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National Cooperative Soil Survey National Soil Information System

By Jim R. Fortner

National Soil Survey Center
Natural Resources Conservation Service
100 Centennial Mall North, Rm. 152
Lincoln, NE 68508-3866
Phone: (402) 437-5755
Fax: (402) 437-5336
Email: jim.fortner@lin.usda.gov

BRIEF HISTORY AND STATUS OF SOIL SURVEY

The organized soil survey effort began in the United States in 1899. The Soil Conservation Service (SCS), now called Natural Resources Conservation Service (NRCS), was designated the lead agency by legislation in 1951. SCS was assigned responsibility for mapping all privately owned land in the Nation. Publicly owned land is the responsibility of the respective managing agency. In the 1950s, the National Cooperative Soil Survey (NCSS) was formed. The NCSS consists of NRCS (which is the lead agency), partners (including other Federal land management agencies such as the United States Forest Service, the Bureau of Land Management, the Bureau of Indian Affairs, and the National Park Service), State Agricultural Experiment Stations, and local governmental entities.

In the same timeframe in which the NCSS was formed, the so-called modern era of soil survey began with the publication of reports based on soil survey areas. In the eastern two-thirds of the United States, the soil survey area generally coincides with a county or parish. In the western one-third, the survey area is commonly a part or parts of one or more counties or is publicly owned land. To date, more than 95 percent of privately owned land has been surveyed and 92 percent of all land has been surveyed (Figure 1).

In the late 1960s, computer records were created for the estimated soil properties and interpretations of the various soil types identified in soil surveys. In the mid-1980s, a state-by-state database of these records was developed. In 1994, the current NASIS (National Soil Information System) transactional database was implemented in each state. In 2000, the NASIS databases were combined into a national centralized database.

Digitizing of soil maps began in the mid-1980s. During this period, standards for map compilation and map digitizing were developed. These standards are known as the SSURGO (Soil Survey Geographic) standards, and are available at http://soils.usda.gov/technical/handbook/contents/part647.html#06. In the mid-1990s, a concentrated effort was begun to digitize all the completed soil maps for the Nation according to these established standards. This effort is scheduled for completion in early 2008. Unmapped areas will be digitized as they are mapped, as part of the ongoing mapping effort. The goal is to have all privately owned land surveyed by 2012.

Late in 2003, the Soil Data Warehouse and Soil Data Mart were established to house all official soil survey (SSURGO) data and to be the central delivery point for that data. The

Soil Data Warehouse stores various versions of the data dating from 2003, while the Soil Data Mart makes only the current version of data available for distribution to a wide-ranging list of customers, including the general public. Downloads of data are by individual soil survey areas.

In 2005, the Web Soil Survey (WSS) was brought online to provide public access to, and online viewing of, information in the Soil Data Mart. Figure 2 shows a schematic of how the various components of the National Soil Information System fit together. More information about the various components will be given later in this paper.

How did we get here?

Development of the current soil survey product involved a number of significant milestones. One of the major milestones was the establishment of the National Cooperative Soil Survey organization itself. Through the NCSS, a number of standards have been developed for:

- Describing and analyzing soils
- Classification of soils—*Soil Taxonomy* (http://soils.usda.gov/technical/classification/taxonomy/)
- Mapping scales, intensity, and procedures, including joins (joins include joining datasets and maps between soil survey areas, and between individual map sheets within a soil survey area.)
- Quality-control and quality-assurance procedures
- Database structure and content
- Map compilation and digitizing specifications
- FGDC Soil Data Standard (http://www.fgdc.gov/standards/projects/FGDC-standards-projects/soils/soil997.PDF)
- Interpretation criteria
- Publication format and content
- Data delivery formats.

Unless noted otherwise, these standards are documented in the National Soil Survey Handbook at http://soils.usda.gov/technical/handbook/ and other technical references maintained by the Natural Resources Conservation Service.

The use of these standards has enabled the development of a database of soil survey data and information that is reasonably consistent across the United States. This effort continues through annual conferences to discuss and resolve ongoing and emerging issues related to soil survey and protection of this most basic of natural resources.

Information about the National Cooperative Soil Survey and its conferences can be found at http://soils.usda.gov/partnerships/ncss/. National NCSS conferences are held in odd-numbered years, with four regional conferences being held in even-numbered years. Locations rotate throughout the regions. They are open to anyone interested in the subject matter. There is a Soil Survey Standards branch of the NRCS National Soil Survey Center that facilitates the disposition of proposed changes or additions to existing standards.

