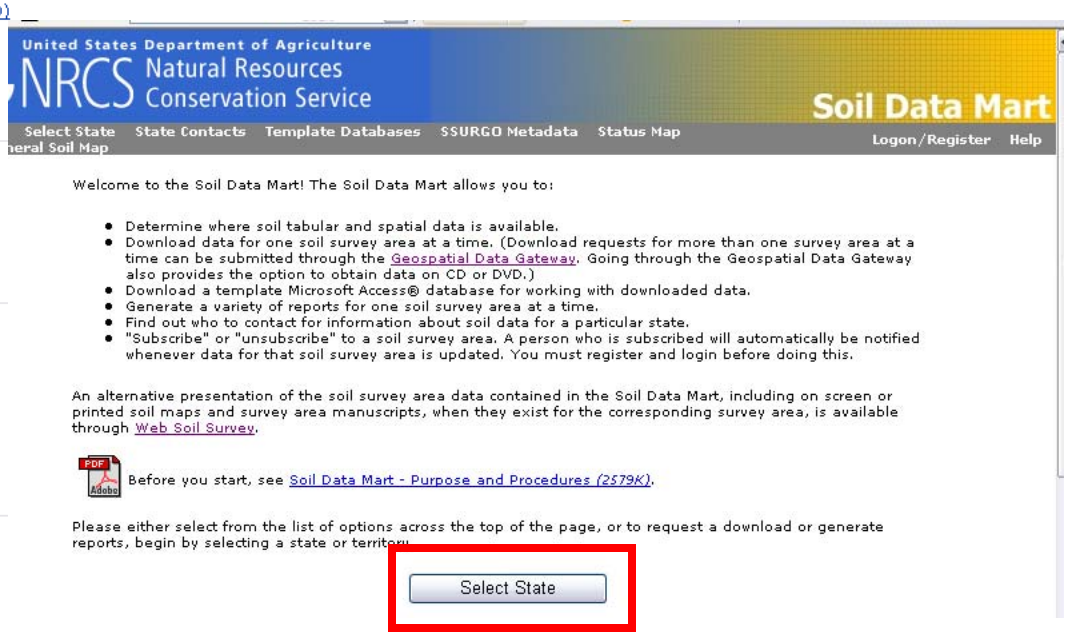
http://www.in.nrcs.usda.gov/mlra11/soils.html

USDA NRCS
Natural Resources Conservation Service

Spatial and Tabular Soil Data

http://www.in.nrcs.usda.gov/mlra11/soils.html

Web Soil Survey (more...)	Indiana Online Soil Surveys
Soil Data Mart	Indiana Major Land Resource Areas Major Land Resource Area Map Tool
Geospatial Data Gateway	State Soil Geographic Database (STATSGO) Indiana STATSGO (map) STATSGO-Download
Soil Data Viewer (Version 5.2)	MLRA Project Offices Indiana Resource Soil Scientist (map)
Official Soil Series Descriptions (OSD)	State Soils World Soil Resources Indiana University Spatial Data Server
National Soil Survey Laboratory	Information for Soil Scientists Information For Teachers and Students
National Soil Information System (NASIS)	Indiana Correlation Amendments Indiana Correlation Documents
Indiana eFOTG	Indiana Highly Erodible Land (HEL) Indiana Hydric Soils List
NRCS Soils National Soil Survey Handbook	Soil Science Society of America Indiana Registry of Soil Scientists



Soil Data Mart

http://soildatamart.nrcs.usda.gov/

Soil Data Access - Query - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://sdmdataaccess.nrcs.usda.gov/Query.aspx

Most Visited Getting Started Latest Headlines

USDA United States Department of Agriculture Natural Resources Conservation Service

Soil Data Access

Home Query Map Query Help Web Service Help Help

Submit your own SQL or SQL Data Shaping query to retrieve data from the Soil Data Mart. You can choose to view the results of the query immediately or, for larger volumes of data, you can choose to submit the query to be queued and run in background. Information about the queries that may be run, including rules and sample queries, can be found on the Query Help page.

If you choose to view the results immediately, they will be displayed in a separate browser window. **In order to view the results, popup blocking must be disabled.** The SDMTabularService.RunQuery web method is used to run the query, therefore this is a good place to test any queries that you would like to use with that web method. Further information is available on the Web Service Help page.

If you choose to submit the query to be queued and run in background, the results will be packaged either one query result set per text file if the Text option was selected or into a single XML file if the XML option was selected, with all files then placed in a WinZip® archive (see the Downloads section of the Help page if you need more information about archives). You will be notified via e-mail when the results are ready to be downloaded, and that e-mail will include an FTP link for retrieving the data you requested.

