USDA- NATURAL RESOURCES CONSERVATION SERVICE
NATIONAL STATE SOIL SCIENTISTS MEETING
2002 PROCEEDINGS
Interpreting the Soil Survey for Conservation Planning

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Compiled by Maxine J. Levin, National Program Manager, Soil Survey Division, USDA-Natural Resources Conservation Service, Washington, D.C., January, 2003.

INTRODUCTIONS AND OVERVIEW

Welcome (Farm Bill) – *Patricia L. Hufford, Area Conservationist, St. Joseph, MO*

I am delighted to have the opportunity to welcome you to Missouri. Missouri is an interesting state with a wide variety of landscapes. To name a few of these landscapes there is the delta area in the Boot heel, the karst region in the Ozarks, and the loess hills of northwest Missouri.

Each of these regions has their own unique natural resource concerns. Each has their own inhabitants who live in and manipulate these natural settings. The inhabitants of course have varying degrees of knowledge about the impacts of their manipulations. In the boot heel there is the ever increasing desire to improve irrigation efficiency and a continued need to mitigate the loss of wetlands. The karst region in the Ozarks offers the best water recreational opportunities in the state. Unfortunately with this recreation come inadequate septic systems and questions of appropriate waste management. The southern reaches of the loess hills, lying as they do through, and to the north of Kansas City, are being degraded by poorly planned subdivisions. The homeowners there experience foundation failures due to home designs with little consideration of the loess hills instability.

A diverse state with diverse needs, and the common thread that ties these people and these regions together in MO, and in fact across the United States and the world, is the need for solid, available soil information. Regardless of the resource concerns or the needs and knowledge of the individuals involved with the resource, the typical source of soils data is the NRCS county soil survey.

Missouri, like many other States, has completed its first generation soils survey. This was marked with great celebration and excitement in 2001. The soil scientist's job, however, is not over. Each of you in the audience today, individuals responsible for your State's soil data knows this. Each of us in the natural resource management field, responsible for the 01 workload, knows this. Continued changes in the use of and the users of the soil survey data necessitate continued updates.

Never was the soil survey put to such test nor brought under such scrutiny as it was by the 1985 farm bill. Conservation provisions used the soil survey to determine what lands were highly erodible and, therefore, subject to conservation compliance. Soils drainage class as well as the duration and depth of saturation during the growing season were used to define hydric soils. Hydric soils being, as you are well aware, one of the 3 indicators of wetlands under the "swamp buster" provision.

Program payments, such as the Conservation Reserve Program, were influenced by soil survey data. Rental rates were associated with soil type and a producer's annual payment was based on the 3 predominant soils in his field.

I had already been working in the field with NRCS when the –85 Farm Bill was applied and I saw the use of the soil survey in our 01 work transform from a guidance document, which was its original purpose, to a regulatory doctrine. You saw that change too and many of you realized I am sure, with considerable frustration, that the existing documents could not adequately meet that new demand. Many of you, and certainly I, worked with the producers who were frustrated by our use of this static tool to make determinations that impacted their economic and social comfort. Obviously wet soils defined in the soil survey as somewhat poorly drained were not hydric and could therefore be drained. While across the property line another wet soil, defined as poorly drained, was hydric and could not be drained.

A soil unit mapped line drawn a bit too wide or a bit narrow could change an annual CRP payment from $65 to $35. A miss drawn line could even result in land being ineligible for CRP all together. Unfortunately, too few soil scientists were available to field offices to make the needed on-site corrections. Typically, counties with completed soil surveys had very limited access to resource soil scientists. Let me state quickly—before I lose you—that these deficiencies were not due to bad soil science. They were due to the lack of time, flexibility and money to do appropriate updates. And let me further state that the use of the Soil Survey for the Farm Bills worked out pretty darn well, so well in fact that each subsequent Farm Bill, including the 2003 Bill, continued to rely heavily on soil survey data.

Let me give you a few samples of how the new Farm Bill will rely on NRCS soil data and soil scientists and give you my answer to the question posed by many– What is the role of Soil Scientist in the 2003 Farm Bill?

It is known that soil data will continue to be used in the Conservation Reserve Program (CRP) to establish and calculate rental rates. Programs, such as CRP and the Environmental Quality Incentive Program (EQIP), where land eligibility is based on environmental benefits index (EBI), will surely continue to use Erosion Index (EI) and or tolerable soils loss (T) as EBI factors. Wetland Reserve Program (WRP) easement purchases will continue to rely on agricultural land appraised values. These appraisals are very reliant on soil data.

New soil data needs will come with the new Farm Bill.

Nutrient and pest management I believe will be widely promoted practices nation wide through the EQIP. The proper application of our Nutrient and Pest Management standards and specifications will rely on the development of phosphorous indexes, the establishment of "excessive nutrient levels", and the ability to predict the potential of a nutrient and/or pesticide to leach through and or runoff from an application site. All of these factors are soil related/soil dependent. The ability of conservationist, weather they are NRCS soil conservationists or Technical Service Providers, to accurately apply our standards to this program will depend on the quality and availability of properly interpreted soil data.

Payments in the Farmland Protection Program will rely significantly on soil data. This program is basically a purchase of the development rights of a land unit that is currently being used for agriculture and that is threatened by urban encroachment. Payments for the easement are the difference between the developed assessed value of the land and the agricultural assessed value of the land. I have never known a land appraiser who did not rely on the county soil survey for some aspect of their assessment process. Additionally, one eligibility criteria for FPP is that 50% or more of the land will meet the definition of prime farmland, or soils of statewide importance.

A new program for 2003 is the Conservation Security Program. There is every expectation that this program will be wildly popular and utilized by 80 to 95% of the producers in Missouri. The program is an entitlement payment to producers who are currently applying conservation to their land. The three tiered payment plan pays most to the producer who is applying a total resource management system (RMS) to his farm. Lesser payments are paid for those with a RMS applied to one resource concern, with smaller payments yet to those applying a progressive plan. Good program? – Yes, it rewards the conservation farmer. Easy for the producer to apply? – Yes, NRCS documents the existing condition and we require no additional practice application. Easy to document?- NO, every producer will want to be in that high tier; every producer will want the conservation planner to document that their system is a total RMS and that their management of their soil-water-air-plant-animal resources meet the state's quality criteria. Currently a soils quality criterion includes soil erosion and soil quality. We 01 planners have a pretty good handle on soil loss, and we appreciate your continued refinement of "K" and "T" values. It is, however, in the evaluation of soil quality that we lack soils guidance. More support here is greatly needed.

Eco-systems restoration programs, such as Wildlife Habitat Improvement Program, the Wetland Reserve Program, and quite possible the new Grassland Reserve Program, will require some consideration of the native vegetation on the site to asses the appropriate restoration plan. From the days of the Soils-5 to the current use of eFOTG and NASIS, soils data is our source of "native vegetation".

Technical Service Providers, a very new addition to our lives, in and of themselves provide an interesting wrinkle to your role in the 2003 Farm Bill. The potential TSPs in Missouri will range from those with no knowledge NRCS soil data, to those who cling stubbornly to the interpretations in a soil survey published in 1968. Where are the TSPs going to get the latest and greatest soils data? How will they even know such data exists? Will they have the expertise to interpret data, or could soil scientists be available to assist them with their interpretations?

Your role in the 2003 Farm Bill, as I see it from the perspective of the field, is clear. It is a role I am sure you see for yourselves.
First, it is to provide soil information that is:

a) based on the best, most current science possible,
b) available in a variety of formats so that it is easily accessed and understood by a wide range of users.

c) And, that the raw data is held in a flexible format such that it can be updated to the minute, as the science, the users, and the applications evolve.

And, second, please do not forget the human aspect of the soil science program. Good soils data alone will not be enough. Resource soil scientists must remain available to the field offices for on-site evaluations and interpretations.

It is clear to me that those of you involved in the development of this week's program, such as Maxine Levin and Dennis Potter, are committed to the future of the soil survey program.

Additionally, those of you who are here to provided presentations on such topics as Soils and Geospatial Initiative, Linking Research to Soil Interpretations, the panel of speakers here for the session "Soils Data and Information- the public interface", and Algorithms and New NASIS Calculations and Validations, are all well on your way to meet the three issues related to soil data that I noted above.

The week ahead for you looks to be exciting, though provoking, and rewarding, much the same as the weeks ahead of you as you face the challenges of the 2003 Farm Bill. We at the field are confident you will more than meet the challenge.
Welcome again to Missouri, and thank you for your attention.

Soil Survey Status and Priorities-- *Berman D. Hudson, Director, Soil Survey Division*

Responsibilities:

Providing soils information for conservation planning: Soil is a strategic natural resource that must be managed and conserved to sustain the economy and health of the nation. NRCS has national responsibility for providing technical assistance to landowners to help them maintain long-term productivity of their soils. Within NRCS, the Soil Survey Division provides the basic information (soil maps and data) needed to maintain soil quality while at the same time producing adequate amounts of food and fiber on a continuing basis. Soil surveys are the basis for predicting the behavior and stability of soil under alternate uses.

Leadership of the National Cooperative Soil Survey (NCSS): The Soil Survey Division leads the federal part of the NCSS, a partnership of federal land management agencies, state agricultural experiment stations, and state and local units of government. The Soil Survey Division leads this partnership in developing and promoting standards for the uniform mapping of soil nationwide.

Current Status and Achievements:

Staffing: NRCS has approximately 950 soils scientist located throughout the country. We have charged this staff with two major functions. They spend about 75 percent of their time and resources preparing and digitizing soil maps and populating the national soils database. The other major function is technical soil services, which involves providing direct assistance to the field on soil-related problems.

Soil Maps and Data : NRCS now has first generation detailed soil maps on more than two billion acres nationwide. These maps are accompanied by data and interpretations on more than 22,000 different kinds of soil. The estimated value of this national database is five billion dollars. The benefit-to-cost ratio of our soils information has been estimated to range from 15:1 in rural areas and more than 45:1 in rapidly developing suburban areas. Because of the high value of this information, NRCS is experiencing an increasing demand from counties, consultants and others across the nation to provide updated soil maps and soils data in digital form. In response, the Soil Survey Division has initiated an accelerated soil-digitizing program. More than 1300 soil surveys have now been digitized (about one-third of the total).

International Leadership: The NRCS Soil Survey Program is the acknowledged world leader in soil classification and mapping. Our technical standards have been adopted for use in many countries of the world. For example, our system of soil classification, *Soil Taxonomy*, is the de facto standard throughout the world and has been translated into many languages. Our technical field guide, the *Soil Survey Manual*, also is used in many countries and has been adopted as a text in soils curricula throughout the world. Members of the NRCS Soil Survey Division are frequently called upon by AID and other international aid agencies to provide assistance in international projects related to soils.

Challenges:

Data obsolescence: Keeping our national soils database current is a continuing challenge. Generally, as a result of the demand for more detailed maps and additional data, soil surveys need updating about every 30 years. However, with our current staffing level and mapping technology, our update cycle is approximately 70 years. We are conducting research and development in a number of technologies such as computer assisted mapping linked to structured knowledge bases to improve the efficiency of soil mapping. It is imperative that we increase the accuracy and precision of the next generation of soil maps by at least 50 percent. At the same time, we will need to at least double our mapping rate – to an average rate of more than 100 thousand acres/person/yr.

Shortage of soil scientists: NRCS could be facing a severe shortage of trained soil scientists in the near future. More than one-half of the approximately 950 NRCS soil scientists nationwide are eligible to retire within five years. Therefore, succession planning is critical issue that must be addressed.

Information delivery: Digitized soil maps are in great demand by NRCS field staff and by the general public. Digitized soil information is the key to providing soil surveys to the public on the web and on CD's and to providing soils information to NRCS for the Field Office Customer Service Toolkit. About one-third of soil surveys in the nation have been digitized. At the current level of funding, digitized soils information for all completed soil surveys in the nation will not be available until approximately 2010. Additional funding is needed to accelerate this process. In addition to finding better ways of delivering data, it is imperative that we revolutionize the delivery of soil survey information in general. The web and other electronic media provide us with an opportunity to really educate the public about the nature of soil and its importance as a fundamental part of the global ecosystem. It is imperative that we form partnerships with interested universities and other entities to explore novel ways of packaging and delivering soils information.

View of the National Cooperative Soil Survey—An Infrastructure for NRCS-- *Chief Bruce Knight, USDA-Natural Resources Conservation Service*

Good afternoon.
I'm sorry I can't be with you today in St. Joseph, but I do want to lend my support to your meeting and to have a chance to talk with you about the future of soil science at NRCS. Even though we now work with other resources, including water, air, wildlife, and community resources,
soil science will always be important to our success as an Agency. It is important for us to have a full complement of soil scientists working to maintain and improve the science behind our conservation work.

We will be getting more conservation done on the land– lots more.
So, it is more important than ever that we have good data available to us and to our customers. I want to thank you for everything you have done to digitize and update our soils data; and get the Electronic Field Office Technical Guide up and running.
You had a very short timeframe for getting that work done, and I appreciate your efforts. As a result of your hard work, your fellow employees and our partners have the latest soil information at their fingertips. Not only is electronic accessibility becoming more and more of an expectation of our partners and customers,

It is also a major part of the administration's e-government initiative, and a major goal of our Agency. Ready access to the latest soils information will be important to the successful implementation of the farm bill.

Because of workload generated by the new farm bill, we will be using a lot of outside help -technical service providers and others – to help us get the job done. These people will benefit from the work you have done to make soils information available electronically.

I know having soils information on the Web is just one of the many new technologies you have implemented or are working to implement.
The data you have provided is valuable in many other applications, including WINPest and RUSLE2. The Soil Survey program has long been on the cutting edge of new technologies. The National Soil Survey Center and Laboratory lead that effort. And the field has been very flexible in testing and adapting these new technologies – often in a short timeframe.

Many states -- among them Illinois, Wisconsin, Texas, and Vermont – have used internal talent to explore new technologies on their own or through the help of partnerships, and I thank you for that effort. The contributions of NRCS soil scientists reach way beyond our Agency.

FSA will be using your data for the next CRP signup. FSA needs that data for the soils part of the Environmental Benefits Index, a major criterion for ranking in CRP. I know it will take a lot of work in the States to prepare specific files for export to FSA, and that you will be talking about this at your meeting.

The work never ends. We have a continuing need to maintain and improve our data to meet new conservation concerns. Because soils data are so important to our business, we must continue working to maintain and update the soil survey.

It is especially important that we complete the basic soil survey. Our soil data simply must be kept up to date. Historically, soil scientist positions have been very important in NRCS, and that will continue to be the case.
Today's soil scientists need to be both field savvy and database savvy to assist soil conservationists with farm bill implementation and customer service toolkit implementation. I know many of you are interested in the future of the soil science profession at NRCS. Let me assure you, that future is bright. Soil scientist positions are critical to the success of the Agency, particularly with the increased emphasis on conservation in the new farm bill. All of the retirements coming up create a challenge for the Agency.

We must attract bright new soil scientists. We must train our present staff and prepare them to move up in the organization. We must have a steady supply of new soil scientists into the soil survey program, so that we can maintain our ability to provide the best soil survey information in the world. We already have started filling in the gaps in our field office structure – gaps caused by retirements and normal workforce turnover.

The USDA Career Intern Program is also helping us maintain a strong cadre of soil scientists. This program allows us to hire entry-level professional and technical employees without advertisement. Right now, we are the only USDA agency using this authority. Hiring these Career Interns will help us in the long run, because we can convert them to permanent status after 2 years. We already have hired about 50 employees under this authority.
We need all the soil scientists we have now, and more,

- To support our field conservation operations.
- To maintain and upgrade soil survey databases, digital products, and soil interpretations,
- To help people understand and use soil survey data appropriately.
- To develop and maintain field office technical guides,
- To carry out educational activities, and
- To perform survey maintenance and update work.

At the same time, farm bill implementation will create a lot of work

- for soil conservationists,
- for other resource professionals,
- and for almost any NRCS profession you can think of.

To get our farm bill work done, we will have to work through our partners and third-party vendors. We have plenty to do within the Agency, and we need all the outside help we can get. If we do not make full use of third-party vendors, too much of your work time will get siphoned off for technical soil services work when you should be focusing on soil science work, such as maintaining our soil survey program capacity. We cannot and will not allow that to happen. Your work as soil scientists is simply too important to our success as an agency.

Your agenda this week is ambitious. It is clearly aimed at helping you meet the challenges of the future. The new farm bill marks the beginning of a new golden age of conservation in America, and soil scientists will play an important role in making that new golden age a reality.
Good luck in your efforts.
Now, I would be happy to answer any questions.