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MAJOR COMPONENTS OF THE NATIONAL SOIL INFORMATION SYSTEM

NASIS

NASIS (the National Soils Information System computer application and database) is a centralized transactional database of tabular soil property and interpretive data about the soils of the United States. It includes onsite detailed descriptions of soils from about 250,000 locations. These descriptions are primarily used as supporting documentation for the soil description and the ranges of physical and chemical properties of soil map unit components. Full laboratory characterization data are available for about 32,000 of these sites. NASIS also includes the data for about 350,000 soil map units and about 1 million map unit components that accompany the soil maps. A major function of NASIS is the ability to generate soil interpretations for the map unit components using standard interpretation criteria and an interpretation system based on fuzzy logic. NCSS field soil scientists log into this database via a Web-based application to input and manage soil survey data on a daily basis.

The method of developing the digital soil maps is currently a parallel process that occurs outside the NASIS database. The soil map files are developed by the seven NRCS digitizing centers, which either digitize the hard copy maps from the field scientists or perform QC/QA functions on field-digitized maps to ensure they meet established standards. When digital map files for a soil survey area are completed, they are placed on a staging server, where they are merged with accompanying tabular data files from NASIS. Following final checking and certification, these merged files then move to the Soil Data Warehouse for storage.

Soil Data Warehouse

This database provides central storage for the various versions of official soil survey data, including both the soil maps and the descriptive, tabular data about each soil. Periodically, a new version of data for a particular soil survey area will be exported from NASIS, certified, and posted to the warehouse database. It may contain enhanced data since the previous version because additional data elements in the database were populated, errors were corrected, data were modified after the gathering of additional documentation, and other factors. This database is not a public access point, but it is possible to retrieve older versions of data if needed.

Soil Data Mart

The Soil Data Mart contains the current version of official data from the Soil Data Warehouse and makes it publicly available for distribution to a wide-ranging list of customers. The data can be downloaded in a standard SSURGO database format for use in a local Geographic Information System (GIS), or the tabular portion of the data can be viewed online via generation of standard tabular data reports. Downloaded datasets are packaged into individual soil survey area files and are time stamped and versioned for reference

purposes. Each downloaded dataset includes an FGDC compliant metadata file. Viewing of soil maps is not available here, but is available through the Web Soil Survey (see below). The Soil Data Mart can be accessed at http://soildatamart.nrcs.usda.gov/.

Soil Data Mart Web Services

These web services provide a mechanism for users to directly access the Soil Data Mart database and acquire spatial and/or tabular data they need by writing custom SQL queries against the database. These services provide:

- The customers with the ability to link their GIS applications directly to the Soil Data Mart database and acquire soil data needed for their local application without the need to actually download a whole soil survey areas dataset as described above.
- The ability for customers to select their spatial area of interest, such as a watershed, farm field, ownership boundary, study area, etc., irrespective of soil survey area boundaries
- The flexibility to select only those data attributes of interest (spatial and/or tabular data)
- Delivery of data in various formats (HTML, XML, and ASCII delimited) for import into a customer's database system
- Data can be acquired in real-time or queued for later delivery via ftp link.

These Web services can be accessed at http://sdmdataaccess.nrcs.usda.gov/.

Web Soil Survey

The Web Soil Survey (Figure 3) is a Web application that provides producers, governmental agencies, consultants, and others with electronic access to, and online viewing of, relevant soil and related information needed to make wise land use and management decisions. Web Soil Survey (WSS) provides an alternative to traditional hardcopy soil survey publication and a means for quicker delivery of information. It provides electronic access to full soil survey report content and access to the most current data available.

With WSS, customers can outline their geographic area of interest (AOI), as shown in (Figure 4), and can obtain available soil survey maps (Figure 5) and associated map unit data and interpretations. Thematic maps showing soil interpretations (Figure 6), various physical (Figure 7) and chemical (Figure 8) soil properties, and soil qualities (Figure 9) can be generated for the AOI. Tabular data reports (Figure 10) like those from the Soil Data Mart also can be generated. This information can be viewed online, or PDF files (Figure 11) can be generated for downloading or printing.

Web Soil Survey has a Shopping Cart function (no cost involved) that allows the user to collect a variety of thematic maps, tabular data reports, and desired explanatory information that they the user decides are important or of interest to their identified resource concern into a Custom Soil Resource Report for the AOI. Some introductory material, soil map, and map unit descriptions are automatically added to the report. When the user goes through Check Out the contents of the Shopping Cart are assembled into a single PDF file for

viewing, saving or printing. Web Soil Survey can be accessed at http://websoilsurvey.nrcs.usda.gov/app/.

Enhancements to the Web Soil Survey application continue. A new version is to be released in Summer 2008. Major enhancements in this version will be a Search function to help users locate desired information in the system. Users can input a keyword or phase and the system will return one or more links to sections that contain the word or phrase. Also included in this version will be a distance measuring tool, a direct link to a glossary of soil related terms, the ability for the user to download the raw data from the Soil Data Mart that has been clipped to the AOI boundary, and the ability to tile soil and thematic maps to multiple pages. Additional and larger computer servers will also be installed in order improve performance of the system.