For immediate queries, the timeout is 30 seconds and no more than 10,000 records can be returned to a browser. Immediate requests that can complete within 30 seconds but return more than 10,000 records must be submitted as a queued request. For queued queries, the timeout is 10 minutes and there is no enforced limit to the number of records that can be returned.

Please enter your SQL query:

```
SELECT mapunit.mukey, legend.areaname, mapunit.musym, mapunit.muname, component.compname,
component.comppct_r, chorizon.hzname, chorizon.hzdept_r, chorizon.hzdepb_r, chorizon.caco3_r FROM (legend INNER
JOIN (mapunit INNER JOIN component ON mapunit.mukey =
component.mukey) ON legend.lkey = mapunit.lkey) INNER JOIN chorizon ON component.cokey = chorizon.cokey
WHERE hzdept_r = (select MIN(hzdept_r) FROM chorizon WHERE chorizon.caco3_r > 0 and component.cokey =
chorizon.cokey ) and legend.areasymbol like 'IN067'
ORDER BY mapunit.muname, component.co[illegible] component.comppct_r DESC , chorizon.hzdept_r, chorizon.caco3_r;
```

Please select the time frame and format in which you would like to see the results:

- ○ Immediate / XML (same format returned in the SDMTabularService.RunQuery web method response)
- ◉ Immediate / HTML (results displayed in tables for easier viewing)
- ○ Queued / XML
- ○ Queued / Text
  - ☐ First row contains column names

Field Delimiter: Vertical Bar

Text Delimiter: Double Quote

Please enter your e-mail address:

Please confirm your e-mail address:

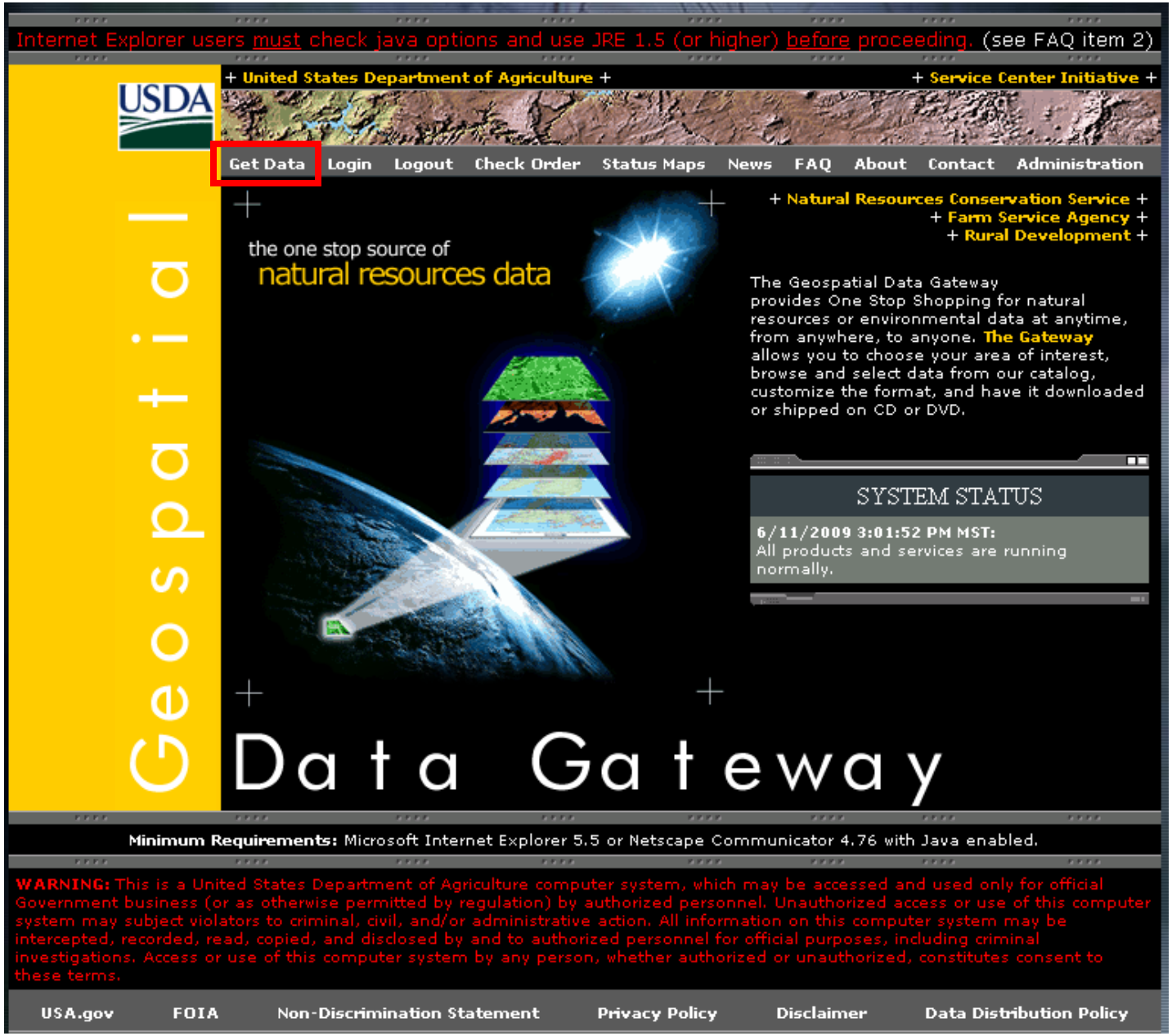
If the e-mail account entered above is protected by spam blocking software, you will need to authorize e-mail from SoilDataAccess@nrcs.usda.gov in order to receive e-mail notification once your query has been processed.