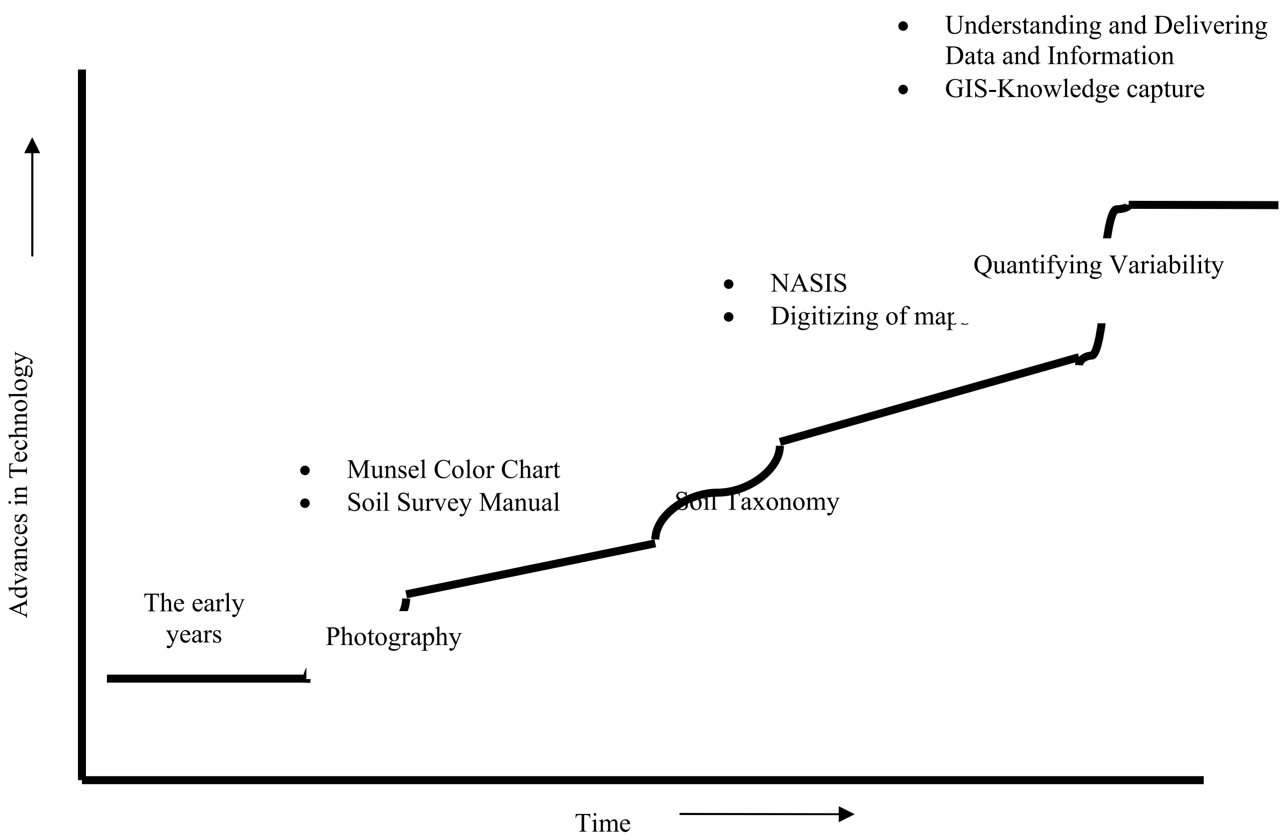
The National Cartography and Geospatial Center (NCGC) Support of Soil Surveys and Interpretations, Landscape Analysis, Training and Data Access-- *Tommie Parham, Director, NCGC, Fort Worth, Texas*

The National Cartography and Geospatial Center (NCGC) supports state, field, regional, and national offices with comprehensive services, products, and technical leadership in cartography, photography, natural resources data access and distribution, geospatial database development, and support with mapping, national resources inventories (NRI), soil survey (digitizing, imagery, digital map finishing, and publications), printing, editing of technical publications and geospatial data warehousing. This presentation gives an overview of NCGC activities in that are related to support of soil survey interpretations, landscape analysis, training and data geospatial access. Nathan McCaleb, NCGC Soils Support Branch Chief will give a more detail presentation on his branch activities later in the week. I will touch on the Integrated Information System; GIS capture tools, training, soil survey publications, and some new technology.

Soil Survey :The Next Level --- *Maurice J. Mausbach, Deputy Chief, Soil Science and Resource Assessment, USDA-Natural Resources Conservation Service, Washington, D.C.*

Introduction

Soil survey has made progress through a series of technological advances as depicted in the following graph. What will be the next major technological advance that defines soil survey for the next 20 to 30 years? Before we answer the question let us look back for the first century of soil survey.



The first concepts of soil survey were developed in the early years as Whitney begins the process of defining the early philosophy of soil survey. Mapping was accomplished with a plane table during a period when the soil series concept was being developed. In my view, the first major technological advance begin with the adoption of aerial photography as the base map. Aerial photography was soon accompanied by development of the Soil Survey Manual and the use of the Munsel color chart.

The next major technological advance came in the late 1950's and early 1960's when the Soil Survey Division began an ambitious effort to upgrade the soil classification system. It was a monumental task accomplished in a collaborative venture with the Land Grant Universities and the international soil science community. What resulted was a revolutionary new approach to soil classification – Soil Taxonomy. Soil Taxonomy has largely guided what we have done in the last 30 years, supplemented with tools such as NASIS, and GIS. It is time that we move on to the next level. Do we need as large an effort as Soil Taxonomy? I think so.

Building on the Past for the Future

Although we have had numerous, long discussions on the paradigm for soil survey; it remains a morphological, (field-based versus laboratory based) soil-landscaped-based product. The project leader develops a soil-landscape model that guides the soil survey activities in an area. This subjective process is tempered by the guidelines and procedures that we have in the Soil Survey Manual and the National Soil Survey Handbook so that any two soil scientists will come up with similar models. This systematic approach is extremely important in standardizing our product for without these standards, any two soil scientists would most likely come up with widely divergent surveys of the same area.

The landscape model is our main tool for describing the variability of soils and their properties in space. As part of the model, we have two basic concepts or units, the Soil Series or Taxonomic Unit and the Map Unit. To further define or describe this variability, we provide a range in characteristics for Soil Series, percent composition of soils in a map unit, and ranges in properties of map unit components (soil data map unit).

What we lack is a systematic way of quantifying the random variability (standard error) once we have addressed variability from soil components, surface texture, landscape units such as slope, geomorphic position, parent material, hill slope position, etc. We need to do this using a systematic, scientifically viable, statistically valid method. We have had a number starts on addressing variability, but soon got bogged down and frustrated, and the start usually fizzled.

Soil Series – is the lowest category in Soil Taxonomy and arguably differs from the other classes in the requirement for mutual exclusivity (it is difficult to attain exclusiveness when numerous properties define a concept). The soil series is defined by numerous morphological, chemical, landscape, and geological properties. The series description provides limits to these properties and includes the typical pedon and a range of characteristics all of which are confined to properties of the family to which it belongs in Soil Taxonomy. The soil series is a subjective concept based on the collective views of soil scientists. Thus, the concept has a propensity to gravitate with time and these collective views. The range in morphology is supported by numerous pedon descriptions that are collected in the course of completing soil survey projects. However, they are not selected at random from the universe of pedons that represent the Series (this universe of pedons is largely unknown). We have systematic ways of locating pedons based on geomorphology, landscape position, etc. but I am not aware of a corporate way of selecting the pedons that meet randomness requirements. However, it may not be so important to randomly sample pedons representing a soil series as having a systematic approach of selecting the pedons that meets statistical procedures.

Characterization of the soil series is even more tenuous in that "representative pedons" are selected, sampled and analyzed based on someone's concept of the typical pedon. The process, assumptions, etc. for selecting the representative pedon are largely unrecorded. In addition, we have little data to support how the range in properties of the series is distributed about some center point. Do we need an almost infinite number of properties that define a soil series? What are the critical properties that define a soil series? Do they vary together, is it important to know the interaction among the properties, etc.

How to best sample the soil series for laboratory characterization? The standard procedure is to sample one or two pedons that represent the central concept of the soil series. These typical pedons are usually located based on soil morphology, parent material, and landscape characteristics. This procedure provides an excellent depth function distribution of soil properties for the point and is good for studying soil genesis and for making soil interpretations. However, we have done little to characterize within and between pedon variability.

Map Units – as previously mentioned map units are systematically defined according to the soil-landscape model. They reflect a repeatable and hopefully identifiable portion of the landscape within the soil survey area. We have excellent protocols for describing and accounting for variability in soil components within a map unit. The inference being that the properties of the components represent the range in properties for the map unit. The range in properties is captured in NASIS via the soil data map unit. We do not have a measure of reliability of these properties in the soil data map unit.

All of our databases related to the map unit and soil series are based on estimated soil properties. These estimates are based on laboratory data, field data such as soil texture, pedotransfer functions and in some cases, subjective, professional guesses. The Soil Interpretation Record and NASIS has served and continues to serve us well, but we can do better. We must move to using real data to describe properties of the map unit. By real data, I mean data that quantifies the random variability associated with the value for a soil or map unit property.

The soil data map unit concept is something we need to seriously debate. I'm not sure that the concept correctly represents the soil landscape model on which the soil survey is based. However, with some modification it may provide a mechanism to quantify the reliability of map unit data.

We have a good start on capturing even more information on map units and soil polygons in the SOILIM project with the University of Wisconsin. If we can build in some measure of reliability, perhaps we can answer the question of map unit reliability.

In addition to variability in space, variability in time is also an important factor in reducing random variability. We are gearing up for describing and capturing information on use-dependent soil properties. We need to continue developing the systems and protocols for handling variability in time.

Pedon Database

We have a wealth of information and data in our soil pedon database. Of the many uses of the information, development of pedon transfer functions ranks high. It is also very useful in geomorphic and pedologic studies if we have adequate morphological and site descriptions. However, the sampling of one or two complete pedons is not very useful for expanding data from the point to a polygon or field. Characterization of soil properties in space has not been an objective of our soil characterization program. It is time that we consider variability in time and space in our soil characterization program.

For example, we know that bulk density varies with time annually, with land use/management, and across a field. How do we best represent this bulk density value? We do not have a way to address variability in time or space with respect to any of the laboratory data. I mention bulk density because it is used to convert all of the weight based numbers to a volume bases. Until we establish protocols for variability in time and space for bulk density we will not be able to estimate soil organic carbon in a field, or map unit polygon. In other words how do we expand the point data to various scales. I believe we need to develop the systematic, statistical procedures for doing this, deciding on the best procedure will be the task.

Statistics

There are a number of statistical approaches to consider but they all boil down to the basic parametric versus non-parametric approaches. We need to keep it simple, but have enough power in our statistics to quantify variability in soil survey. I am partial to non-parametric approaches because we do not have to meet the rigors of the parametric statistics, mainly the properties of soils meet the normally distributed requirement. However, I know only enough about statistics to be dangerous!

Earlier, I mentioned that we do not have procedures for randomly selecting pedons from the universe of pedons representing a series or map unit component. We now have a pretty good idea of the universe of pedons with the completion of the initial soil survey. It is time to develop procedures and protocols for random sampling to characterize our soil series and map unit components.

Next Steps

The next technological advance of soil survey depends on our ability to address and quantify variability of soil properties in time and space. We need to move forward from an estimated property based delivery of data and information to use of real data in time and space. To accomplish this task, we should consider the following:

1. Our ability to do national and regional assessment of soil properties and characteristics,
2. Use of new technology (SOLIM) to capture more of the systematic variability,
3. Understand/characterize random variability and develop means to express this uncertainty to users, and
4. Understand relationships between taxonomic limits and natural variability on the landscape.

We should have the initial concepts (first or second approximations) developed and presented at the 2006 World Congress of Soil Science.

SOIL INTERPRETATIONS

Defining the National Soil Survey Center's and State's Roles with Regard to Interpretations --*Karl W. Hipple, National Leader - Soil Survey Interpretations, NSSC, Lincoln, NE*

The National Soil Survey Handbook (NSSH) defines most of the roles of both State Offices (States) and the National Soil Survey Center (NSSC) in terms of responsibilities for interpretations. Both NSSH Parts 617 and 618 contain guidance pertaining to the topic. I don't want to go into great detail because one can read the responsibilities of the 2 entities, but there are some issues that I would like to emphasize.

First, let me philosophize a bit about soil interpretations. Soil interpretations are not new by a long shot. Certainly ancient societies knew that some soils made better bricks than others did and that some soils were too wet to successfully build on. Milton Whitney stated in 1899, "We needed to be able to transfer experience from research or the use of soils, from the fields or areas where we have experience, to other soils or areas where it is applicable." Making soil interpretations is "one" way to classify soils - by placing them in response groups so that like soils react in the same way(s) to like management(s). However, Whitney also wrote in a letter in 1914 that the purpose of the Soil Survey was limited to "…. the gathering of fundamental soil information to be used as the basis for experimental work by other bureaus or offices." Charles Kellogg became responsible for the Soil Survey Program in 1935 and soil interpretations once again became an important focus of the program. So soil interpretations have been at the forefront at times and behind the scenes at other times throughout the history of the NSCC Soil Survey Program.

However, from my experience, soil taxonomy and mapping dominated the NCSS for many years and interpretations were its secondary priority. The NCSS was focused on completing the once over and that task dominated most of what the NCSS did for many years. This fact, in my opinion, is and was well illustrated in our targets/goals for the NSCC reporting system. The dominant goal for the NSCC has been acres mapped, although more recently soil surveys digitized and manuscripts have been added and tracked.

I believe that soil interpretations are now different in some ways than in the past. The larger the earth's population becomes, the more we will be faced with making soil interpretations for soil materials based on human induced changes to the soil materials and less on nature induced changes to soil materials. Disturbed or altered materials don't respond or react to management in the same way that undisturbed material responds. Hence, the issues related to use-dependent properties must be considered. We must better understand the changes that result from man's influences or management over time (seasons, decades, centuries, etc.) if our goal is accurate interpretations. We must do more with the relationships and interactions between use dependent properties and soil interpretations than just talk about them.

It is also critical to realize and understand that the NRCS' definition of "technical soil services" and "soil interpretations" overlap dramatically. It is extremely hard to draw a clean concise line between the two subject areas and label a task solely a soil interpretations task and/or visa versa. An example is the task of training. Technical soil services requires training users to correctly use soil survey data and soil interpretations requires training users to understand the paradigm that we use to make soil interpretations based on soil survey information. As one can see, there is a large amount of overlap in both "training" situations. So I will not try to make distinctions between technical soil services and soil interpretations responsibilities in this presentation.

First, let's briefly discuss the NSSC's roles and responsibilities. Initially, the NSSC has the responsibility to develop policy, standards, guidelines, and procedures for making soil interpretations. Oversight must be provided so that quality standards are maintained in all aspects of developing, testing, and publishing interpretations. It would do a user little good to use soil interpretations that require a common standard soil property that has been determined by several different methodologies. Therefore, it is the NSSC's responsibility to prepare and maintain the standard guides and procedures for rating soils.

Next, the NSSC must maintain all National soil interpretations so that again they are uniform in criteria, methodology, and use across the country. Part of this task is the development of policy and procedures that assure consistent estimation and population of data elements. Soil interpretations must be the same from state to state and region to region so that national conservation program eligibility and application will be equitable and consistent for all national conservation programs. This also requires the NSSC to work closely with other disciplines and programs to assure that soil interpretations and standard procedures are coordinated with other program requirements at the national level.

Training is another responsibility of the NSSC although states also have significant training responsibilities. NSSC is responsible to provide training to other customers in developing, maintaining, storing, and retrieving soil interpretations. This role is addressed by several of the formal courses taught at the NSSC and by one-on-one or small group training provided by NSSC staff at remote locations. Another part of this task is helping others understand the science and principles related to making sound interpretations.

Now let's discuss states' roles in soil interpretations. Data population is a state responsibility and one that has not yet received enough attention and priority, in my opinion. The NSSC can and does assist with data population by developing algorithms for certain properties but the algorithms need accurate basic data to run. There is currently a strong effort underway here in the NSSC to develop algorithms that validate and calculate data entries. Laboratory data can also be provided but it too must be entered into the database. States must make data population a higher priority so that as modelers and others attempt to use our data they will locate the needed associated data.

States and soil survey project offices will take the lead role in developing new soil interpretations and providing them to customers. NSSC will play a supporting role in these situations. NSSC soil interpretation specialists are available to assist states as demands for new interpretations occur.

States are also responsible for assisting customers understand, use and apply soil information. This task also encompasses the role of coordinating and assisting in the development of local interpretations based on local criteria. As we assist others develop soil interpretations, it allows us to explain our data and to make recommendations regarding additional data needed and standard methods used to collect it. When users work with us and assist us in developing soil interpretations for their use(s) based on local criteria and/or need, they begin to understand our products and develop trust in us, in our methods, and ultimately in our data. Another goal of this process is to introduce customers to our products and services and to increase and expand their use of natural resource data.

Soil interpretation validation is a task where both the NSSC and States have responsibilities. States certainly must validate new local interpretations made for customers as part of technical soil service quality assurance but states also play a role in validating national soil interpretations. If states identify problems with national soil interpretations, then the NSSC must address them. If NSSC cannot make the needed adjustments then States may want to develop regional or local interpretations to correct the problem. However, national soil interpretations must be used for national programs so states cannot replace a national interpretation with a local interpretation for national program use but states may develop local interpretation for local programs.

Current Vision for Soil Interpretations

The National Soil Interpretations Advisory Group (NSIAG) has organized and will provide crucial input to the National Cooperative Soil Survey (NCSS) Soil Interpretations program. One of their first tasks will be to review the existing national soil interpretations and to define a "new" set of national soil interpretations. The "new" set may include some interpretations for other agencies like the National Park Service (NPS), Bureau of Land Management (BLM) and/or US Forest Service (USFS). Once these are identified, the NSSC will look critically at the interpretation criteria and then standardize documentation for all interpretations. These are 2 items that I have heard described as high priorities by State Soil Scientists and other field soil scientists. They are also high priorities for the NSSC.

We started the process of soil interpretation criteria review in FY02. Joyce Scheyer headed up a team that evaluated the existing criteria for 2 soil interpretations (Sanitary Landfill-Area and Septic Tank Absorption Fields). This task has been completed and a final report written. One issue identified by Joyce's group deals with interactive effects of soil properties for rating soils. This issue is not new but we need to take the time necessary to resolve interactive effects. The evaluation process will be completed for all of the "new" national soil interpretations and the NSSC will then maintain these interpretations.

The NSSC soil interpretation staff will be available to provide a larger role of assisting states and MLRA Offices develop custom interpretations for state or regional issues. We may have fewer "national soil interpretations" to maintain so hypothetically this will free up time to provide more assistance to states while broadening out interpretations for different uses (e.g. urban, forestlands, etc.). NSSC scientists will also spend more time on the science behind each data element and soil interpretation and then provide more assistance to states. Some of the assistance may be providing additional options to populate more data elements using algorithms.

The NSSC will also spend more time with model developers to assure correct use and application of soil data. It provides the NSSC a method to assure that all models are driven by a single authoritative set of data instead of several side data sets that can become outdated and/or inaccurate over time. This is needed badly right now.

To summarize, the need for soil interpretations has not changed over time except maybe in its magnitude and complexity. We have the best soil database in the world and its potential is only partially realized at present. The more use that is made of soils data, the stronger the demand for new and up-to-date interpretations. Modern tools like GIS allows us to display our data and interpretations in new more meaningful ways that seem to increase customer's desire for new products. This is probably the "best problem" one could ever imagine. It is a great and demanding challenge and one we are capable of meeting. One key to maintaining a strong soil interpretations program is, as David Hammer says, "Relevance". If we can't meet user needs, the accuracy of our soil data won't matter and neither will we.