Future enhancements planned include the ability for the user to Save their defined AOI for later use, the ability for the user to identify multiple tracts of land within an AOI, and the ability to import an AOI boundary from an outside application. Increasing the allowable size of an AOI is also desired.

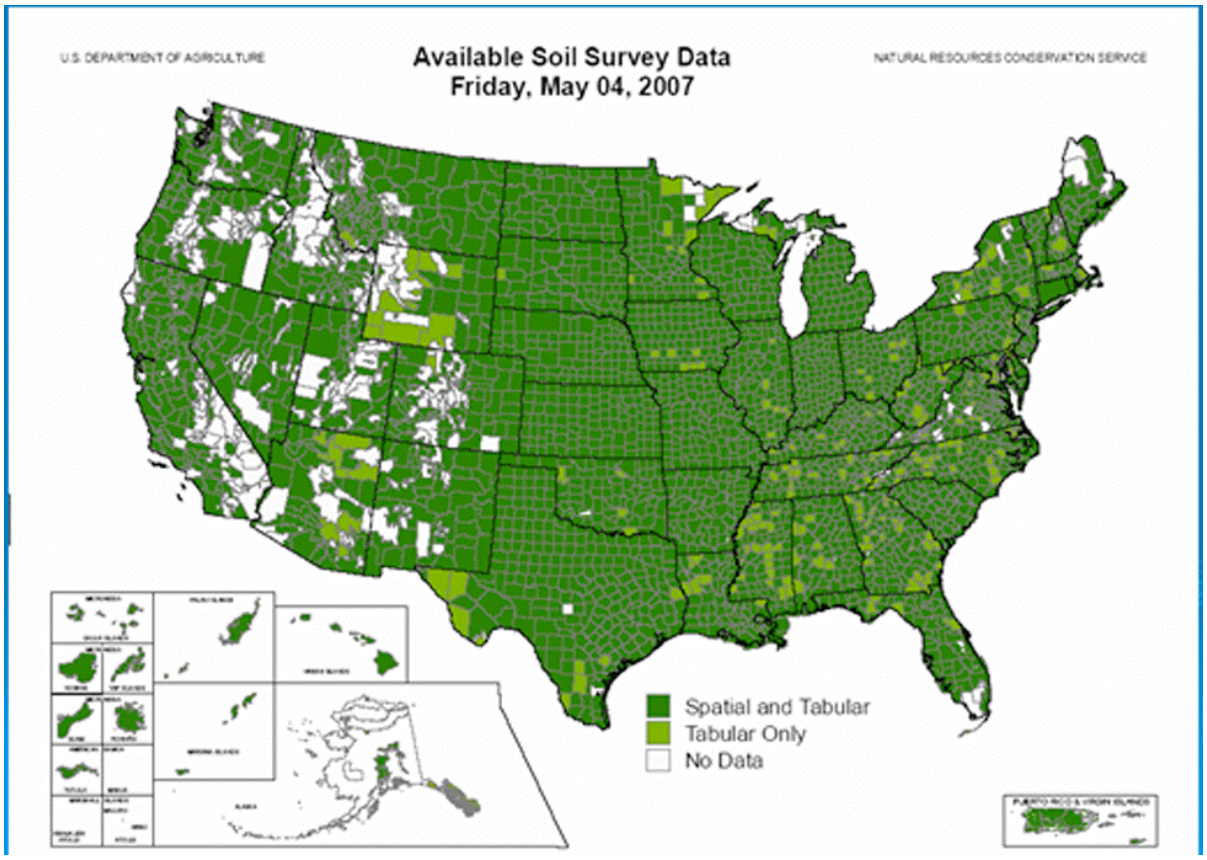

Figure 1. Soil survey data availability for the United States and territories. For the darker green areas, maps have been digitized and are available through the Soil Data Mart and Web Soil Survey. The lighter green areas have been surveyed but are not yet digitized. White areas remain to be mapped.