Submit Query

County Fip Code can be changed. This query generates Representative values (RV) for depth to Carbonates for the soil series mapped in Howard county, Indiana.

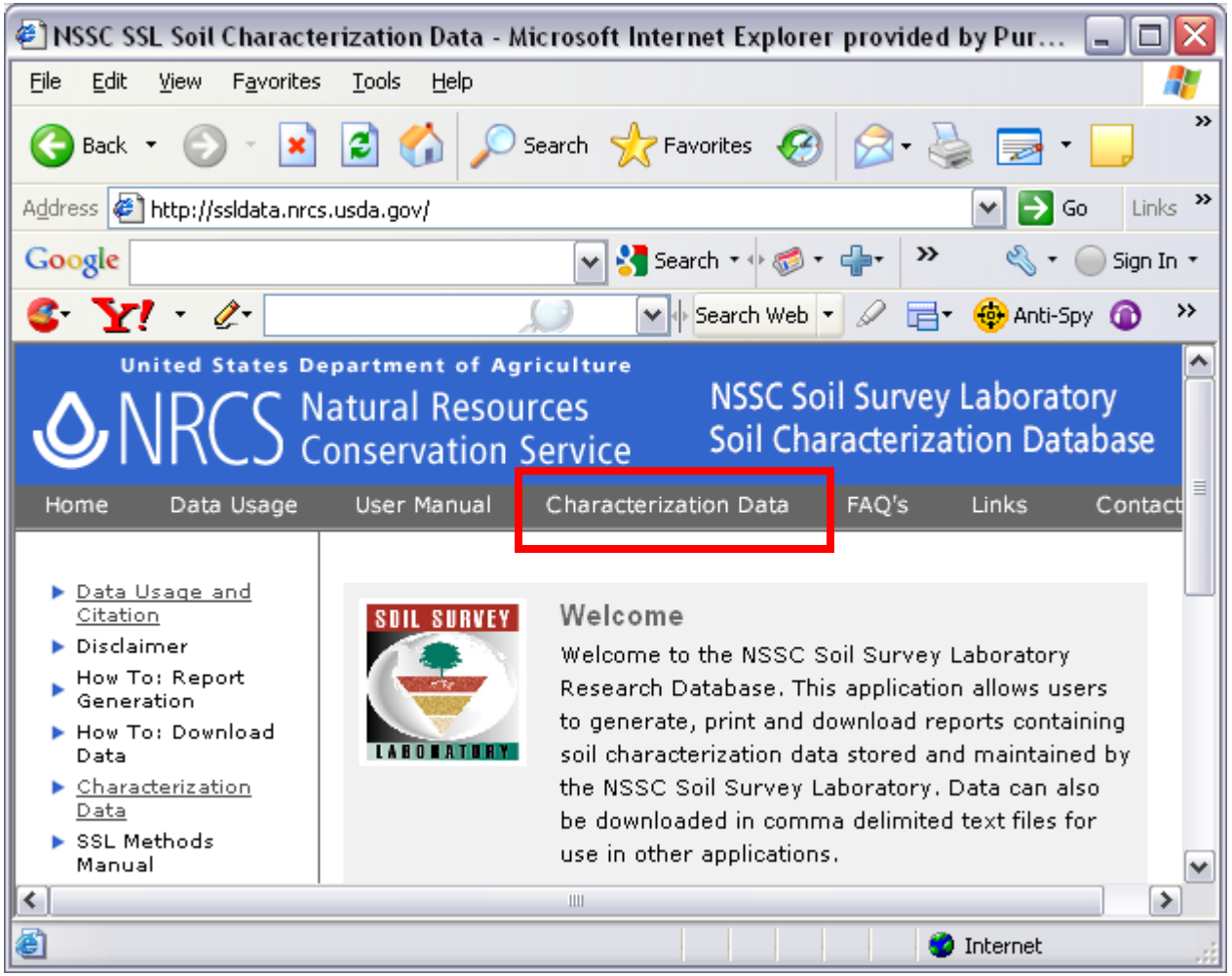