Linking Research to Soil Interpretations--*Robert B. Grossman, Research Soil Scientist, NSSC, Lincoln, Nebraska*

The following is a portion of a larger paper. Only aspects that pertain fairly closely to use-dependency are given.

I started work on the subject in the early 1980's with Fred Pringle and others in the Texas High Plains, under the sponsorship of Charles Thompson. The question was how to explain the poor relationship between near surface texture (read soil series) and the large number of infiltration measurements that had been made by the Amarillo area office. We came up with the "Soil Property Record" in which we made monthly assignments of soil properties for map unit components by use. We assigned Hydrologic Group monthly dependent on near surface compaction and obtained hydrologic properties therefrom. The record was computerized. The effort went nowhere explicitly in West Texas. We did publish a paper (Grossman and Pringel, 1987.) I quote one paragraph: "Soil use can be evaluated by remote sensing. If a given area of land has a soil map and the use is known from remote sensing techniques, then the appropriate soil property record can be a basis for predicting aspects of behavior for the area of land possibly on a real-time basis."

We presented the idea (Grossman, et al, 2001a) of a composite record that consisted of use-dependent data for where soils use markedly affected the values (bulk density to 50 cm, for example) and of use-invariant data (texture throughout if not eroded.) The latter would be drawn from current NASIS entries. We proposed the term "exclusion zone" which would be the depth for a particular measurement through which use-invariant data were inapplicable. We suggest that the soil use concepts for which different records were obtained should be decided upon regionally and that to the extent possible we should apply formulations of different uses that are common to agronomy and plant growth disciplines.

Bulk Density

The clod method (Brasher et al, 1966) has the disadvantage that samples cannot be obtained from many kinds of zones that are fragile. Such zones are common at the near surface. Hence, the clod method has limitations for establishment of a use-dependent database (Grossman, et al, 2001b). Deb Harms and I developed several excavation bulk density methods that permit sampling zones that cannot be sampled by the clod method (Grossman and Reinsch, In Press b). Tom Reinsch and I developed a method to obtain clod bulk densities on the <2mm that had been taken through a standardized sequence of wetting and drying. (Reinsch and Grossman, 1995). The intent is to have an index bulk density for the tillage zone free of the effect of tillage practices in order to compare against the measured bulk density for documentation of compaction.

We have provided definitions of kinds of infiltration in the Manual. Transient ponded infiltration pertains to between initiation of ponding and reaching the steady ponded state. It is the stage of infiltration that is the more relevant to agriculture. Steady ponded infiltration is the rate after long continued ponding. It pertains to the minimum infiltration rate. For engineering purposes it is the relevant quantity because engineers deal with the limiting case of highest runoff. In NRCS, the paramount quantity in terms of relevancy to money spent is the Hydrologic Group, which is a class set of steady ponded infiltration under conditions of bare soil and long continued wetting.

We have done much work on infiltration measurement. Our methods contributions are the use of the Amoozemeter to measure inflow, development of several simple infiltrometers, and presently the introduction and development of the Cornell Sprinkler infiltrometer, which seems to be catching on. Our approach is to pre-wet and inset the ring 15cm or so into where cultivated soils are usually compacted in order to obtain values that are relevant to prediction of the Hydrologic Group. We do not make shallow measurements and/or measurements in the transient ponded range which may be both more relevant to soil quality.

Morphology

For concepts-defining pedons, we need to explore the extent to which the water state can be standardized by pre-wetting. We commonly can at least moisten the uppermost foot of the soil.

We have developed a Morphology Index for the uppermost 30 cm based on structure, rupture resistance, crust, and surface connected macropores (Grossman et al, In Press a). The objective is to provide a tool to describe the macroscopic organization for the evaluation of tilth and hence soil quality.

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NASIS Interpretations Overview—*Bob Nielsen, NSSC, Lincoln, NE*

In NASIS, (National Soil Information System) soil interpretations are fuzzy systems based and can deal with soil property interactions, relative weights, and the gradation of how true (or false) a soil property's contribution is to the base interpretation. NASIS interpretations' translate ranges of soil properties into a uniform scale (between 0 being false and 1 being true). These soil interpretations are always current because an interpretive result is a function of the current soil's property data, criteria, and the rule description of the soil property's contribution to the base interpretation.

There are three **NASIS** soil survey interpretations system objectives:
Interpretations are Constant, and large shifts in soil survey interpretive results do not occur among similar soils that have insignificant differences in physical, chemical, or climatic properties differences. Thus, soils with relatively similar physical, chemical, or climatic properties will have relatively similar NASIS interpretive results for any given practice, program application such as CRP, or other use or management involving soils.
Interpretations are Natural, and the interpretive results represent the natural gradation of a soil's physical, chemical, and climatic characteristics across landscapes and broad geographical areas. The interpretive result is a natural fit, and slight shifts in soil interpretive properties create similar shifts in interpretive response.
Interpretations are Defensible, and require few or no subjective exceptions to the basic interpretive rules to correctly array soil interpretive numeric rating values across large geographical areas. This feature brings NASIS interpretations into alignment with NRCS national, state, and local programmatic and assessment requirements.

Advantages of NASIS Interpretive System are:

1. NASIS provides interpretations of mapunit component properties instead of interpretations from SIR projected properties.
2. NASIS uses a different set of properties converted into NASIS data elements.
3. Interpretations can now deal with interactions, such as the interaction of slope and water table where, as slope increases, water table decreases.
4. Interpretations can now deal with relative weights, such as when slope may have more importance to the interpretation than depth to water table.
5. With NASIS, you can get a complete gradation of the membership a soil has relative to the interpretive statement. In other words, you can use fuzzy logic to translate ranges of properties into a uniform basis.
6. In NASIS, you are not constrained by crisp rating classes such as slight, moderate, and severe. NASIS can handle any number of rating classes.
7. Because the interpretive result is a function of running the soil property data through criteria, the NASIS, interpretive results are always up-to-date with the data and criteria. If the data or the criteria change, the result can change.

8. In NASIS, you cannot edit interpretive results (cannot do overrides). Instead, you can edit the physical and chemical soil properties or the criteria itself. This allows NASIS to automatically document the interpretive result.
9. NASIS lets you copy and modify other rules and evaluations for use in creating local or regional interpretations.
10. NASIS helps you convert your property (data element) values to fuzzy numbers with a graphing tool called the Evaluation editor.
11. NASIS helps you record interpretations with a graphical tool called the Rule editor.
12. NASIS gives you a choice list of properties from which to choose.
13. NASIS lets you generate an interpretation report based on selected criteria.
14. The NASIS interpretation report gives you the ability to easily identify data voids (null data).

Basic Difference Between the Legacy and NASIS Interpretive Process

The legacy interpretation system uses rating classes or crisp limits that do not provide comparative capabilities between similar soils. For example, referring to slope the crisp rating classes defines both 8% and 15% slopes as having moderate limitations for picnic areas. Give these conditions of 8 and 15% slope are of moderate limitation while a 16% slope is considered severe. Therefore, significantly different slopes get the same rating while soils with very similar slopes are assigned significantly different ratings.

On the other hand using fuzzy system to interpret soil provides a much more uniform approach to the interpretive process. The fuzzy systems approach provides for a continuous evaluation of a soil property as it change on the landscape. Using this system as soil is a complete member, partial member, or no member of the set of soil that have a slope limitation. Using the previous example, the 8% slope soil maybe have a .05 membership in the set of soil that are steep while the 15% soil may have a membership of .95 in the set of steep soils. In this case, both soils with 8 and 15% slopes respectively are members of the set of soil whose limitation is steep but the greater the membership the greater the limitation. Now there is discrimination between these two soils and their relative steepness to the interpretation.

NASIS Interpretations Generator Module, Draft Requirements Statement, 1994

SCOPE:

Soil interpretations are a fundamental part of the National Soil Survey Information System (NASIS). These interpretations encompass natural resource assessments and various engineering uses of the soil resource. Generally, these interpretations are available as tables or reports in published soil surveys, Field Office Technical Guides (FTOG), and other technical reports. Conceptually, the soil interpretation component of NASIS will consist of a set of computerized tools that will provide the user with more flexibility and specificity than the current centralized system. These tools will have broad applications related to the many uses of the soil resource. These broad applications encompass such natural resource assessments as water quality; Conservation Practice and Physical Effect (CPPE); ecosystem-based planning and evaluation; and various engineering, sanitary, recreational other mechanistic uses of the soil resource.

Soil interpretations are the results of processes in which specified geomorphic, surficial, and horizon criteria are applied to a soil pedon or to field, county, MLRA, or state soil survey map unit component data. These interpretations are based on criteria developed and maintained by the Soil Survey Division, Soil Conservation Service. Historically, these criteria are the geomorphic, surficial, and horizon soil properties that affect a specified use of the soil resource.

The NASIS Soil Interpretation Criteria Module and the NASIS Soil Interpretation Generator Module are the major components of the NASIS Interpretation Subsystem. The Soil Interpretation Criteria Module (ICM) creates, stores, maintains, and manages the soil interpretive criteria database. This database contains the soil interpretive criteria and logical operators. The data contained in the interpretive database are essential information needed by the Soil Interpretation Generator Module (IGM). The IGM uses these data to construct and execute a query of the soil component properties database, then reports the resulting interpretation(s).

The ICM (Soil Interpretation Criteria Module) "Total Requirements Statement" (TRS) and "Operation and Physical Design" (OPD) are complete and the ICM is on the NASIS project slate. Analysis of the IGM (Soil Interpretation Generator Module) is under way and lags development of the ICM by about 6 to 12 months. This delay is intentional and accommodates the development and testing of the ICM and corresponding Interpretive Criteria database. Thus, the Soil Interpretive Criteria database will be available for the development, testing, and implementation of the IGM.

BACKGROUND:

Since the early 1970's, computerized soil survey interpretive criteria and interpretations have been maintained by the Soil Conservation Service. The interpretive criteria used to derive these soil interpretations were developed by soil scientists, engineers, and natural resource specialists. This criteria have been modified periodically, with the last major criteria modification implemented in 1983. These interpretations are made available through soil survey reports, the Field Office Technical Guide (FOTG), and most recently in a computerized format to soil scientists, natural resource planners, engineers, and others who use or control the soil resource.

Soil survey interpretations are made for named components of a soil survey map unit. Conassociation map units are assigned the interpretations of the named taxa, while complex and association map units are assigned the interpretations of the named components. In some cases, multi-component map units are assigned the most restrictive map unit component rating(s). The resulting map unit interpretations may be unnecessarily restrictive. This situation arises when the most restrictive component is the least extensive component of the map unit.

CURRENT SITUATION:

PROCESS: Presently, soil survey interpretations are computer generated at Iowa State University (ISU), Ames, Iowa, then are reviewed by the state soil scientists or their representative responsible for the soil interpretation records. The reviewing soil scientist either accepts the computerized interpretation(s) or manually substitutes an interpretation(s) in lieu of those provided by the computerized system. Manually-substituted interpretations are referred to as "OVERRIDES." In either case, interpretations are fixed in time relative to the interpretive criteria and the known properties of the soil. If the ratings criteria are modified or the soil's properties are better defined, then an update of any affected soil interpretations must be manually initiated.

The SIR soil property data, performance information, and interpretations represent the informational base of a soil or miscellaneous area across its geographic extent. The soil properties, performance information, and interpretations for a specific soil survey area are selected from the SIR via the SCS-SOI-6, Map Unit Record. The SOI-6 data record contains information specific to the soil survey area and key linkages to the SIR data record. These key linkages are the SOI-6's phase determining data. The phase determining data optimizes the SIR soil properties, performance information, and interpretations to a specific soil survey or geographic area. This optimized soil survey or geographic area data and information are the foundation of soil survey reports, Field Office Technical Guides, and all other technical soils' data provided to users of the soil resource.

CRITERIA DATA: Some standard interpretive criteria employ "derived" or "class" data, as well as primary soil data, for making soil interpretations. For example, the interpretation for road-fill includes AASHTO and shrink-swell criteria, which are "class" data, and fraction greater than 3 inches criteria, which is primary data. Interpretations based on "class" or "derived" data are affected when class or derivation criteria change. In addition, interpretations made from "class" or "derived" data do not specify the soil property(ies) which contribute to the limitation(s). This obscures the corrective measures needed to overcome the limiting property(ies) or feature(s).

SOIL SPECIFIC DATA: Soil properties are generally expressed as a range of values. In some cases, the range given for a soil component's property includes values that are both above and below the critical limit of an interpretation criterion. Generally, the more restrictive values are selected. This practice provides soil interpretations for the extreme conditions and not for local norms or the correlated representative conditions.

COMPUTERIZED PROCESS: The current process for generating computerized soil interpretations revolves around a centralized system that is maintained and supported by the Iowa State University (ISU) Statistical Laboratory at Ames, Iowa. This system, except for a alteration in 1993, has not changed significantly over the past 20 years. It resides on the ISU Statistical Laboratory's main frame computer, and the interpretive algorithms and logic are imbedded in PL/I computer code. The input data (soil properties and characteristics) reside in the Soil Interpretations Record (SIR) database, which is also maintained by the ISU Statistical Lab. The SIR database stores computer-generated soil interpretations and soil performance information for soil series, phases of series, higher taxa, and miscellaneous land types. These interpretations and performance information are relative to the SIR's representative profile and to the SIR's physical and chemical data, which portrays the range of these properties across the geographical extent of the SIR.

1993 COMPUTERIZED PROCESS ALTERATION: Soil map unit component properties that can be modified via the SOI-6 Map Unit Record are surface texture, slope, layer depths, and the presence or absence of soil layer(s) within the typifying pedon. Layer depth and the presence or absence of soil layer(s) modifications are not reflected in the stored SIR performance information and interpretations. The stored SIR performance information and interpretations are specific to the typifying SIR pedon only. Under these conditions, the reported performance information and interpretations for a soil survey area do not reflect any of the local variations recorded and correlated by the SCS-SOI-6, Map Unit Record.

The 1993 alteration to the pre-NASIS system allows for the generation of computerized soil survey interpretations from local modification to the soil layer properties. To use this alteration, the client sends the map unit component record containing the modified data to ISU. The statistical lab updates the soil map unit component performance data and interpretations from the map unit component data record inputs. ISU then reports the locally specific map unit component performance information and interpretive product back to the sender.

CONSTRAINTS: Constraints are characteristics or properties of a system or process that confine or restrict the full application or implementation of current technology or local, regional, or national expertise. The following constraints are relative to the current computerized system of generating soil interpretations employed by the Soil Survey Division, Soil Conservation Service.

Rigidness. The current centralized computer system used to generate soil interpretation is rigid and does not fully utilize available computer technology or advanced interpretive techniques, nor will it optimize future technology advancements. ISU computer-generated soil interpretive capabilities are only available through a cumbersome set of JCL's. Users can retrieve soil interpretations from ISU by downloading the stored SIR interpretations or by submitting the map unit component record to ISU for interpretation. This capability generally is available only to the State offices, NTC's, NSSC, and a few other governmental and private entities.

Developmental Tools. Under the current system, locally available automated soil interpretation developmental tools do not exist. Those technical specialists who prepare, test, or revise traditional soil interpretations do so without the aid of these tools and must rely on the remote ISU system for assistance. This shortcoming restricts the development, testing, and implementation of innovative soil interpretive concepts and strategies and also impedes the timely development and application of national, regional, and local soil interpretations and soil performance information. Thus, many new soil interpretive concepts and strategies, which could have been developed and evaluated on local computerized systems, are discounted and lost because these tools are not available.

Local Interpretations. Users of the current soil information system have to use the OVERRIDE concept to locally modify soil interpretations. They do not have the capability to develop or test local modification to soil interpretive criteria. The current system does not provide for the application of local field or pedon data to established soil interpretive criteria. Consequently, area and field personnel, who must make site and field specific soil-related determinations, interpretations, or evaluations, must do so manually. This manual process generally is not applied consistently, requires extensive time and effort, and underutilizes locally available computer technology.

Soil Potentials. Soil potentials are different from soil interpretations because potentials do not depend solely on the physical, chemical, and geomorphic properties of the soil. The soil potential concept is unique and includes soil and climate data, management practice impacts, and economic factors. There is no nationally-based soil potential rating system, and most soil potential ratings are made manually. Computerized tools to develop, test, and implement soil potentials are also unavailable. This lack of computerized capabilities results in resource specialists not having the necessary tools to develop or test soil potentials nor easily adapting and applying soil potentials developed by others.

Interpretation update. Soil interpretation updates are the product of revising soil interpretive criteria or modifying soil interpretive properties data. Presently, soil interpretive updates that result from criteria revisions or soil property modifications are downloaded for map units and map unit components in new or ongoing soil surveys. Older soil surveys that are affected by these revisions or modifications may not be updated as the changes become effective. Generally, soil interpretations for these older surveys are updated only when the state downloads a new set of interpretations from ISU. These periodic downloads, containing the interpretive updates and revisions, are rarely correlated or coordinated with the other map units in the subject soil survey area or with map units in adjacent soil surveys. It is not until the survey itself is formally updated that the needed correlation or coordination occurs. Furthermore, overrides no longer may be valid when an interpretation is revised or modified. Thus, overrides of the modified interpretation must be manually checked and verified before the new interpretive data or performance information is certified.

Updating map unit interpretations and performance information in this manner is cumbersome, resource intensive, and ineffective. Under the current system the database manager must first update the SIR and then incrementally download the updated interpretation(s) for each map unit in all affected soil survey areas. Then database manager must manually check the correlation and coordination of all updated soil map unit interpretation(s) with those of other map units in the soil survey area and with those in adjacent soil survey areas. This procedure is not only cumbersome but is also extremely labor and time resource intensive.

Criteria Development and Modifications. When a technical specialist modifies an interpretation or develops a new one, the soil interpretation's PL/I program, maintained at ISU, must be written or revised. The program is then debugged and the new or modified interpretations are tested at National Soil Survey Center, the National Technical Centers, and in selected states. Test results are sent to technical specialists for review and comment. These specialists recommend any needed changes to the criteria or program, and the testing process repeats until the desired results are attained.