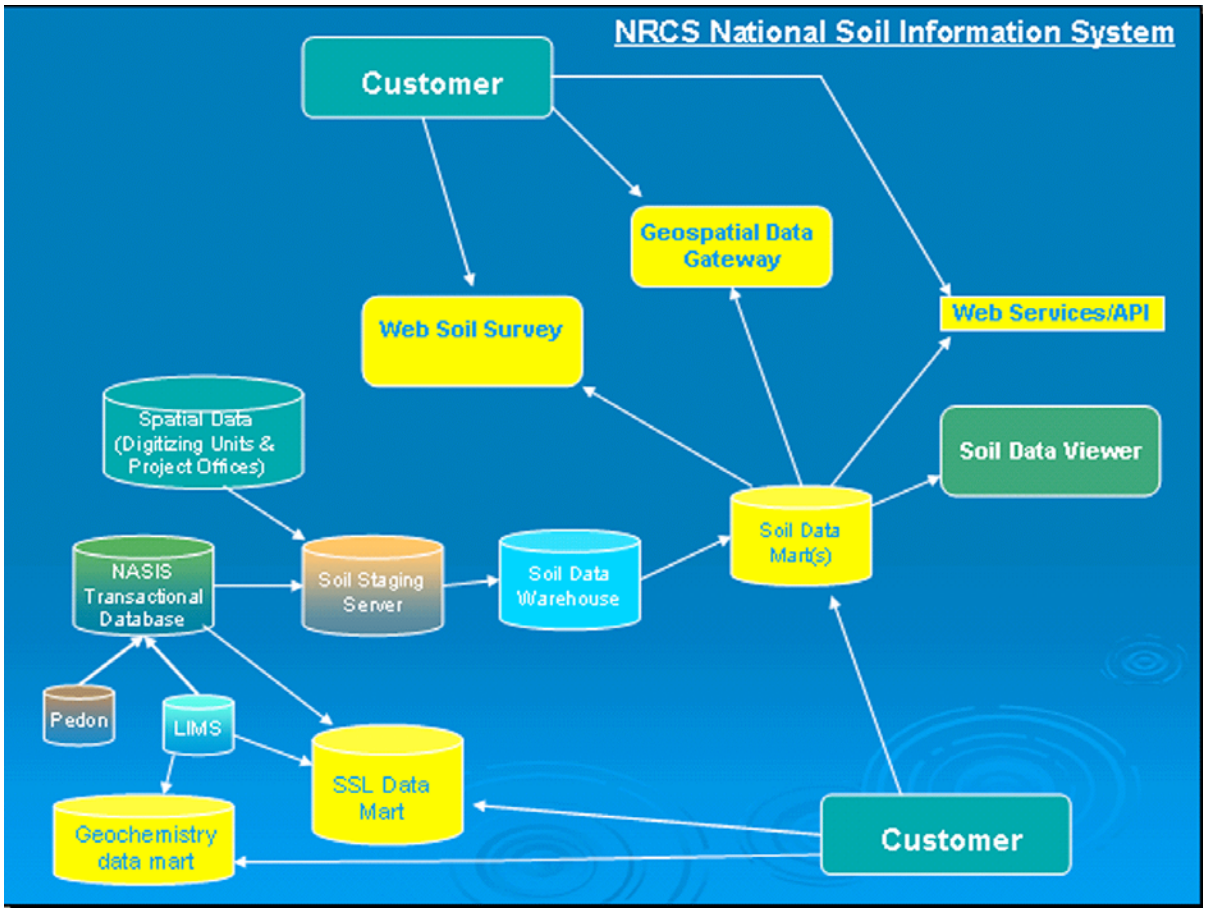

Figure 2. A schematic of the overall NRCS National Soil Information System showing data flow pathways. Major parts of the information system are explained elsewhere in this paper.

Figure 3. Web Soil Survey homepage.