Geospatial Data Gateway

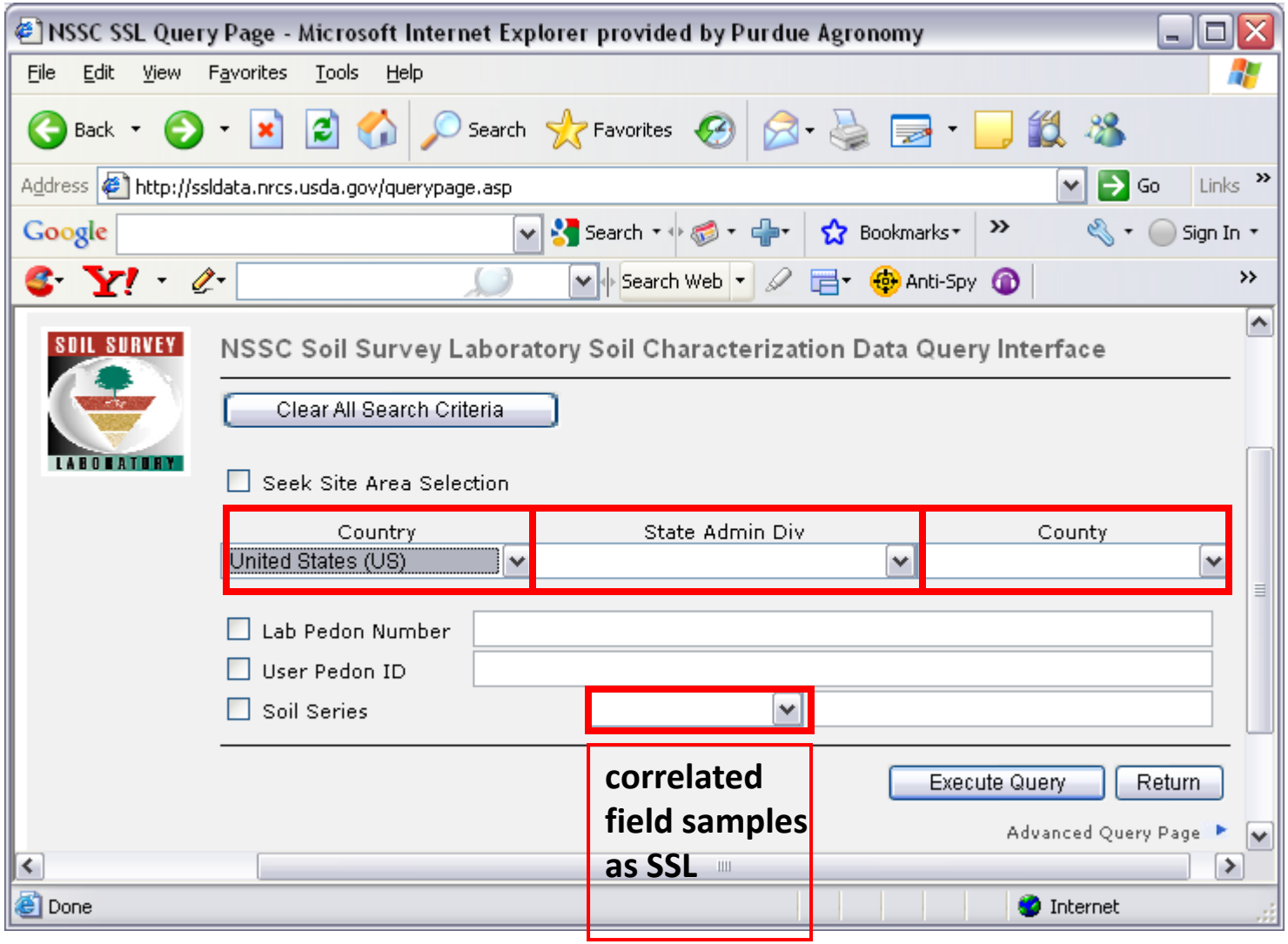
http://datagateway.nrcs.usda.gov/



Soil Laboratory Characterization Data

http://ssldata.nrcs.usda.gov/





correlated field samples as SSL