Experience has shown that this process is ineffective and inefficient. It normally takes a year or more to develop, test, and implement a new interpretation or a modification to a present interpretation. From a business point of view, this lack of timeliness is not warranted or acceptable and must be overcome if soil survey interpretations are to remain a viable component of the soil survey process.

Tracking and Documentation. Tracking and documentation of the development, testing, implementation, and modifications of a soil interpretation are random or nonexistent. Furthermore, there are no established tracking or documentation procedures or protocols used to devise or maintain a soil interpretation. The existing documentation is not readily available to the user or technical specialists. Increasingly, this lack of an available historical record impedes the understanding of currently supported soil interpretations and performance information.

Interpretations of Soil Survey Map Units. Map units are delineated on the landscape, yet their components and not the map units as a whole are interpreted. In some case an interpretation for a map unit is required and must be provided. Currently, this is a manual process that relies on component interpretations, and the most restricting component interpretations are generally applied to the map unit. This procedure disregards many important soil and geomorphic properties contained within a map unit.

Reports. Currently, soil interpretation reports formats are rigid in form and not user modifiable. They are available through ISU JCL's, the 3SD soil information system, soil survey manuscripts, the Field Office Technical Guide (FOTG), and Computer Assisted Management and Planning Software (CAMPS).

Soil survey report interpretive tables are generated by ISU JCL's and are not easily modified. Soil survey report table modifications that are needed to localize soil properties and interpretive information to the soil survey area are edited by pen and ink to the appropriate tables. Identical manual edits are also required to maintain 3SD's and Section 2 of the FOTG's compatibility with the published soil survey. This system is inherently unstable, and updates made to the SIR or to the 3SD interpretive record after publication of the soil survey are rarely made in the official published manuscript. This instability leads to conflicts between the automated soil data systems and the published soil survey report.

<u>SUMMARY:</u> The current centralized process is time and resource intensive, inherently unstable, and does not utilize available computer technology. Developing computerized soil interpretive technology that uses local expertise (knowledge, skills, and abilities) and locally available computer technology will bolster soil survey interpretive capabilities and capacities. It also will enhance the Soil Survey Division, Soil Conservation Service's ability to deliver soil interpretations to our clients. The development of this technology and the abandonment of the current centralized concept will provide many benefits. These include but are not limited to:

1. Significantly reduce the time and resources needed to develop, test, and implement a soil interpretation.

2. Give local technical specialists the tools to develop, modify, and test soil interpretations that are specific to their areas of responsibility.

3. Modular design and programming precludes rewriting the computer code containing the interpretation's criteria and logical evaluators when changes and updates are needed.

4. Provide the ability to apply Geographic Information System (GIS) analytical capabilities.

5. Is a distributive system that provides real-time soil interpretations for the soil surveys, watersheds, MLRA's, and SCS field, area, and State offices.

6. Allow for the interpretation of all similar and dissimilar components of the map unit and not just the named components.

7. Interpret map unit components that are specific to a defined geographical area and that reflect observed component properties.

8. Allow for the evaluation, development, and implementation of fuzzy numbers, fuzzy logic, clustering, and neural network analytical techniques.

9. Optimize soil interpretation's aspect development and implementation.

10. Furnish the users with an interpretation tracking mechanism and modification record.

11. Allow the client (user) to develop interpretations that are a product of most, least, or representative component data inputs.

NASIS INTERPRETATION SUBSYSTEM

The NASIS Interpretation Subsystem embodies an automated, semi-distributed system for the timely creation, testing, delivery, and maintenance of soil survey interpretations and soil potential ratings. The soil survey interpretation subsystem's functional requirements are those related to the intrinsic objectives described in and established by the NASIS Draft Requirement and NASIS Total Requirement Statements (NASIS-DRS and NASIS-TRS, respectively). Also, some subsystem functions are not explicitly recognized in the NASIS DRS or TRS. These non-explicit functional requirements are those associated with the independent and interdependent functions and operational requirements of the Interpretations Criteria and Interpretations Generator modules.

CONCEPTS:

Aspects. Standard soil interpretations are made for major uses of the soil resource. However, within any major interpretation or use of the soil several subdivisions or "aspects" of use occur which are generally not described. For example, construction, health considerations, and system maintenance could be considered aspects of "Suitability for Septic Tank Systems."

Aspects are themselves interpretations or sub interpretations of a master interpretation. Aspects include but are not limited to "SAFETY," "HEALTH," "CONSTRUCTION," "PERFORMANCE," and "MAINTENANCE." They provide additional information about an interpretation that can be useful to planners and users of the soil resource. Currently, an interpretation for any use of the soil resource does not provide any information about an interpretation's "aspects."

Data Mode Limiting Parameters. The data mode limiting parameters cover two basic topics. The first is in the form of high, low, or representative value. Some of the data in NASIS is represented by a range of characteristics, and a single interpretive result may not be sufficient. Interpretation(s) using different data mode inputs will provide the user with different ratings for the same interpretation. These differences represent the least restrictive, most restrictive, or the representative value rating for the prescribed soil attribute. The Interpretations Generator Module identifies which data mode the desired interpretive rating(s) was derived from and provides that information to the user. The user has the option of selecting one or more data modes and reporting the respective interpretive rankings.

The second type of limiting parameters are handled as subordinate criteria. They are similar to a Standard Query Language (SQL) "where" clause. Subordinate criteria allow the evaluation of property(ies) that are conditional to depth, horizon, layer, or some other conditional parameter.

Representative or Expected Value. Many new uses of soils data, such as natural resource assessment models, require a single value for a soil property rather than a range in values. NASIS has the ability to portray a representative or expected value (RV) for each property (where appropriate) of a map unit or component data record.

The methods for selecting the representative value will vary based on availability of data and purpose for which the data will be used. The first method is an average for the range of the recorded values. The second is selecting a reference profile as an expression of an expected value(s). The last method for determining a representative or expected value is based on a sampling of statistical collected soil attribute data.

ESSENTIAL FUNCTIONAL REQUIREMENTS:

These are the explicit and non-explicit functional requirements of the NASIS Interpretations Subsystem. They are the functions that are required to integrate the subsystem into NASIS and produce reliable and consistent soil survey interpretations. The essential functional requirements for the implementation of the NASIS Interpretation Subsystem are:

1. The NASIS Interpretations Subsystem is an integral component of NASIS.

A. OBJECTIVE: Develop, implement, and maintain the soil interpretive capabilities as described and defined by the NASIS Total Requirements Statement and overcome the soil interpretive constraints and limitations of the present centralized computer system.

B. METHODS/PROCEDURES: Focus the development and construction of the subsystem on NASIS concepts, specifications, and technology as established by the NASIS Total Requirements Statement and developmental technology, respectively.

C. INPUTS/OUTPUTS: The NASIS Interpretation Subsystem will rely on input information (data) from standard or user specified interpretive criteria and the soil properties selected by the criteria for evaluation. The selected interpretive criteria and soil properties inputs are those established by and maintained within NASIS and include site data (PEDON) and map unit component data (SSURGO, STATSGO, and NATSGO). The resultant outputs are the interpretations specified by the user.

D. ENABLING TASKS:

i. Design a interpretive subsystem that provides interpretations for standard or user specified criteria and soil properties data. Develop the Operation and Physical Design (OPD). NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Develop and establish policies and procedures to ensure consistent and proper application of the NASIS Interpretation Subsystem. Soil Survey Interpretation Team, NSSC.

2. Create, maintain, and generate an interpretation from explicit criteria and evaluation data.

A. OBJECTIVE: Soil interpretations will change or be refined as more about soil properties and expected soil behavior are learned. Using automated data processing principles and techniques to create, test, store, and maintain soil interpretive criteria and to spawn user specified interpretations, the NASIS Interpretation Subsystem will provide the following capabilities:

i. Spawn and report an interpretation ranking or rating and its respective restrictive feature.

ii. Validate, track, and document soil interpretations, interpretive criteria, interpretive modules, aspects, and data.

iii. Function as a developmental tool for the development and testing of interpretation(s) or interpretive criteria on locally available automated data processing systems.

iv. Provide for routine addition or revision of standard or user defined soil interpretation criteria as part of an integrated soil interpretations system.

v. Revise or update an interpretation's criteria to fit localized policies and conditions.

vi. Edit interpretation(s) (override) and document override rational.

vii. Define and describe aspects of a interpretation.

B. METHODS/PROCEDURES: Construct an automated data processing system for creating, testing, and maintaining interpretive criteria (the Interpretations Criteria Module) and for the generation of a soil interpretation(s) (the Interpretations Generator Module).

Design and establish the functions of these modules as integral components of the NASIS Interpretation Subsystem.

Assure that the independent and interdependent functions and operations of these modules produce consistently reliable interpretations from the user specified criteria and soil attribute data.

C. INPUTS/OUTPUTS: The Interpretative Criteria Module is the tool used by trained technical specialists to create and maintain the Interpretations Criteria database. The resultant interpretive criteria provide the evaluator inputs for any interpretation or group of interpretations specified by the user. Soil interpretive attributes are accessible from the soil survey map unit record or pedon record and maintained via the NASIS ADD/REVISE subsystem or the PEDON subsystem, respectively. The specified interpretive outputs spawned by the interpretations generator are the result of the interdependent functions of these modules and selected attribute data.

D. ENABLING TASKS:

i. Prepare the standard soil survey interpretations (those in Section 620, National Soil Handbook) for conversion to the NASIS Interpretation Subsystem. Pre-conversion of this material will require a thorough review of criteria compatibility, evaluator logic, and logical operators. Furthermore, consolidation of known historical background for each interpretation is essential to begin the documentation process. Soil Survey Interpretation Team, NSSC.

ii. Convert current soil interpretations criteria from the Section 620, National Soil Survey Handbook hardcopy format to the relational database format. The Alpha and Beta tests of the Interpretations Criteria Module provide the opportunity to test the module and convert the soil interpretive criteria from the non-electronic to an electronic format. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

iii. Interpretations stored. Accommodates overrides. Interpretation overrides may be a function of the NASIS ADD-REVISE Module, and overrides must be justifiable and documented. Override documentation and justification must be included as part of the soil survey documentation policies and procedures. This objective could be achieved through the NASIS ADD-REVISE Module "Map Unit Component Notes" function. Interpretation documentation and justification would then be incorporated as part of the MUIR and soil survey area reliability information. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

3. Provide for the timely, on-site management and propagation of standardized and user specified soil interpretation and potential ratings.

A. OBJECTIVE: The semi-distributed NASIS Interpretation Subsystem decreases reliance on the present centralized soil interpretations computing system. It will take advantage of on-site resources and will exploit local computer capabilities, resource knowledge, and data (spatial and tabular). It also minimizes the human, monetary, and time resources needed to develop, test, and implement a soil interpretation or potential rating.

The on-demand feature of the NASIS Interpretation Subsystem will provide trained users with timely soil behavioral, performance, or potential ratings for a specified soil application. These ratings, as derived from current criteria and applied to the area's certified soil database, will provide the users with a functional, timely, and uniform method of updating and maintaining Section 2 of the Field Office Technical Guide, the Field Office Computing System soil database, and the NASIS interpretations database.

B. METHODS/PROCEDURES: Devise an interpretations subsystem that provides the trained user with on-site, on-demand soil interpretation capabilities. The implementation of this subsystem will provide local and MLRA soil survey interpretive support for natural resource assessment and other soil use applications. The subsystem's standardized FOTG and soil survey manuscript update reports and FOCS and NASIS database update routines enables the user to routinely maintain these products. The implementation of this subsystem will require equipping the user with computers and the necessary computerized tools to maintain the interpretive criteria and soil resource data and to propagate a soil interpretation or potential rating. At a minimum, the initial release of the subsystem will provide the soil interpretive capacity presently available through the AMES centralized system.

C. INPUTS/OUTPUTS: Inputs include the training and equipping the user to apply the NASIS Interpretation Subsystem to support natural resource assessment and other soil use applications. The required user initialization inputs will specify the following: standardized criteria or user specified criteria, report or interpretation data download, interpretive input dataset, and evaluation data mode. Timely user training and interpretations technical support is essential and enhances the prospect that the NASIS Interpretation Subsystem will be applied properly. The user will need the following to propagate on-site interpretations:

* Hardware with the capability to support the interpretations subsystem,
* Interpretations Criteria Module (ICM) and Interpretations Generation

Module (IGM) interpretations software, and
* The necessary certified soil resource data and associated databases.

Outputs include on-demand soil resource interpretation and potential ratings, standardized and user specified reports, and interpretation data downloads that are propagated on-site using local computer assets, interpretive criteria and soil resource data specific to the area of concern.

D. ENABLING TASKS:

i. Develop and implement computer-based tools and standardize processes that provide the users with on-site, on-demand standard and user specified interpretations. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Secure for each operational office the hardware, software, and databases needed to support the interpretations subsystem. State IRM and Soil Survey Staff Leader.

iii. Develop, administer, and deliver the training that users need to acquire the skill and abilities to properly and consistently apply the interpretations subsystem and achieve accurate and dependable soil interpretation and potential ratings. Soil Survey Interpretation Team, NSSC.

iv. Develop and implement a system to maintain and support the technical application and capabilities of the interpretations subsystem. Soil Survey Interpretation Team, NSSC.

v. Develop policies and procedures for updating and maintaining Section 2 of the FOTG, soil survey manuscripts, and FOCS and NASIS databases. Soil Survey Interpretation Team, NSSC.

4. Furnish the ability to develop and employ the concepts of modularity and interpretive aspect into the NASIS Interpretation Subsystem.

A. OBJECTIVE: The NASIS Interpretation Subsystem supports the concept of interpretation and criteria modularity as the alternative to hard-coded soil interpretive computer programs. The modular concept provides four functions that are not available under the current centralized system. The first eliminates the need to rewrite computer interpretive programs whenever a new interpretation is created or an existing interpretation or interpretive criteria is modified. The second provides the trained user or resource specialist with the ability to create, modify, or maintain an interpretation or interpretive criterion on their local computing system. The third treats interpretive criteria as evaluation data that are selectively applied to one or more interpretations. The last function enables the implementation of interpretive aspects as a functional component of the NASIS Interpretation Subsystem.

B. METHODS/PROCEDURES: Develop the modularity and interpretive aspect concepts as functional components of the NASIS Interpretation Subsystem. The employment of these concepts allow for either one-to-one or one-to-many relationships between an interpretation and its criteria. Illustrations of the one-to-one and one-to-many modular relationships are provided for clarity.

One-to-one relationships are those where interpretations are independent of other modules and their criteria are subject to a specific interpretation.

One-to-many relationships are those where interpretations are dependent on other

modules, including the following:
* The criteria module - A module containing a single criterion applicable to multiple interpretations and interpretive aspects.
* The interpretive aspect module - An independent or dependent module containing multiple criteria that are related to a specific aspect and applicable to multiple interpretations and other interpretive aspects.
* The interpretation module - An independent or dependent module containing multiple criteria that are related to a specific interpretation or applicable to multiple interpretations.

C. INPUTS/OUTPUTS: Inputs are the expertise provided by the user to develop and test the modular and interpretive aspect concepts and their interdependencies as implemented in the NASIS Interpretation Subsystem.

Outputs are the functional validation of the modularity and interpretive aspect concepts.

D. ENABLING TASKS:
i. Develop a maintenance and tracking mechanism to ensure that changes made to a module are applicable to all aspects or interpretations to which the module is applicable. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.
ii. Differentiate and develop interpretive aspects for each of the standardized interpretations. Soil Survey Interpretation Team, NSSC.
iii. Develop and test the optimization of the standard interpretive criteria (Section 620, National Soil Survey Handbook) using modular concepts and the one-to-many relationship between interpretive criteria and their respective interpretation. Soil Survey Interpretation Team, NSSC.

INTERPRETATION CRITERIA MODULE

Soil interpretations and interpretive aspects will change or be refined as more is learned about soil properties and expected soil behavior. New interpretations, aspects, or interpretive criteria will be added to the list of those that are already available. NASIS requires the capability to routinely add or revise soil interpretations, aspects, or interpretive criteria as part of an integrated automated data processing system.

<u>ICM Functional Requirements:</u> This summary of the functional requirements of the Interpretation Criteria Module (ICM) is provided as a frame of reference for describing the independent and interdependent functions of both the ICM and IGM (Interpretations Generator Module). The following discussion of these functions is not a complete description of the ICM's functions or objectives. The "ICM - Draft Requirements Statement" and "ICM - Outline Physical Design Statement" contain a complete description of the ICM's functions and objectives.

The generalized functional requirements of the Interpretations Criteria Module are:

1. Enter, edit, store, and document soil survey interpretations, interpretive aspects, and interpretive criteria.

A. OBJECTIVE: Create an automated system that is accessible at all levels of soil survey management to add, maintain, and document of soil interpretation criteria.

B. METHODS/PROCEDURE: Using up-to-date automated data processing philosophy and technology to enter, edit, and maintain soil survey interpretations,

interpretive aspects, interpretive criteria, and interpretive criteria logical operators or evaluators. Other applicable process are:
* Storage of interpretations, aspects, and interpretive criteria attributes in a database format.
* Document and track the development and performance of an interpretation, aspect, or criterion. This documentation and tracking includes history, references, performance accuracy and precision, logical bugs, data omissions, interpretive criteria inconsistencies, and application constraints.
* Describe the interpretive criteria evaluator relationship to the prescribed soil layer or component property and support the application of if-then, boolean, arithmetic, and algebraic statement.

C. INPUTS/OUTPUTS: Inputs are interpretations and interpretive criteria as described and defined by Section 620, National Soil Survey Handbook, and the relative documentation, comments, notes, and AMES evaluator logic.

Outputs are fully documented soil interpretations and interpretive criteria that are supported and available to the user as an integral component of the NASIS Interpretation Subsystem.

D. ENABLING TASKS:

i. Perfect a system for maintaining and tracking soil interpretations, interpretive aspects, and interpretive criterion that is based on current automated data processing philosophy and technology and is an integral component of the NASIS Interpretations Subsystem. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Review and revise interpretive criteria in Section 620, National Soils Handbook to reflect the differences between the 3SD and NASIS soil interpretive attributes and data structure. Soil Survey Interpretation Team, NSSC.

iii. During the ALPHA and BETA tests of the ICM import Section 620, National Soils Handbook interpretations and interpretive criteria into the NASIS Interpretive Subsystem database. Soil Survey Interpretation Team, NSSC.

iv. Review and consolidate past and present soil interpretation and interpretive criterion documentation, references, comments, and evaluator logic. Soil Survey Interpretation Team, NSSC.