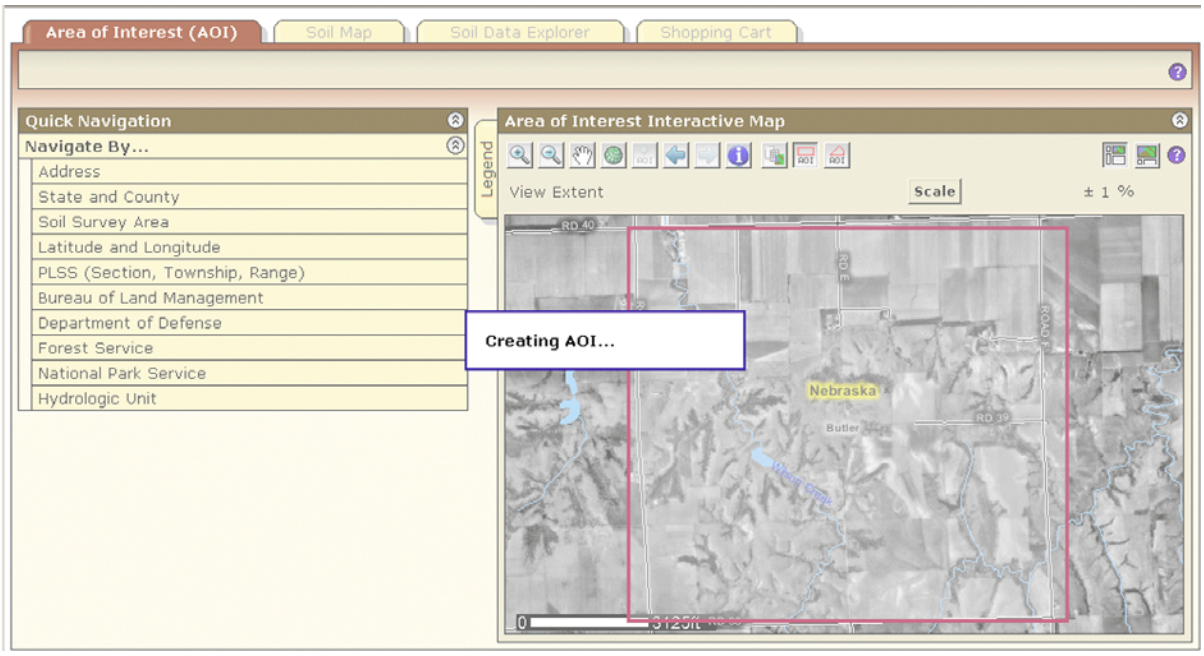

Figure 4. Defining the Area of Interest (AOI) in Web Soil Survey. A number of navigational tools are available for finding the AOI.

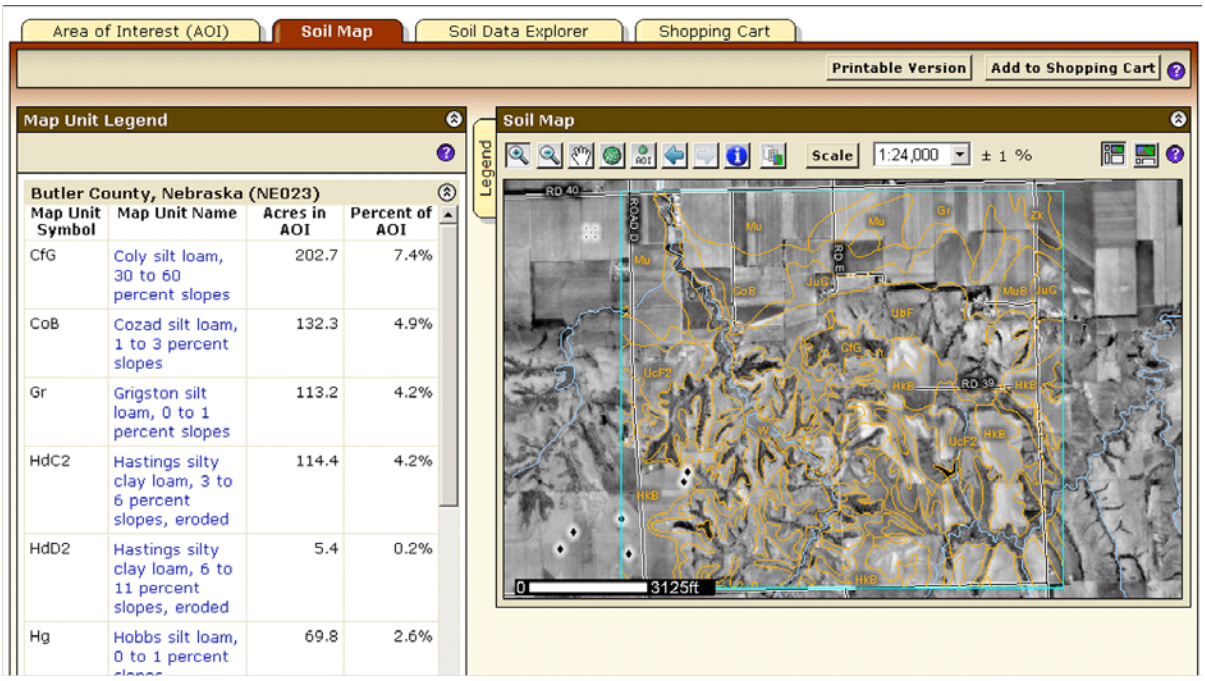

Figure 5. By selecting the Soils Map tab, the soil map of the AOI is displayed along with a list of map units in the area and their extents within the AOI. Clicking the highlighted map unit names displays a map unit description of that map unit.