2. Modify and document soil interpretive criteria to meet local, state, and regional soil application demands.

A. OBJECTIVE: The intent is to allow authorized users to modify an interpretation's or aspect's criterion and document the modification. Many users need interpretations for locally specific soil applications and have developed well defined local, state, or regional criteria for those applications. The resultant interpretations reflect the criteria associated with the specified local, state, or regional conditions and specifications applicable to the interpretation.

B. METHODS/PROCEDURES:
Using automated data processing techniques, the ICM has the capability to copy, revise, and document soil interpretive criterion to depict local, state, or regional conditions or specifications relative to any given soil application.

The ICM furnishes the user with a set of automated tools that can be used to easily modify and adjust soil interpretive criteria to reflect these conditions or specifications.

Using these techniques the authorized user can select the interpretation or aspect to be modified and edit the respective soil interpretive criteria to reflect local, state, or regional specifications. Users, who are not authorized to modify a given interpretation may copy the interpretation or aspect and modify the copy's interpretive criteria to depict local, regional, or national conditions or specifications. This edited copy does not change the original and is relative only to the spatial extent of the application and the authority of the author.

C. INPUTS/OUTPUTS: Inputs are those relevant to regional, state, and local interpretations. The Section 620, National Soil Handbook provides the user with fundamental information and criteria for many type of interpretations. Other sources of relative interpretive criteria for a specific soil application or interpretation are NCSS cooperators, other SCS discipline specialists, legislative or administrative mandates, and local, state, or regional agency specialists.

Outputs consist of tailored soil interpretations, interpretive aspects, and interpretive criteria that reflect local, state, or regional soil application concerns and user requirements.

D. ENABLING TASKS:

i. Develop policies, guidelines, and methods for the authorized modification, validation, and implementation of local, state, and regional user specific interpretive criteria. Soil Survey Interpretation Team, NSSC.

ii. Develop ICM editing tools that allow authorized users to routinely modify interpretive criteria or to modify a copy of an approved or archived soil interpretations. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

iii. Provide training to local, state, and regional soil interpretive specialists to insure the proper and consistent application of user specific soil interpretive criteria. Soil Survey Interpretation Team, NSSC.

3. Distribute local, state, regional, or national interpretations and their respective criteria to NASIS users.

A. OBJECTIVE: Provide an interpretation's distribution network that allows users access to all approved local, state, regional, and national interpretations. The benefits provided by this network are the ability to access current interpretations and to reference the knowledge and expertise employed to develop and validate an approved interpretation.

B. METHODS/PROCEDURES: Using automated systems and telecommunications techniques, develop and implement an interpretation's distribution network that provides users with access to approved local, state, regional, or national interpretations and interpretive criteria.

C. INPUTS/OUTPUTS: Inputs include approved local, state, regional, and national soil interpretations and their respective criteria and documentation.

Outputs are timely user access to local, state, regional, and national interpretations and interpretive criteria as they are approved and implemented.

D. ENABLING TASKS:

i. Develop an interpretation distribution network that uses electronic data transfer technology to distribute approved local, state, regional, or national interpretations and interpretive criteria. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Develop procedures to access and retrieve soil interpretations and their respective criteria and documentation. Soil Survey Interpretation Team, NSSC.

INTERPRETATION GENERATOR MODULE

The Interpretations Generator Module (IGM) is an integral component of the NASIS Interpretations Subsystem. The IGM is dependent on the Interpretations Criteria Module (ICM) for the criteria to construct an interpretive query and for those functions associated with the maintenance of soil interpretations or soil potential ratings and their respective interpretive criteria. The explicit and non-explicit functions of the IGM are those that provide the user with reliable, consistent and accurate soil interpretations and supporting interpretive information and that integrate the module into the interpretations subsystem.

The fundamental objective of the NASIS Interpretation Subsystem and Interpretations Generator Module are to provide the user with a computerized method of making soil interpretations that is dynamic and easy to use. Several basic requirements of this fundamental objective are:

Interpret all map unit component data records.
The user has the ability to interpret all map unit components (similar and dissimilar) and miscellaneous areas for which data resides in NASIS. In addition to providing interpretations for all map unit components, the user can generate interpretations for named components, included components, or any combination of named and included components. This capability provides much more flexibility than the current interpretive system and still accounts for the current system's design of interpreting only name components.

Interpret user specified soil attribute data.
Historically, soil interpretations are generated from the most restrictive value of a soil attribute's range. The NASIS Interpretation Subsystem will allow the user to replicate this process. In addition, it will provide the user with the capability of generating interpretations for the least restrictive value of the range, the representative value, the low value of the range, the high value of the range, or a user specified combination of these soil attribute inputs.

<u>IGM Functional Requirements:</u> The specific functions of the IGM are to create and execute an interpretive query, preview the results of the query, report the interpretive ranking(s), and provide the user with supporting input data and other interpretive information. Other functions are those related to the development, testing, validation, and maintenance of NASIS soil interpretations, the interpretations database, and SCS soil survey reference documents.

1. Select an interpretation and it's criteria for rating.

A. OBJECTIVE: Interpreting the limitation, performance, or suitability of a soil for a specific purpose or resource management practice is dependent upon a set of relative criteria. The interpretation selection routine furnishes the user with the ability to define the interpretive query by selecting one or more interpretation(s) and retrieving the relative criteria from the Interpretation Criteria Module database.

B. METHODS/PROCEDURES: This routine offers the user a selection list of available soil interpretations. This list will include all approved interpretations that are applicable to the users' geographic area and all unapproved interpretations that are owned by the user. Once the interpretation selection is made, the system will retrieve the interpretive criteria from the Interpretation Criteria database.

C. INPUTS/OUTPUTS: Inputs are the user's soil interpretation's selection. The authorized users may select one, multiple or all of the following.

a) Interpretation(s) by Name or ID number
b) Aspect(s) or Interdependent Interpretation(s)
c) Interpretive Ranking (Data Limiting Mode)

i. Most Limiting
ii. Least Limiting

d) Spatial Application(s)

i. National
ii. State
iii. MLRA
iv. County
v. Soil Survey Area

e) User Initialized Macro's - Standardized Interpretations for:

i. Soil Survey Reports
ii. Field Office Technical Guide
iii. Hydric Soils List
iv. etc.

Outputs are the interpretive criteria and corresponding ancillary data designated by the user's selection and retrieved from the Interpretation Criteria database. The retrieve criteria are redirected as inputs to the "Query Construction" routine. The ancillary data are the interpretation(s) and criteria's relational database keys. These data are reference data used to identify the interpretation(s) and its relative criteria. All ancillary data are directed to PREVIEW.

D. ENABLING TASKS:

i. Develop and enable the Interpretations Criteria Module and its supporting interpretation's criteria database. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Convert the current soil interpretations criteria, "Section 620, National Soil Survey Handbook", to the Interpretive Criteria database. Soil Survey Interpretation Team, NSSC.

iii. Develop, test, and employ the interpretation's selection routine of the Interpretations Generator Module. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

iv. Train the user to properly initialize the specified interpretation. This training provides the user with an understanding of the principles, functions, and operation of the interpretation's selection process and the knowledge to properly initialized the selected interpretation. Soil Survey Interpretation Team, NSSC.

2. Construct an interpretive query from the selected interpretation(s) and relative criteria and logical evaluators.

A. OBJECTIVE: The user will be able to create interpretive queries for all approved interpretations applicable to the user's geographic area and all unapproved interpretations owned by the user. The query construction routine converts the selected criteria and logical evaluators into one or more executable queries. It allows users flexibility in the creation and execution of an interpretive query and does not require a high level of user query expertise to operate the system successfully.

B. METHODS/PROCEDURES: The query construction routine constructs interpretive queries from the inputs supplied by the user via the interpretation selection routine. It is run-time only and the resultant queries are reconstructed each time the interpretation is selected. Thus, interpretive queries are not permanently stored or maintained on the computing system. Once the query is constructed and the soil data inputs selected, the query is executed and the resultant interpretation is reported to the user.

C. INPUTS/OUTPUTS: Inputs are the interpretive criteria and logical evaluators specified by the user's interpretation(s) selection and retrieved from the Interpretation Criteria database.

Outputs are the soil interpretive queries that were constructed from the selected criteria and logical evaluators. Queries are directed to the "Interpretation Execution" routine.

D. ENABLING TASKS:

i. Develop, test, and implement the query construction routine. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Train the user to properly initialize the specified interpretation. This training provides the user with an understanding of the principles, functions, and operation of the query construction routine. Soil Survey Interpretation Team, NSSC.

3. Select and retrieve map unit, map unit component, or pedon interpretive attribute data.

A. OBJECTIVE: Interpreting the limitation, performance, or suitability of a pedon, map unit component, or map unit for a specific purpose or resource management practice is soil attribute dependent. The soil attribute selection routine furnishes the user with the ability to select one or more pedons, map unit components, or map units and retrieve the corresponding soil interpretive attribute data from the respective NASIS soil database.

B. METHODS/PROCEDURES: The system offers the user a selection list of available soil interpretive attribute data. This list will include all pedons, map unit components, map units, and data limiting mode that are applicable to the user's geographic area or the selected interpretation. Once the soil attribute data is selected, the system will retrieve the appropriate soil interpretive data from the soil attribute database. These data are the soil attribute inputs for the interpretive query.

C. INPUTS/OUTPUTS: Inputs are the user's selection of pedon, soil component, or map unit soil interpretive attributes. The authorized users may select one, multiple, or all of the following.

a) Map Unit(s)
b) Map Unit Component(s)

i. Name
ii. Percent Composition
iii. Sequence Identification

d) Pedon(s)
e) Horizon(s)
f) Attributes (Data Limiting Mode)

i. High
ii. Low
iii. RV (Representative Value or Expected Value)

Outputs are the soil attribute data and corresponding ancillary data designated by the user and retrieved from the soil attribute database.
* The retrieve attribute data are the soil data inputs to the "Query Execution" routine.
* The ancillary data are the relational database keys and soil attribute mode data (High, Low, RV) that produced the ranking. These data are reference data needed to define the soil attribute inputs. All ancillary data are directed to PREVIEW.

D. ENABLING TASKS:
i. Develop and implement the NASIS soil attribute database. NASIS Development Team, TISD and Soil Survey Division.
ii. Develop, test, and employ the soil attribute selection routine of the Interpretations Generator Module. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.
iii. Train the user to properly initialize the soil interpretive attribute data. This training provides the user with an understanding of the principles, functions, and operation of the soil attribute selection process and the knowledge to properly initialized the soil interpretive attribute data. Soil Survey Interpretation Team, NSSC.

4. Execute the interpretive query and report the resultant interpretations, rankings, and supporting information to PREVIEW.

A. OBJECTIVE: The execution routine initiates the interpretive query and provides the user with limitation, performance, or suitability rankings for selected soil use(s) or resource management practice(s). Execution of the interpretive query applies the specific conditions set forth by the interpretive criteria to the selected soil attribute data. Interpretive rankings are obtained when the selected soil attribute data meets the specific conditions of the query and these rankings are reported to PREVIEW.

B. METHODS/PROCEDURES: The system provides the user with the ability to initiate the interpretive query and obtain the requested interpretive rankings for the specified soil attribute data. Invoking the execution routine enables the interpretive query, queries the selected soil attribute data, and directs the resultant rankings to PREVIEW.

A NULL interpretive ranking is generated when special conditions are encountered during the execution of the interpretive query. These special conditions are:

1. The soil attribute data are incomplete and data required by the interpretive query is missing or the data field is null. Under these conditions the following procedure applies:

a) A NULL interpretive ranking is report for the criteria dependent on the missing data.
b) All available soil attribute data are evaluated and their respective interpretive rankings are reported.
c) The user is notified that there are missing soil attribute data and the missing attributes are reported to user.
d) NULL interpretations that result from missing data will carry a disclaimer that the ranking is incomplete and based only on the available attribute data.

2. If no evaluator is detected a null ranking is returned. This condition occurs when the interpretive criteria is not a characteristic of the soil component or soil component's horizons. Example - An interpretive criteria that rates a soil SEVERE if texture is ICE. For this criterion the rating is NULL if texture is not ICE.

C. INPUTS/OUTPUTS: Inputs are the query(ies) and the selected soil attribute data.

Outputs are "CRITERIA_RANKING" and "CRITERIA_RESTRICTION" and are directed to PREVIEW.

D. ENABLING TASKS:

i. Develop, test, and implement the Query Execution routine component of the NASIS Interpretation Generator Module. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

5. Preview, Edit, Select, and Order interpretive ranking(s), restriction(s), and ancillary outputs for the final interpretive report.

A. OBJECTIVE: The PREVIEW routine allows the user to preview the interpretive outputs before they generate the final report or interpretive data download. The preview process is essentially a query of the interpretive rankings, restrictive features, and supporting input data and criteria. During PREVIEW the user has an opportunity to review the interpretation(s) and supporting data and to select, edit, and order pertinent information.

B. METHODS/PROCEDURES: NASIS Interpretation Subsystem users may broadly initialize the interpretation(s) by selecting all or multiple interpretations, spatial areas, data limiting mode, or soil attribute data inputs. The PREVIEW routine then provides the user with the ability to review, select, and order the resultant interpretation(s) and ancillary supporting data and to make any appropriate edits. (Note: Ancillary outputs are the soil attribute inputs, domain identifiers - "HIGH," "LOW," and "RV", interpretation criteria, and the soil and criteria relational database keys.) The PREVIEW routine provides for the following:

1) PREVIEW - The user may review, on screen, "ALL" interpretation rankings, restrictive features and ancillary data used to initialize the selected interpretations.

2) EDIT - The user may selectively edit "CRITERIA_RANKING," "CRITERIA_RESTRICTION," and over-ride justification statements. These edits or over-rides are the only IGM editable information and are available to update interpretation databases and standard reports. Input attributes, interpretive criteria, and input-criteria key data are not editable. Documentation will be provided for each over-ride edit.

3) SELECT and ORDER - The subsystem uses a choice lists rather then a query interface to select and order the interpretive information. From these choice lists, the user may select and/or order interpretations, ancillary data, and input-criteria keys; review and compare interpretive results and supporting data; and report selected information.

Other limiting parameters can also be specified, as desired, to modify the final interpretive output. These limiting parameters are:

In percent composition, the delineated area that must be occupied by a unique combination of selected data or interpretations. (i.e. Greater than 40 percent of the area is moderate.)

Specification that an interpretive rating or feature must be greater than, equal to, or less than some other rating or feature. (i.e. Its area is greater than the area of any other rating for the same interpretation rating or feature).

Select by:

First Level: One, Multiple, All
1) CRITERIA_RANKING
2) SOIL ATTRIBUTE INPUTS
3) INTERPRETATION
4) MAP UNIT LEGEND
5) STANDARD OUTPUT

Second Level: One, Multiple, All
1) CRITERIA_RANKING

a) Slight
b) Moderate
c) Severe
d) Most Restrictive
e) Least Restrictive
f) "CRITERIA_RESTRICTION"
g) Null

2) SOIL ATTRIBUTE INPUTS

a) High
b) Low
c) RV (Representative Value or Expected Value)

3) INTERPRETATION

a) Name
b) Interpretation ID
c) Aspect
d) Parent Interpretation
e) Spatial Relevance

i. National
ii. State
iii. MLRA
iv. County
v. Soil Survey Area

f) Type of Interpretation (Derived, Manual Override, Failed, Null)

4) MAP UNIT LEGEND

a) Data Map Unit
b) Component
i. Name
ii. Percent Composition
iii. Sequence Identification
c) Horizon
d) Attribute

e) Spatial Relevance

i. National
ii. State
iii. MLRA
iv. County
v. Soil Survey Area
vi. Site

5) STANDARD OUTPUT

a) Soil Survey Manuscript
b) Field Office Technical Guide
c) Others (User Defined)

Order by:

Primary Sort: (One, multiple, all)
1) By Legend Map Unit
2) By Interpretation
3) By CRITERIA_RANKING

Secondary Sort: (One, multiple, all)
1) By Legend Map Unit:

a) By Data Map Unit
b) By Component
NOTE: Horizons are always sorted from top to bottom.

2) By Interpretation:

a) By Name or Identifier
b) Criteria

c) Aspect
d) "CRITERIA_RANKING"
e) "CRITERIA_RESTRICTION"

C. INPUTS/OUTPUTS: Inputs are the interpretive rankings and restrictive features, ancillary interpretive information, the user's selection of one, multiple, or all of the selection parameters. Other user inputs are over-rides and their relative documentation.

Outputs are the selected interpretive rankings, their respective restrictive features, over-rides, and supporting data. This information is directed to standard output (screen) for review or to the IGM Report routine.

D. ENABLING TASKS:

i. Develop, test, and employ the PREVIEW routine of the Interpretations Generator Module. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Train the user to properly review, over-ride, and document an interpretation(s). This training provides the user with an understanding of the principles, functions, and operation of the PREVIEW process and the knowledge to properly review and report the selected interpretation and supporting information. Soil Survey Interpretation Team, NSSC.

6. REPORT. Report the interpretation(s) and supporting data in a user specified format.

A. OBJECTIVE: The REPORTS routine receives the selected and sorted interpretation(s) and supporting data from the PREVIEW routine. It prepares and formats the interpretive report as per the specifications provided by the user. The user has the option of downloading the information into an interpretive database, printing the information as a hard-copy report, or storing the information electronically in hard-copy format.

B. METHODS/PROCEDURES: The REPORTS routine will interface with the "NASIS Reports Generator" and will accept outputs from the IGM PREVIEW routine. However, there is still a need to provide the user with other report options such as downloads to databases, electronic storage of formatted reports, and debugging reports.

Initially, the REPORTS routine will provide standardized reports for NASIS and the Field Office Computing System (FOCS) interpretive database downloads and for Soil Survey Manuscript Interpretive Tables and Section 2, FOTG. The Soil Survey Manuscript Interpretive Tables and Section 2, FOTG reports maybe either hard-copy, electronic-copy, or both.

Standardized reports are:

1) Database Download (All interpretation attribute are downloaded.)

   i. NASIS Interpretations data store
   ii. Field Office Computing System data store.

2) SCS Soil Survey Interpretation Reference Documents

   i. Soil Survey Manuscript.
   ii. Field Office Technical Guide.
   iii. User Specified.

The routine will also allow the user to create specialized reports. These specialized reports are specific to the users needs and contain the interpretations and interpretive attributes selected by the user. These user defined reports may contain one, multiple, or all of the following:

1) "CRITERIA_RANKING"
2) "CRITERIA_RESTRICTION"
3) Legend Map Unit ID and Name
4) Data Map Unit ID
5) Component ID
6) Input Attributes
7) Interpretation ID and Name
8) Interpretation Criteria
9) Aspect.

The debugging report is a special report that is either turned on or off by the user. The purpose and function of this report is to provide the user with a report of errors, missing data, query interruptions, etc.

C. INPUTS/OUTPUTS: Inputs are the selected interpretive rankings, restrictive features, over-rides, and supporting data as developed through PREVIEW.

Outputs are the standardized, user initialized, or debugging reports or database downloads.

D. ENABLING TASKS:

i. Develop, test, and employ the REPORTS routine of the Interpretations Generator Module. NASIS Development Team, TISD and Soil Survey Interpretation Team, NSSC.

ii. Train the user to properly prepare and execute a report. This training provides the user with an understanding of the principles, functions, and operation of the REPORT process and the knowledge to properly create a report. Soil Survey Interpretation Team, NSSC.

IMPLEMENTATION

Implementation Requirements: These are the explicit and non-explicit functional requirements of the NASIS Interpretations Subsystem. They are the functions that are required to integrate the subsystem into NASIS and produce reliable and consistent soil survey interpretations.

Initially, the NASIS Interpretation Subsystem is fully redundant and will be tested and implemented using current criteria and interpretations. When the module is fully tested and debugged, the redundancy within the criteria and among interpretations will be addressed. Furthermore, Interpretative Aspect (such as performance, health, construction, installation, and environmental) is a concept that has been incorporated in the NASIS Interpretation Subsystem. Dependencies identification and tracking are also an integral part of the NASIS Interpretation Subsystem and were incorporated into the design early in the analysis process.

It is recommended that a team of NSSC and NTC soil scientists conduct the Alpha and Beta tests of the Interpretations Criteria Module and the Interpretations Generator Module. In addition to testing, this team will develop the necessary policies and training materials needed to implement the NASIS Interpretation Subsystem at the state and soil survey office.

The NTC soil scientists have a vested interest in this software and their involvement in the development, testing, and implementation is critical to the success of the NASIS Interpretation Subsystem and is strongly recommended. The following steps and processes are needed to implement the NASIS Interpretation Subsystem.

Strategies for implementing of the NASIS Interpretation Subsystem are:

1. Develop, test, and initiate the Interpretation Criteria Module (ICM). The recommended team of NSSC and NTC soil scientists will test the ICM by entering and maintaining the criteria in Section 620 of the National Soil Survey Handbook. Probable time requirements to fully test and implement the ICM are 1.5 to 2.0 staff months.

2. Develop, test, and initiate the Interpretation Generator Module (IGM). The recommended team of NSSC and NTC soil scientists will test the IGM using current NSH interpretative criteria and will compare the results against AMES MUIR based interpretation. At a minimum, initial implementation must provide an emulation of current capabilities. Testing will require 3 to 6 staff months to insure that the IGM is functioning properly and that the interface between the ICM and IGM is working properly.

3. Evaluating and documenting the test results will require 2 to 3 staff months and is the responsibility of the NSSC/NTC testing and evaluation team. Team will compare NASIS interpretative results with their respective MUIR interpretations. Further, the team will review the outputs for consistency between the properties and criteria selected.

4. NASIS Interpretation Subsystem documentation and training are required to fully implement the software at the state, regional, and production soil survey office. The NSSC/NTC team will develop the software documentation with the assistance of NASIS Development Team, TISD. Training is the responsibility of the NSSC/NTC team. Training delivery methods or schedules are not yet developed.

Training Topics include but are not limited to:

A) Use of software.
B) Developing, testing, and authorizing an interpretation or its criteria.
C) Boolean, if-then and soil horizon properties relationships as applied to interpretive criteria.

5. The implementation of this software will require the development of policies and procedures that will ensures consistent dissemination of soil data and interpretations across all organizational levels. These policies and procedures should be the responsibility of the NSSC/NTC team and should not be approved or implemented until the NASIS Interpretation Subsystem capabilities are fully evaluated and understood.

HOW SHOULD BUSINESS AREA LOOK 5 TO 10 YEARS INTO THE FUTURE:

This section of the Draft Requirements Statement deals with future soil interpretation capabilities and enhancements that are necessary to meet the expanding demands of the user. These future capabilities and enhancements are:

1) GIS applications.
2) Comprehensive soil potential ratings.
3) Integration of external databases (i.e. plants, climate, and resource management) into the interpretation process.
4) Application of advanced analysis techniques (i.e. fuzzy logic, clustering, neural network analysis, and risk assessment).

5) Establish proximity and adjacency relationship of interpretations.
6) Interpret site or map unit delineation data.

GIS application. In the future, Geographic Information System (GIS) will be used to develop, test, and report (display) soil interpretations and potential ratings. GIS provides a change of direction from the current tabular-based interpretive system to one that is based on spatial data. Not only will this change enable soil scientist to analyze and display soil interpretations as we now understand them, it will also integrate external ancillary databases into the interpretive process and it will allow for the analysis of proximity and adjacency relationship of soils and soil properties. Extensive analysis, development, and testing will be required prior to implementation of this technology.

Comprehensive soil potential ratings. Soil potential ratings are developed, documented, and maintained by the State Soil Scientist(s) and are applied to a specified state(s), MLRA, or local soil survey area(s). The ability to produce soil potential ratings is limited in the initial release of the NASIS Interpretation Subsystem. The constraint is a lack of databases that will support a true soil potential rating. These essential databases are vegetative, climatic, resource management, economic, and social.

The NASIS 2.0 release of the Interpretation Subsystem will support partial soil potential ratings. These partial ratings are dependent on NASIS soil component and horizon attribute and soil performance data.

Integration of external databases. Future soil interpretation and potential rating enhancements will require access to relevant external databases. These external databases will contain information and data relevant to vegetation, landscape features, climate, geology, resource management practices, and social and economic conditions. The integration of these external databases is essential to the development of the NASIS Interpretation Subsystem and will greatly enhance the quality of NASIS soil interpretations and potential ratings.

Resource assessment such as Conservation Practice Physical Effects (CPPE) are a special type of soil potential. The NASIS Interpretation Subsystem will have the capability of generating CPPE ratings. However, these conservation practice ratings are not solely depended on soil interpretive or performance data. Land management, soil temporal properties, crops, and conservation practice data are also important components of these ratings. Future development and application of computerized CPPE ratings is dependent on the integration of these data into the interpretive subsystem.

Application of advanced analysis techniques. Fuzzy logic, neural network analysis, cluster analysis, and risk assessment may strengthen the soil interpretation process. These analytical tools may have potential for soil interpretations but their potential is not yet fully understood or tested. The potential of these techniques should be carefully analyzed and functional prototypes should be developed to test and demonstrate their applicability to soil interpretations. This developmental effort should be establish as soon as the NASIS Interpretation Subsystem is implemented.

Establish proximity and adjacency relationships. Individual soils and soil horizons exist in a universe of complex interaction and dependencies. Soils map unit components have known characteristics, extents, and spatial patterns but the affects of adjacent components or component horizons or of components in the vicinity of any given component are not known. Where feasible and logical, the NASIS Interpretation Subsystem should provide information relative to these dependencies and incorporate that information into the interpretive process. This function serves as a method to discover relationships in the behavior and occurrence of soils and will require data that is currently not stored within NASIS or are external to the scope of NASIS.

Future releases of the NASIS Interpretation Subsystem should provide support for interpretations that consider the proximity and adjacency of soil map unit components and component horizons.

Interpret site or map unit delineation data. The NASIS Interpretation Subsystem relies on the NASIS database for all its soil interpretive data inputs. A future requirement of the interpretive subsystem is the ability to interpret site or delineation data collected by the user. Site data may be accessed through the pedon database as soon as it becomes an integral part of NASIS. The interpretation of a specific delineation however will require the user to input the interpretive data directly into the interpretive subsystem. This will require the development of a data input routine that is linked directly to the interpretation generator. This entry software already resides in FOCS and with modification may be applicable to NASIS. A through analysis of this objective is required before extensive resource are invested in its implementation.

NASIS Generated Soil Interpretations: Strengths and Challenges--*Steve Lawrence, Assistant State Soil Scientist, Georgia*

The National Soil Information System (NASIS) was established in 1994 as the tool for managing soil survey data within the National Cooperative Soil Survey Program. NASIS introduced several new concepts to the way we manage soil information, which in turn affects the way we interpret the information, and how we convey this to others.

The new concepts created potential for improved soil information management and interpretation. Subsequent challenges to implementation are associated with the potential.

Some of the new concepts relate to management of map unit and component information. Map units can have an unlimited number of components and components can have an unlimited number of layers (or horizons). Inclusions are now minor components. Information can be stored for representative values, in addition to ranges of low and high. Water tables, flooding, and ponding information is managed for each month, individually. Many new data elements were added to the system. These conceptual changes affect the way information is populated and managed in NASIS. Interpretations are affected because interpretations are now generated directly from component data.

Some new concepts directly affect the manner in which soil information is interpreted. Whenever possible, interpretive criteria are now based on actual soil properties, rather than on classes or other interpretations. Interpretations are generated from actual component data. Interpretive results are not edited; soil physical and chemical properties are edited, or interpretive criteria are adjusted to achieve desired results. National interpretations are "templates" to use in creating regional or local interpretations.

Soil information management and interpretation capabilities have been strengthened through these new concepts and features. Interpretations are now for actual component properties, rather than conceptual entities. Therefore, we have better representation of what is actually in the soil map unit. Interpretations stay current with soil properties and interpretive criteria, and interpretations can be or adjusted or developed for regional or local conditions or needs. Soil scientist most closely associated with and knowledgeable of the soils information now have more input into the way the information is interpreted.

Challenges also exist. Some errors were created by conversion of data from the prior system to the current system. Many new data elements that were added, and are used in interpretations, are null and need to be populated. The magnitude of data population needs is substantial. Consistent soil interpretations now depend on consistent data population. The process of generating soil interpretations through NASIS is complex, and documentation of criteria and changes to criteria is limited.

The concept of "generated interpretations" was introduced in 1996. NASIS exports incorporating generated interpretations became available in 1999. In many areas, the use of "legacy interpretations" continued until November 2001, at which time SSURGO exports ceased to include them. As a result, many states only recently began evaluating these NASIS generated interpretations.

Several efforts are underway at the national, regional, state, and project levels to overcome some of the challenges. A National Soil Survey Interpretations Advisory Group has been formed to analyze these issues and our soil interpretation process. A major issue associated with the way "null data" was interpreted has been resolved with the introduction or "not rated" options into national interpretations. Many MLRA Offices, State Offices, and Project Offices have evaluated national interpretations and have revised them or created new ones to meet regional or local needs. Calculations have been developed to assist in data population. Other data population efforts are continuing.

Digital soil surveys and the electronic Field Office Technical Guides will greatly increase the utilization of our soil information and interpretations. Efforts to adequately populate data should continue, along with efforts to evaluate, document, and refine interpretive criteria. End users of interpretations, including NRCS field offices, university and other cooperators, and the private sector can be of great value to improve our capability to adequately interpret soil information. Communication between developers of soil interpretations will greatly educe duplication of efforts and improve our technical knowledge and abilities. Communication between developers of interpretations at all levels and users of the interpretations will greatly enhance our efforts toward "Helping People Understand Soils".

Initial Evaluation of NASIS "null hedge" Interpretations and Other Interpretation Activities---*Darrell Kautz, SDQS-Databases, MO17, Palmer, AK*

1. Original version of NASIS Interpretation Generator
   - Generated ratings for all components
   - Default values used for missing data elements for un- and under-populated components
     - primarily miscellaneous area, higher taxa, and minor components
   - Default values often resulted in favorable ratings, i.e., "Suitable" or "Not limited"
   - Interpretive maps created in Soil Data Viewer using generated ratings potentially misleading
     - Example: For Anchorage Area, Alaska, Knik Arm of Cook Inlet, which is ocean, is displayed as "Not Limiting" for "Dwellings w/ Basements"

2. Latest version of NASIS Interpretation Generator and New "null hedge" Functionality
   - "Not Null And", "Null Or", and "Null Not Rated" hedges added to better handle missing data elements
   - Null hedges incorporated into national interpretations
   - Interpretative maps created in Soil Data Viewer display "Not Rated" class
     - Example: For Anchorage Area, Alaska, Knik Arm of Cook Inlet is now more appropriately displayed as "Not Rated" for "Dwellings w/ Basements"

3. Performance of initial versions of selected "null hedge" interpretations against different 'vintages' of NASIS data for Alaska
     - Converted SSSD surveys
       - Only updates since conversion – known conversion errors and national model data elements
       - Excessive/unacceptable number of components not rated
     - Modern NASIS surveys
       - New data or comprehensive updated converted SSSD data
       - Depending on the interpretation, tests results varied
         - all components rated except for miscellaneous area and some higher taxa components
         - every non-miscellaneous component not rated

4. Conclusions
   - New "null hedge" interpretations applicable only with modern (new or updated) NASIS surveys
   - Initial versions of "null hedge" interpretations still in need of some 'fine tuning'
     - Problems with organic layers in both mineral soils and organic soils
     - Problems with soils with permafrost
   - Potentially, "null hedge" interpretations will provide complete control over which components are rated and which are not

- "null hedge" interpretations and special INTERP reports in NASIS provide an effective and powerful tool for data quality control

5. Certified interpretations for Alaska survey areas
    - Modern soil surveys – new "null hedge" interpretations or, as necessary, local "null hedge" interpretations
    - Converted SSSD surveys that have not been updated – Ames legacy interpretations
        - NASIS generated interpretations never tested and validated
        - Legacy interpretations validated and certified
        - Legacy interpretations stored in NASIS and published interpretations in complete agreement

6. Local version of SSURGOv2 Access template
    - Fairly complex and involved process
        - Necessary if state wants reports other than the national set
        - Customization Guide available
    - Legacy interpretations
        - Exported from NASIS and imported into the SSURGOv2 Access template
        - Local reports added to template for FOTG and field office use
    - Other reports in Alaska template
        - Mapunit Description
        - Local versions of selected national reports

7. Other recent interpretation activities
    - Develop data standards and NASIS report for displaying monthly soil moisture-temperature profile
    - Develop data standards and reports for use of common (non-soils) names for mapunits and components
        - Target audience – non soil scientists and other non technical users
    - Create local hydric soils map in ArcView
        - Based on query in SSURGOv2 Access template and ArvView SQL Connect and Legend Editor functionality
        - More refined categories that national hydric soils map in Soil Data Viewer
            - <15, 15 to 50, 50 to 85, and >85 percent hydric (Alaska version)
            - All Hydric, Partially Hydric, Not Hydric (national version)
        - Process applicable to other local interpretations

Case Study of Developing Soil Interpretations for Military--*Edgar Mersiovsky, Data Quality Specialist, MO-16, Little Rock, AR*

During soil survey updates of Arkansas Army National Guard Bases, Camp Robinson and Fort Chaffee, the NRCS was asked to develop soil interpretations for some military operations. These interpretations are to help the military find new areas in planning maneuvers and to help in resting others.

One of the soil interpretations was soil trafficability of military vehicles. We based the soil interpretations on the information found in military manuals on soil trafficability and maneuverability. We used the same rating classes based on the probability of the vehicle or vehicles to make a pass through an area as described in the manuals. We used seven vehicle classes that were supplied in the manual. Unified texture within a critical depth for each of the vehicle classes was used to determine soil strength, stickiness, and slipperiness. The minimum and maximum slope was determined using the vehicles specs within each class. We added surface stoniness to the interpretation.

The personnel on the bases found this data useful when used with Soil Data Viewer. While at the base, we worked with a group from Virginia Tech who were measuring vegetative basal area. This data together with the soil trafficability data will help the military plan maneuvers in seldom used areas on the base allowing overused areas to re-vegetate. We also adapted other soil interpretations to fit their needs. The interpretations for excavations for fighting positions were adapted from shallow excavations along with depth requirements from military manuals. Some interpretations just needed a name change as in the case of camping areas to bivouac areas. We relied on the military manuals and standards for development of the soil interpretations more than field studies. When opportunity arose, we were allowed to observe activity during wet periods to see if the interpretations were accurate.

Local Interpretation Generation Using NASIS--*Susan B. Southard, Soil Data Quality Specialist, MO-2, Davis, CA*

California soils are highly managed and manipulated for many uses. Contrast the soil information needed for growing over 250 different crops with information needed to manage military desert training grounds. National parks, public recreation areas, national forests, private timber production lands, water supply and urban living areas all demand soils information that transcends the typical use of agronomic soil surveys. These uses all require soils data and interpretations that focus on the preservation and sustainability of the soil resource. They also involve air quality, water quality, water conservation and human safety.

Using the interpretation generation tool in the National Soils Information System (NASIS) the Pacific Southwest MLRA Office (MO2) has developed water management interpretations that help conserve water and help prevent soil erosion. Five irrigation designs were used to develop design-specific soil interpretations. The five designs include graded border, level border, sprinkler, drip and furrow irrigation systems. The 1993 NSSH Irrigation Rating Guide was used as a template and a starting point for developing criteria. The criteria were marked up by the NRCS state agronomist and by an irrigation specialist from the University of California for each of the five design systems. A corresponding interpretation was then developed in NASIS and tested on soils with known performance under the different systems.