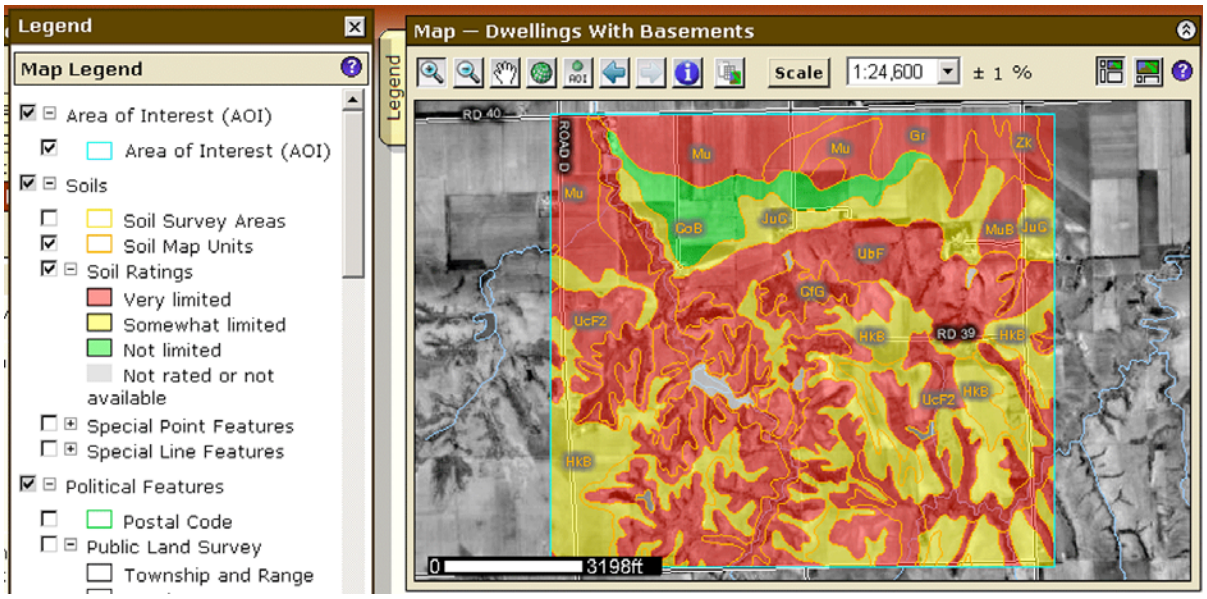

Figure 6. Thematic map showing soil interpretations available from the Web Soil Survey; here, the degree of limitations for dwellings with basements.

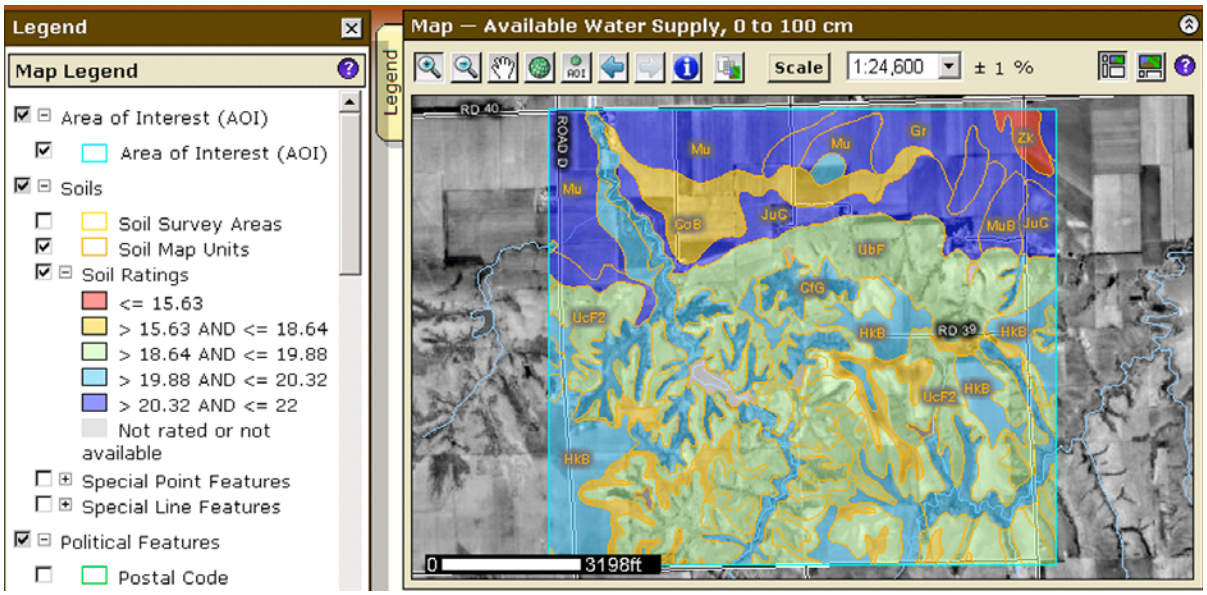

Figure 7. Thematic map showing available water capacity in 0- to 100-cm zone of each map unit.