The Pacific Southwest MO has also developed rating classes that clarify the "restrictive features" listed in the NSSH rating guides. The intent of the new rating classes is to provide component level information to the soil scientist who is testing their interpretations and database population. The rating classes provide more informative reports and maps for the soil survey user. Some examples of MO2 rating classes are in Table 1 below:

Table 1: Comparison of NSSH Restrictive Feature and MO2 Rating Classes

NSSH Restrictive Feature	MO2 Rating Class
Flooding	Flooding > = Occasional
Depth to Bedrock	Depth to Bedrock 20-40"
Slope	Slope > 35%
Too Clayey	Clay > 40%
Too acid	pH in surface < 4.5

The rating classes allow the soil scientist to quickly recognize either a mistake in their soil data or an evaluation inconsistency. They also become familiar with the criteria limits used in the interpretation. When a soil survey user reads the report they gain a better understanding of the rating result and can use their professional judgment in assessing the result. The rating classes use key words similar to the restrictive features, they are defined in the pre-written material, the glossary and are displayed in a brief summary footnote at the bottom of the NASIS-generated interpretation reports.

MO2 has also developed a system of documenting criteria with dated edits in the existing framework of NASIS. The criteria documentation is in sync with the actual interpretation design in NASIS. These “rule descriptions” can be generated directly from NASIS in report form or displayed on screen when using the Customer Service Toolkit Soil Data Viewer application (SDV). The SDV user always knows what criteria were used to generate the result they see on the screen.

By using new NASIS and Soil Data Viewer tools MLRA office staff can provide customized interpretations and soil survey information that is tailored to individual users.

Draft Format for Documentation of Interpretation for Section 620 National Soils Handbook- *Bob Nielsen, NSSC, Lincoln, NE*

Three of four views
(Web based view not presented in this document)
View one:
Daily Cover for Landfill:

These soils are either partial or complete members of the set of soils that are limited for use as "Daily Cover for Landfill" if one or more soil properties within 150 cm (60 inches) of the soil surface are limiting.

Scope:

"Daily Cover for Landfill" interpretation is a tool for guiding the user in site selection for the safe disposal of solid waste. The interpretation is applicable to both heavily populated and sparsely populated areas. The ratings are for soils in their present condition and do not consider present land use or mechanical alterations. The use of this interpretive guide ("Daily Cover for Landfill") is important in site selection. Improper site selection, design, or installation may cause contamination of ground water and surface waters and may create health and environmental hazards. Potential hazards and limitations may be reduced or eliminated by installing systems designed to overcome or reduce the effects of the limiting soil properties.

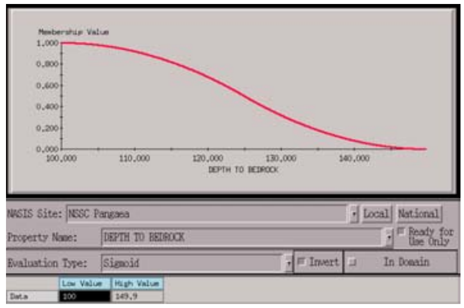
Daily cover for landfill is the soil material that is applied daily to compacted solid waste in an area sanitary landfill. The cover material is obtained offsite, transported, and spread on the area. The required soil characteristics for both daily and final cover materials are similar enough to share one rating.

Suitability of a soil for use as cover is based on properties that reflect workability and the ease of digging and of moving and spreading the material over the refuse daily during both wet and dry periods. Soils that are loamy or silty and that are free of stones are better suited than other soils. Clayey soils may be sticky and difficult to spread, and sandy soils may be subject to soil blowing. Slope affects the ease of excavation and of moving the cover material. It also may affect the final configuration of the borrow area and, thus, runoff, erosion, and reclamation.

The soils selected for daily cover for landfill should also be suitable for growing plants. They should not contain significant amounts of substances that are toxic to plants, such as a high content of sodium, salts, or lime. They should be thick enough over bedrock, a cemented pan, or the water table so that material can be removed efficiently while leaving a borrow area that can be revegetated. However, some damage to the borrow area is expected and plant growth may not be optimum.

The interpretive rating is the maximum fuzzy membership value for the child rules that comprise the "Daily Cover for Landfill" interpretation.

Interpretive Child Rules:

Description	Property Summary	Evaluation	Restrictive Feature
Depth to bedrock restricts the constructio n, installation, and functioning of the installed application.	Evaluation uses: 1. Depth to the top of the first restrictive layer and; 2. Restrictive feature type is "bedrock (lithic)" or "bedrock (paralithic)" Logic: Finds the top depth of the first restrictive layer where restrictive type is "bedrock (lithic)" or "bedrock (paralithic)." Depth to restrictive feature must be synchronized with the depth to the restrictive feature horizon shown in the horizon table. Returns values for low, high, and rv: each has a single value.	 This evaluation checks for the presence of bedrock and if present evaluates bedrock depth. A soil can be a complete or partial member of the set of soils that are limited by the depth to bedrock and DEPTH TO BEDROCK is the set's restrictive feature. If the depth to bedrock is less than 100cm (40 inches), then the soil is a complete member of the set. If the depth to bedrock is greater than 100cm (40 inches) and less than 150cm (60 inches) then the soil is a partial member of the set. A soil that has bedrock at a depth of more than 150cm (60 inches) is not a member of the set.	Depth to bedrock

View two:

Subject: Interpretation NSSH Design -- FOR YOUR REVIEW AND COMMENT

AWM Land Application of Manure and Food Processing Waste:

If any condition specification is limiting then the rating is very limited for those restrictive conditions.

If all condition specifications are neither limiting nor non-limited then the ratings are either somewhat or slightly limited.

If all conditions are non-limiting then the rating is unlimited.

	Condition Specifications		
Restrictive Condition	General	Specific	
		Limiting	Non-Limiting
permafrost	permanently frozen	texture in lieu of is cpf or texture modifier is pf	all other
poor filter	rapid saturated hydraulic conductivity (0 to 150 cm)	Ksat >_42 ptm sec"'	Ksat < 14 ~tm sec-'
slow percolation	slow saturated hydraulic conductivity (0 to 150 cm)	Ksat < 1 ~Lm sec"'	Ksat > 4 [m sec $^{-1}$
wetness	shallow high water table	< 60 cm	> 120 cm
ponding	ponding in any month	>_ 4 hours	< 4 hours
slope	steep slopes	>_ 15 %	<8%
depth to rock	shallow bedrock	< 50 cm	>_ 100 cm
cemented pan	shallow cemented pan	< 50 cm	>_ 100 cm
excess sodium	high sodium adsorption ratio	SAR > 13	SAR < 4

View three:

CURRENT NASIS REPORT CAPABILITIES:
Rule: ENG - Daily Cover for Landfill

Description:
These soils are either partial or complete members of the set of soils that are limited for use as "Daily Cover for Landfill" if one or more soil properties within 150 cm (60 inches) of the soil surface are limiting.

Scope:

"Daily Cover for Landfill" interpretation is a tool for guiding the user in site selection for the safe disposal of solid waste. The interpretation is applicable to both heavily populated and sparsely populated areas. The ratings are for soils in their present condition and do not consider present land use or mechanical alterations. The use of this interpretive guide ("Daily Cover for Landfill") is important in site selection. Improper site selection, design, or installation may cause contamination of ground water and surface waters and may create health and environmental hazards. Potential hazards and limitations may be reduced or eliminated by installing systems designed to overcome or reduce the effects of the limiting soil properties.

Daily cover for landfill is the soil material that is applied daily to compacted solid waste in an area sanitary landfill. The cover material is obtained offsite, transported, and spread on
the area. The required soil characteristics for both daily and final cover materials are similar enough to share one rating.

Suitability of a soil for use as cover is based on properties that reflect workability and the ease of digging and of moving and spreading the material over the refuse daily during both wet
and dry periods. Soils that are loamy or silty and that are free of stones are better suited than other soils. Clayey soils may be sticky and difficult to spread, and sandy soils may be subject
to soil blowing. Slope affects the ease of excavation and of moving the cover material. It also may affect the final configuration of the borrow area and, thus, runoff, erosion, and reclamation.

The soils selected for daily cover for landfill should also be suitable for growing plants. They should not contain significant amounts of substances that are toxic to plants, such as a high content of sodium, salts, or lime. They should be thick enough over bedrock, a cemented pan, or the water table so that material can be removed efficiently while leaving a borrow area that can be re-vegetated. However, some damage to the borrow area is expected and plant growth may not be optimum.

The interpretive rating is the maximum fuzzy membership value for the child rules that comprise the "Daily Cover for Landfill" interpretation.

Property Used: SOIL REACTION 1-1 WATER THICKEST LAYER IN DEPTH 25-150cm

Data used: ph1to1h2o, hzdept, and hzdepb from component horizon table.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. 1 to 1 water pH.

Logic: Finds the value of soil reaction (pH) for the thickest horizon in the depth range 10" to 72" (25-180 cm).

Evaluation Used: Soil reaction 25-150cm thickest layer

This evaluation is crisp and checks the pH of the thickest layer between 25 and 150 cm (10 to 60 inches).

The soil is a member of the set of soils that are too acid if the pH of the thickest layer between 25 and 150 cm is less than or equal to 3.5. The soil is not a member of the set of soils that are too acid if the thickest layer pH is greater than 3.5.

Impact of Child Rule: Acid < 3.5 Thickest Layer 10 to 60 inches

Soil with high acidity in the thickest layer have an acidity limitation. When this layer is used as daily cover for landfill re-vegetation and vegetative growth is inhibited. Measures that reduce acidity will be required to achieve optimum growth.

Property Used: CALCIUM CARBONATE THICKEST LAYER IN DEPTH 25, >150CM

Data used: hzdept_r, hzdepb_r, caco3_l, caco3_h and caco3_r from the component and component horizon tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. Percent Calcium Carbonate.

Logic: Finds the value of Calcium Carbonate Equivalent for the thickest horizon that has any portion in the depths 25" to 60" (25 to 150 cm) or to a restrictive layer. Portions outside the depth range are not considered in the horizon thickness.

Returns values for low, high, and rv: normally each has a single value; if horizons tie for thickest, a value will be returned for each.

Evaluation Used: CaCO3 >40 25, >150cm Thickest Layer

This evaluation is crisp and checks the calcium carbonate percentage of the thickest layer between 25 and more than 150 cm.

The soil is a member of the set of soils that have high CaCO3 content if the thickest layer has a calcium carbonate content of more than 40%. The soil is not a member of this set if the calcium carbonate content of the thickest layer is 40% or less.

Impact of Child Rule: CACO3 > 40% in the Thickest Layer 25 to 150cm

Soils with high calcium carbonate content in the thickest layer may limit vegetative growth of some plant species. Plants that are not sensitive to high calcium carbonate should be selected for re-vegetation and phosphorus fertilization will probably be need for optimum plant growth.

Property Used: TAXONOMIC MINERALOGY CLASS

Data used: taxonomic_family_mineralogy from the component_tax_fam_mineralogy table.

Consideration:

1. Taxonomic mineralogy family.

Logic: Finds the mineralogy family class for the component and returns the name as the rv.

Evaluation Used: Taxonomic Mineralogy Exclusion - Kaolinitic (nssc)

This evaluation is crisp and checks taxonomic mineralogy class.

The soil is a member of the set of soils that have low shrink swell if the taxonomic mineralogy class matches kaolinitic. This evaluation is usually grouped with other evaluations to interpret the soil's response when the soil either is or is not a member of the set of soil that are kaolinitic.

Property Used: USDA TEXTURE THICKEST LAYER IN DEPTH 25-150cm

Data used: texcl, hzdept_r, hzdepb_r, and rvindicator from component, chorizon, and chtexturegrp tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. USDA texture class
4. USDA texture class rv flag set.

Logic: Finds the USDA texture of the soil horizons between 25 and 150cm where the texture rv is set to yes else the first texture listed is selected. The representative or first texture for each horizon is returned as an array of textures with are reported as rv values.

Portions outside the depth range are not considered in the horizon thickness.

Evaluation Used: USDA Texture-Mod Clayey 25-150cm, Thickest Layer

This evaluation is crisp and checks USDA texture class of the thickest horizon and above any restrictive layer.

The soil is a member of the set of soils that are considered moderately clayey if the udsa texture of the thickest horizon matches SICL, CL, or SC.

Property Used: USDA TEXTURE THICKEST LAYER IN DEPTH 25-150cm

Data used: texcl, hzdept_r, hzdepb_r, and rvindicator from component, chorizon, and chtexturegrp tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. USDA texture class
4. USDA texture class rv flag set.

Logic: Finds the USDA texture of the soil horizons between 25 and 150cm where the texture rv is set to yes else the first texture listed is selected. The representative or first texture for each horizon is returned as an array of textures with are reported as rv values.

Portions outside the depth range are not considered in the horizon thickness.

Evaluation Used: USDA Texture-Very Clayey 25-150cm, Thickest Layer

This evaluation is crisp and checks USDA texture class of the thickest horizon and above any restrictive layer.

The soil is a member of the set of soils that are considered very clayey if the udsa texture of the thickest horizon matches SIC, or C .
Property Used: TAXONOMIC GREAT GROUP

Data used: taxgrtgroup from the component table.
Consideration:
1. Taxonomic Great Group.

Logic: Finds the great group name for the component and returns the name as the rv.

Evaluation Used: Taxonomic Great Group - *torr*

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if it the taxonomic great groups matches "torr". This evaluation is usually grouped with other evaluations with the intent to evaluate the soil's moisture regime because taxonomic moisture regime is generally an unpopulated field.

Property Used: TAXONOMIC ORDER

Data used: taxorder from component table.
Consideration:
1. Taxonomic order.

Logic: Finds the taxonomic order for the component and returns the name as the rv.
Evaluation Used: Taxonomic Order - aridisol

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if the taxonomic order matches aridisols. This evaluation is usually grouped with evaluations for aridic subgroups and the *torri* great groups to determine if the soil is in a dry moisture regime.

Property Used: TAXONOMIC SUBGROUP

Data used: taxsubgrp from component table.
Consideration:
1. Taxonomic subgroup.

Logic: Finds the taxonomic subgroup for the component and returns the name as the rv.

Evaluation Used: Taxonomic SubGroup - aridic

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if the taxonomic subgroup matches "aridic". This evaluation is usually grouped with evaluations for *torri* great groups and the order aridisols to determine if the soil is in a dry moisture regime.

Impact of Child Rule: Not Aridic

This rule provides for addition of the statement "AND NOT ARIDIC". It is used when arid conditions modify or temper the affect a specified soil interpretive property has on the interpretation. Arid conditions are determined by the soil taxonomic classification.

Impact of Child Rule: Clayey 25 to 150cm (10 to 60 inches)

Soils with high clay content effect excavation, soil manipulation, compaction, and vegetative growth. Textures of cl, sicl, and sc are rated as moderately clayey and have a lesser effect on excavation, soil manipulation, compaction, and vegetative growth. Textures of sic and c are rated as too clayey. If clay mineralogy is kaolinitic then the potential restrictive nature of the soil is less and the restrictive rating is reduced by 0.5 or if the soil is in an aridic moisture regime then clay content is not a restrictive feature.

Property Used: FRAGMENTS 2mm-<75mm WT. AVE. 0-150cm

Data used: hzdept_r, sieveno10_l, sieveno10_h, sieveno10_r, frag3to10_l, frag3to10_h, frag3to10_r, fraggt10_l, fraggt10_h and fraggt10_r from the component, component horizon, and component restrictions tables.

Considerations:

1. Depth to the top of the first restrictive layer;
2. Horizon depth;
3. Percent Passing the 10# sieve and
4. Percent coarse fragments > 3 inches.

Logic: Finds the rv weighted average of rock fragments of size 2mm to <75mm in all horizons above a restrictive layer or within 150cm of the surface. Uses sieve and rock percents from the Horizon table. Selects depth from horizons whose upper depth above a restrictive layer is within the 0 to 150 cm depth. For horizons extending below 150 cm, the weighted average may be biased.

The 2mm to <75mm fragments are represented by the percent retained on the #10 sieve (100 - #10). This is adjusted for stones by multiplying it times the fraction less than 75mm (1 - (Rock 3-10 + Rock >10)/100).

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Fragments 2mm-<75mm in 0-150cm

This evaluation checks for the weighted average of gravel size particles between 0 and 150cm.

A soil can be a complete or partial member of the set of soils that are limited by the presence of gravel sized particles and GRAVEL CONTENT is the set's restrictive feature. If the content of gravel size particles is greater than 50%, then the soil is a complete member of the set. If the content of gravel size particles is greater then 25% and less then 50% then the soil is a partial member of the set. A soil that has content of gravel size particles less then 25% is not a member of the set.

Impact of Child Rule: Fragments 2 to 75mm Wt. Ave. to 60"

Soils with high gravel content effect soil percolation, water holding capacity, and strength which restricts the construction, installation, and functioning of the installed application.

Property Used: UNIFIED THICKEST LAYER 25-180cm
Data used: hzdept_r, hzdepb_r, unifiedcl, rvindicator from component, component horizon, and component horizon unified tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. Unified class
4. Unified rv flag set.

Logic: Finds the first or rv Unified class of the soil horizons between 25 and 180cm where the Unified class rv is set to yes else the first Unified class listed is selected. The representative or first Unified class for each horizon is returned as an array of classes with are reported as rv values.

Low and high contain all values, and rv contains only those rows whose unified classification is oh, mh, ch, or ol all other rv values are null.

Portions outside the depth range are not considered in the horizon thickness.

Evaluation Used: Unified (Organic 25 to 150cm (10-60"))

This evaluation is crisp and checks UNIFIED class by horizon and above any restrictive layer.

The soil is a member of the set of soils that have high organic matter content if the UNIFIED class of any horizon matches PT.

Impact of Child Rule: Humus Between 25 to 150cm (10 to 60")

Excess humus restricts or reduces manipulation, stability, and workability of the soil material.

Property Used: FRAGMENTS > 75mm Wt. Ave. 0-180cm

Data used: hzdept_r, hzdepb_r, frag3to10_l, frag3to10_h, frag3to10_r, fraggt10_l, fraggt10_h and fraggt10_r from the component, component horizon, and component restrictions tables.

Considerations:

1. Depth to the top of the first restrictive layer;
2. Horizon depth;
3. Percent coarse fragments > 3 inches.

Logic: Finds the weighted average percentage of rock fragments of size greater than 75mm in the horizons above a restrictive feature or from 0 to 180 cm deep. Uses the rock percents from the Horizon table.

To compute a weighted average, the sum of rock > 75mm for each horizon is multiplied by the horizon thickness, then averaged over all horizons above a restrictive feature or to 150cm.