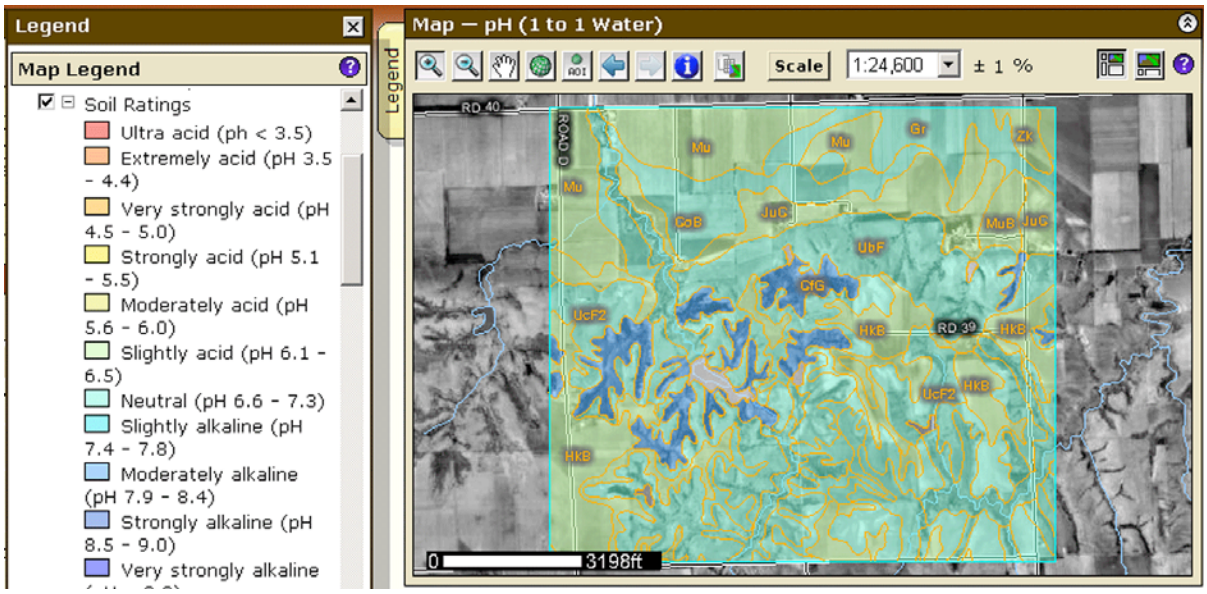

Figure 8. Thematic map showing pH in the surface layer of each map unit.

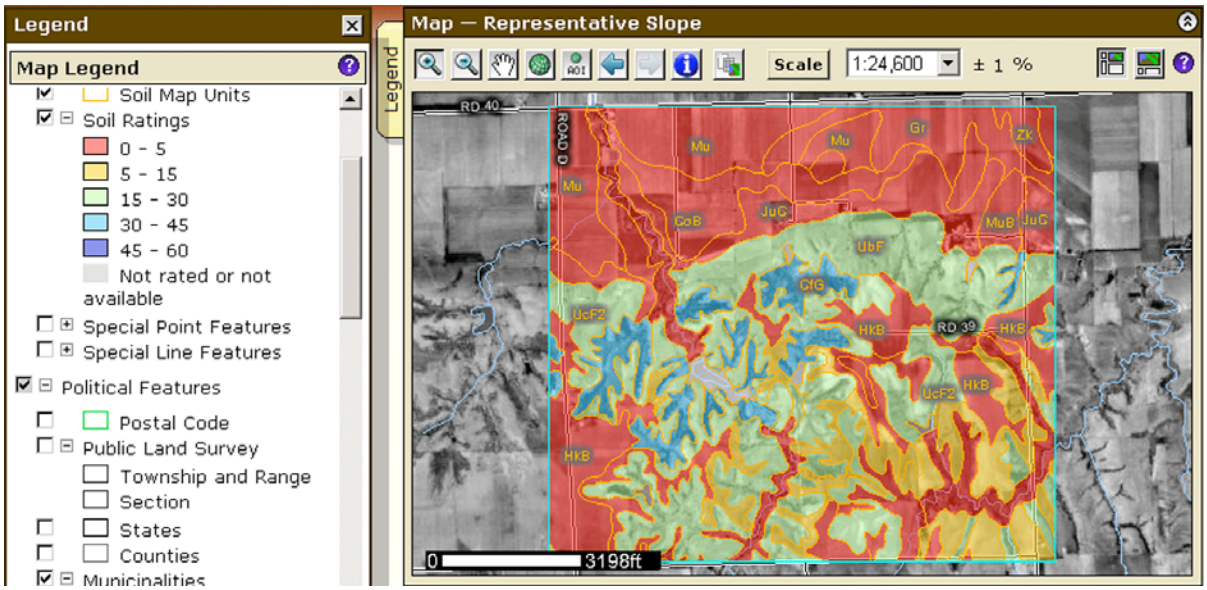

Figure 9. Thematic map showing representative percent slope of each map unit.

Report — Land Capability Classification

Butler County, Nebraska

Map unit symbol and name	Pct. of map unit	Component name	Land Capability Subclass	
			Nonirrigated	Irrigated
CfG—Coly silt loam, 30 to 60 percent slopes				
	100	Coly	7e	—
CoB—Cozad silt loam, 1 to 3 percent slopes				
	100	Cozad	2e	2e
Gr—Grigston silt loam, 0 to 1 percent slopes				
	99	Grigston	1	1
HdC2—Hastings silty clay loam, 3 to 6 percent slopes, eroded				
	99	Hastings	3e	3e
HdD2—Hastings silty clay loam, 6 to 11 percent slopes, eroded				
	99	Hastings	4e	4e
Hg—Hobbs silt loam, 0 to 1 percent slopes				
	99	Hobbs	2w	2w

Figure 10. Tabular data report generated from Web Soil Survey.

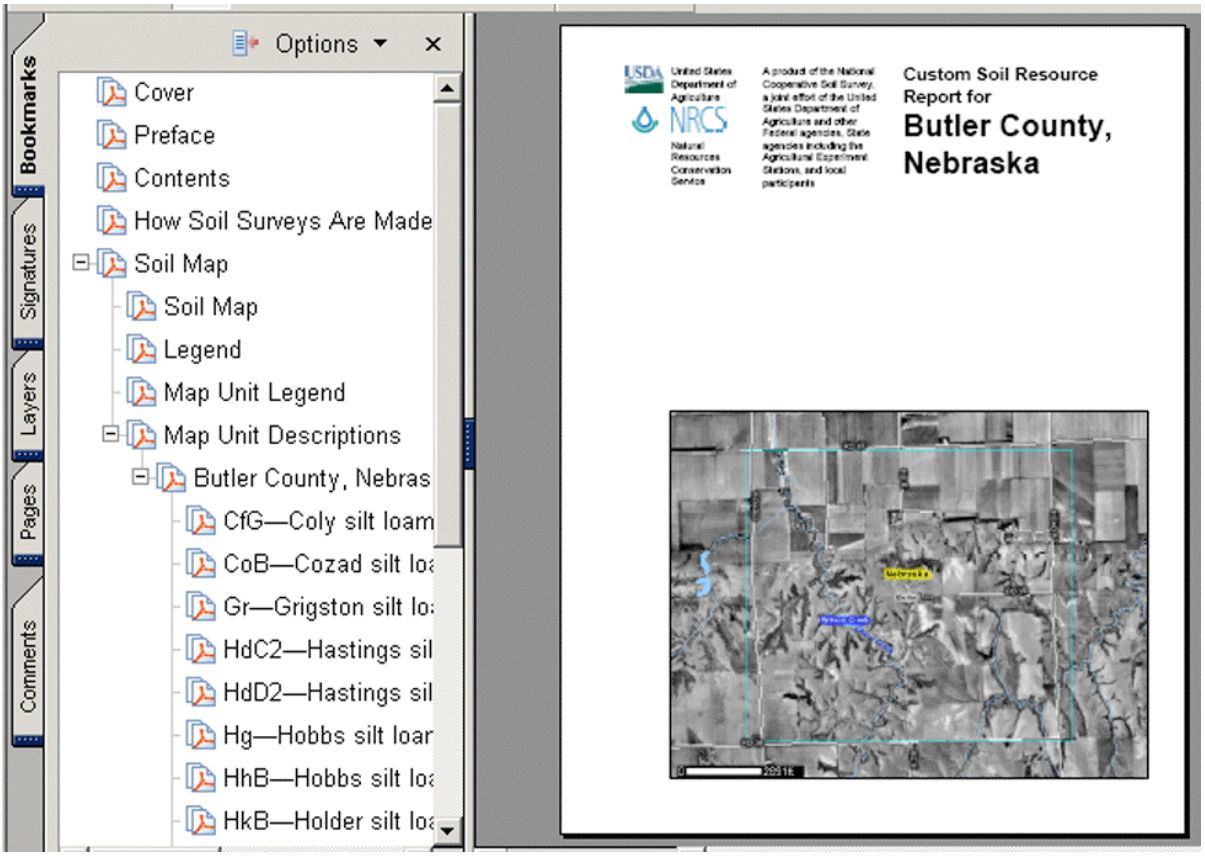

Figure 11. PDF report document generated by Web Soil Survey using the Shopping Cart function. Content of the report can be customized by the customer; hence the name "Custom Soil Resource Report for…" Individual thematic maps and tabular reports can be added as desired. The basic soil map, map unit legend, and map unit descriptions are added by default.