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Fragments >75mm in 0-180cm

This evaluation checks for the weighted average of rock size fragments between 0 and 180cm.

A soil can be a complete or partial member of the set of soils that are limited by the presence of rock sized fragments and CONTENT OF LARGE STONES is the set's restrictive feature. If the content of rock size fragments is greater than 50%, then the soil is a complete member of the set. If the content of rock size fragments is greater then 25% and less then 50% then the soil is a partial member of the set. A soil that has content of rock size fragments less then 25% is not a member of the set.

Impact of Child Rule: Large Stones (Fragments >75mm Wt. Ave. to 60")

Soils with high rock fragment content effect soil percolation, water holding capacity, and strength which restricts the construction, installation, and functioning of the installed application.

Property Used: PERMEABILITY THICKEST LAYER IN DEPTH 25-150cm

Data used: hzdept_r, hzdepb_r, ksat_l, ksat_h and ksat_r from the component and component horizon tables.

Considerations:

1. Depth to the top of the first restrictive layer;
2. Horizon depth and
3. Horizon permeability (Ksat).

Logic: Finds the value of permeability (K-Sat) for the thickest horizon above any restrictive layer that has any portion in the depths 10" to 60" (25 to 150 cm). Portions outside the depth range are not considered in the horizon thickness.

If a restrictive layer is present then the component restrictive data mush be populated with restrictive feature kind and depth.

Returns values for low, high, and rv: normally each has a single value; if horizons tie for thickest, a value will be returned for each.

Evaluation Used: Percolation Layer Thickness (> 14um/sec) 25 to 150cm

This evaluation checks for the permeability of the thickest layer above any restrictive feature between 25 and 150cm.

A soil can be a complete or partial member of the set of soils that are limited by high permeability and SEEPAGE is the set's restrictive feature. If permeability of the thickest layer is greater than 42 micrometers/second then the soil is a complete member of the set. If permeability of the thickest layer is greater then 14 and less then 42 micrometers/second then the soil is a partial member of the set. A soil that has permeability of the thickest layer less then 14 micrometers/second is not a member of the set.

Impact of Child Rule: Percolation Thickest Layer (> 14 um/sec) 10 to 60 Inches

When the thickest soil horizon's Ksat is high then the rate of water movement through these materials is high and seepage and/or leaching is an environmental, health, and performance concern.

Property Used: USDA TEXTURE IN-LIEU-OF "Permafrost"

Data used: lieutex from component horizon texture table.
Consideration:
1. Terms used in lieu of texture.

Logic: Finds the terms used in lieu of texture for all horizons. If for any horizon the term used in lieu of is "cpf" then the rv output is set to "cpf".

Evaluation Used: Permafrost (Consolidated) InLieuOf

This evaluation is crisp and checks for the presence of Permafrost.

The soil is a member of the set of soil that have permafrost limitation if terms_used_in-lieu_of_texture equal "cpf" for any horizon.

Property Used: USDA TEXTURE MODIFIER "Frozen"

Data used: texmod from component horizon texture modifier table.

Consideration:

1. Texture modifier.

Finds the textural modifiers for all horizons. If for any horizon the textural modifier is "pf" then the rv output is set to "pf".

Evaluation Used: Permafrost (Permanently Frozen) Modifier

This evaluation is crisp and checks for the presence of Permafrost.

The soil is a member of the set of soil that have permafrost limitation if texture_modifier equals "pf" for any horizon.

Property Used: DEPTH TO PERMAFROST

Data used: resdept and reskind from component restriction table.

Reports the top depth of the first restrictive layer where kind equal "permafrost".

Evaluation Used: Shallow to Permafrost (50 to 100cm (20 to 40"))

This evaluation checks for the presence of permafrost and if present evaluates permafrost depth. The component data are check for restriction_kind = "permafrost" and restriction_depth_to_top is evaluated.

A soil can be a complete or partial member of the set of soils that are limited by the depth to permafrost and PERMAFROST is the set's restrictive feature. If the depth to permafrost is less than 50 cm (20 inches), then the soil is a complete member of the set. If the depth to permafrost is greater than 50 cm (20 inches) and less than 100 cm (40 inches) then the soil is a partial member of the set. A soil that has permafrost at a depth of more than 100 cm (40 inches) is not a member of the set.

Impact of Child Rule: Permafrost

Permafrost (permanently frozen soil layer) restricts or effects excavation, manipulation, transport, stability, and workability of the soil material.

Property Used: PONDING DURATION

Data used: ponddurcl from component month table.

Considerations:

1. Ponding duration.

Logic: Finds the ponding duration classes for all months.

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Ponding Duration > Very Brief

This evaluation is crisp and checks for a ponded condition at the soil surface.

The soil is a member of the set of soils that have a ponding limitation if the ponding_duration_class in any month is equal to "VERY BRIEF", "BRIEF", "LONG" or "VERY LONG". The soil is not a member of the set of soils that have a ponding limitation if the ponding_duration_class in all months is NULL.

Property Used: PONDING FREQUENCY

Data used: pondfreqcl from component month table.
Considerations:
1. Ponding frequency.

Logic: Finds the ponding frequency classes for all months.

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Ponding Frequency None

This evaluation is crisp and checks for a ponding frequency equal to NONE.

The soil is a member of the set of soils that are not ponded if the ponding_frequency_class in all months is equal to "NONE" or NULL. The soil is not a member of the set of soils that are not ponded if the ponding_frequency_class in ANY month is not "NONE" or is NULL.

Impact of Child Rule: Ponded > 4 hours

Ponding is the condition where standing water is on the soil surface for a period of time. Soils that pond have wetness restrictions that limit the installation and function of most landuse applications.

Property Used: SALINITY MAXIMUM IN DEPTH 25-150cm

Data used: hzdept_r, hzdepb_r, ec_l low, ec_h high and ec_r rv from the component and component horizon tables.
Considerations:
1. Hoizon depth
2. EC - (electrical conductivity)

Logic: Finds the highest value of salinity (electrical conductivity) for horizons that have any portion in the depth range 10" to 60" (25-150 cm).

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Salinity, EC >16mmhos, 25-150cm

This evaluation is crisp and checks the maximum EC (salinity) between 25 and 150 cm.

The soil is a member of the set of soils that have high EC if the maximum salinity is more than 16 mmhos/cm. The soil is not a member of this set if the salinity is 13 mmhos/cm or less.

Property Used: TAXONOMIC GREAT GROUP

Data used: taxgrtgroup from the component table.
Consideration:
1. Taxonomic Great Group.

Logic: Finds the great group name for the component and returns the name as the rv.

Evaluation Used: Taxonomic Great Group - *torr*

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if it the taxonomic great groups matches "torr". This evaluation is usually grouped with other evaluations with the intent to evaluate the soil's moisture regime because taxonomic moisture regime is generally an unpopulated field.

Property Used: TAXONOMIC ORDER

Data used: taxorder from component table.
Consideration:
1. Taxonomic order.

Logic: Finds the taxonomic order for the component and returns the name as the rv.

Evaluation Used: Taxonomic Order - aridisol

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if the taxonomic order matches aridisols. This evaluation is usually grouped with evaluations for aridic subgroups and the *torri* great groups to determine if the soil is in a dry moisture regime.

Property Used: TAXONOMIC SUBGROUP

Data used: taxsubgrp from component table.
Consideration:
1. Taxonomic subgroup.

Logic: Finds the taxonomic subgroup for the component and returns the name as the rv.

Evaluation Used: Taxonomic SubGroup - aridic

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if the taxonomic subgroup matches "aridic". This evaluation is usually grouped with evaluations for *torri* great groups and the order aridisols to determine if the soil is in a dry moisture regime.

Impact of Child Rule: Not Aridic

This rule provides for addition of the statement "AND NOT ARIDIC". It is used when arid conditions modify or temper the affect a specified soil interpretive property has on the interpretation. Arid conditions are determined by the soil taxonomic classification.

Impact of Child Rule: Salinity (EC > 16mmhos), not Aridic

Soils with high salinity and not in aridic moisture regimes have reduced available water capacity which restrict plan growth and re-establishing vegetation in disturbed area.

Property Used: DEPTH TO BEDROCK

Data used: reskind and resdept lieutex from the component restrictions table.

Considerations:

1. Depth to the top of the first restrictive layer and;
2. Restrictive feature type is "bedrock (lithic)" or "bedrock (paralithic)"

Logic: Finds the top depth of the first restrictive layer where restrictive type is "bedrock (lithic)" or "bedrock (paralithic)." Depth to restrictive feature must be synchronized with the depth to the restrictive feature horizon shown in the horizon table.

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Shallow to Bedrock (100 to 150 cm (40 to 60"))

This evaluation checks for the presence of bedrock and if present evaluates bedrock depth.

A soil can be a complete or partial member of the set of soils that are limited by the depth to bedrock and DEPTH TO BEDROCK is the set's restrictive feature. If the depth to bedrock is less than 100cm (40 inches), then the soil is a complete member of the set. If the depth to bedrock is greater than 100cm (40 inches) and less than 150cm (60 inches) then the soil is a partial member of the set. A soil that has bedrock at a depth of more than 150cm (60 inches) is not a member of the set.

Impact of Child Rule: Shallow to Bedrock 100 - 150 cm

The depth to bedrock limits the volume of material suitable for use as landfill cover. Soils that are shallow are also difficult to reclaim and revegetated.

Property Used: DEPTH TO CEMENTED PAN

Data used: reskind and resdept lieutex from the component restrictions table.
Considerations:
1. Depth to the top of the first restrictive layer and;
2. Restrictive feature type is "fragipan", "duripan", "petrocalcic", "ortstein", or "petrogypsic"

Logic: Finds the top depth of the first restrictive layer where restrictive type is "fragipan", "duripan", "petrocalcic", "ortstein", or "petrogypsic". Depth to restrictive feature must be synchronized with the depth to the restrictive feature horizon shown in the horizon table.

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Shallow to Cemented Pan (100 to 150cm (40 to 60"))

This evaluation checks for the presence of cemented pan and if present evaluates the depth to the restrictive feature.

A soil can be a complete or partial member of the set of soils that are limited by the depth to cemented pan and DEPTH TO CEMENTED PAN is the set's restrictive feature. If the depth to cemented pan is less than 100cm (40 inches), then the soil is a complete member of the set. If the depth to cemented pan is greater than 100cm (40 inches) and less than 150cm (60 inches) then the soil is a partial member of the set. A soil that has cemented pan at a depth of more than 150cm (60 inches) is not a member of the set.

Impact of Child Rule: Shallow to Cemented Pan 100 - 150 cm

Depth to cemented pan restricts the construction, installation, and functioning of the installed application.

Property Used: SLOPE

Data used: slope_l low, slope_h high, slope_r rv from the component table.

Finds the component slope.

Returns values for low, high and rv: each has a single value.

Evaluation Used: Slopes <8 to >15%
This evaluation checks slope.

A soil can be a complete or partial member of the set of soils that are too steep and SLOPE is the set's restrictive feature. If the slope is greater than 15 percent, then the soil is a complete member of the set. If slope is greater than 8 percent and less than 15 percent then the soil is a partial member of the set. A soil that has slope less than 8 percent is not a member of the set.

Impact of Child Rule: Slope 8 to > 15%

Steep slopes impede trafficability of heavy machinery and reclamation of borrow sites.

Property Used: SODIUM ADSORPTION RATIO MAXIMUM IN DEPTH 25-150cm

Data used: hzdept_r, hzdepb_r, sar_l low, sar_h high and sar_r rv from the component and component horizon tables.
Consideration:
1. SAR - (sodium adsorption ratio)

Logic: Finds the highest value of sodium adsorption ratio for horizons that have any portion in the depth range 10" to 60" (25-150 cm).

Returns values for low, high, and rv: each has a single value.

Evaluation Used: SAR Maximum in depth 25-150cm

This evaluation is crisp and checks the maximum SAR (sodium adsorption ratio) between 25 and 150 cm.

The soil is a member of the set of soils that have high SAR if the maximum sodium adsorption ratio is more than 13. The soil is not a member of this set if the sodium adsorption ratio is 13 or less.

Property Used: TAXONOMIC GREAT GROUP

Data used: taxgrtgroup from the component table.
Consideration:
1. Taxonomic Great Group.

Logic: Finds the great group name for the component and returns the name as the rv.

Evaluation Used: Taxonomic Great Group - *torr*

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if it the taxonomic great groups matches "torr". This evaluation is usually grouped with other evaluations with the intent to evaluate the soil's moisture regime because taxonomic moisture regime is generally an unpopulated field.

Property Used: TAXONOMIC ORDER

Data used: taxorder from component table.
Consideration:
1. Taxonomic order.

Logic: Finds the taxonomic order for the component and returns the name as the rv.

Evaluation Used: Taxonomic Order - aridisol
This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if the taxonomic order matches aridisols. This evaluation is usually grouped with evaluations for aridic subgroups and the *torri* great groups to determine if the soil is in a dry moisture regime.

Property Used: TAXONOMIC SUBGROUP

Data used: taxsubgrp from component table.
Consideration:
1. Taxonomic subgroup.

Logic: Finds the taxonomic subgroup for the component and returns the name as the rv.

Evaluation Used: Taxonomic SubGroup - aridic

This evaluation is crisp and checks taxonomic classification.

The soil is a member of the set of soils that are considered dry if the taxonomic subgroup matches "aridic". This evaluation is usually grouped with evaluations for *torri* great groups and the order aridisols to determine if the soil is in a dry moisture regime.

Impact of Child Rule: Not Aridic

This rule provides for addition of the statement "AND NOT ARIDIC". It is used when arid conditions modify or temper the affect a specified soil interpretive property has on the interpretation. Arid conditions are determined by the soil taxonomic classification.

Impact of Child Rule: Sodium, not Aridic

Soils with high sodium adsorption ratio and not in aridic moisture regimes have the potential to restrict plan growth and re-establishing vegetation in disturbed area.

Property Used: TAXONOMIC MINERALOGY CLASS

Data used: taxonomic_family_mineralogy from the component_tax_fam_mineralogy table.

Consideration:

1. Taxonomic mineralogy family.

Logic: Finds the mineralogy family class for the component and returns the name as the rv.

Evaluation Used: Taxonomic Mineralogy Exclusion - Kaolinitic (nssc)
This evaluation is crisp and checks taxonomic mineralogy class.

The soil is a member of the set of soils that have low shrink swell if the taxonomic mineralogy class matches kaolinitic. This evaluation is usually grouped with other evaluations to interpret the soil's response when the soil either is or is not a member of the set of soil that are kaolinitic.

Property Used: UNIFIED THICKEST LAYER 25-180cm

Data used: hzdept_r, hzdepb_r, unifiedcl, rvindicator from component, component horizon, and component horizon unified tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. Unified class
4. Unified rv flag set.

Logic: Finds the first or rv Unified class of the soil horizons between 25 and 180cm where the Unified class rv is set to yes else the first Unified class listed is selected. The representative or first Unified class for each horizon is returned as an array of classes with are reported as rv values.

Low and high contain all values, and rv contains only those rows whose unified classification is oh, mh, ch, or ol all other rv values are null.

Portions outside the depth range are not considered in the horizon thickness.

Evaluation Used: Unified 25-180cm for packing

This evaluation is crisp and checks UNIFIED class of the thickest layer within a depth of 25 to 180cm.

The soil is a member of the set of soils that are hard to pack if the UNIFIED class of the thickest layer matches MH, OL, OH, or CH.

Impact of Child Rule: Soil Materials for Packing, Unified and Kaolinitic
Soil's are HARD TO PACK if they have either Kaolinitic mineralogy or that are in Unified classes mh, ol, oh, or mineralogy.

Property Used: USDA TEXTURE THICKEST LAYER IN DEPTH 25-180cm

Data used: texcl, hzdept_r, hzdepb_r, and rvindicator from component, chorizon, and chtexturegrp tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. USDA texture class
4. USDA texture class rv flag set.

Logic: Finds the USDA texture of the soil horizons between 25 and 180cm where the texture rv is set to yes else the first texture listed is selected. The representative or first texture for each horizon is returned as an array of textures with are reported as rv values.

Portions outside the depth range are not considered in the horizon thickness.

Evaluation Used: Mod sandy USDA Textures - thickest layer in 25-180cm

This evaluation is crisp and checks USDA texture class of the thickest horizon and above any restrictive layer.

The soil is a member of the set of soils that are considered moderately sandy if the udsa texture of the thickest horizon matches LCOS, LS, LFS, or VFS.

Property Used: USDA TEXTURE THICKEST LAYER IN DEPTH 25-180cm

Data used: texcl, hzdept_r, hzdepb_r, and rvindicator from component, chorizon, and chtexturegrp tables.

Considerations:

1. Calculated horizon thickness;
2. Horizon depth;
3. USDA texture class
4. USDA texture class rv flag set.

Logic: Finds the USDA texture of the soil horizons between 25 and 180cm where the texture rv is set to yes else the first texture listed is selected. The representative or first texture for each horizon is returned as an array of textures with are reported as rv values.

Portions outside the depth range are not considered in the horizon thickness.

Evaluation Used: Sandy USDA Textures - thickest layer in 25-180cm
This evaluation is crisp and checks USDA texture class of the thickest horizon and above any restrictive layer.

The soil is a member of the set of soils that are considered sandy if the udsa texture of the thickest horizon matches COS, S, FS, or SG.

Impact of Child Rule: Thickest Sand Layer 10 to 72 inches.

If the USDA texture of the thickest layer within 180 inches of the soil surface is sandy, then the texture of the thickest layer is a restrictive feature.

Property Used: HIGH WATER TABLE DEPTH MINIMUM

Data used: soimoistdept_l, soimoistdept_h and soimoistdept_r from component month, and component soil

moist tables
Considerations:
1. Depth to the top of the soil moisture layer where
2. soil moisture status is either wet or saturated.

Logic: Finds the top depth of the first layer where soil moisture layer status is wet or saturated during any month.

Returns values for low, high, and rv: each has a single value.

Evaluation Used: Wet, Ground Water Near Surface (45 - 105cm)

This evaluation checks for the presence of a water table and if present evaluates water table depth.

A soil can be a complete or partial member of the set of soils that are limited by the depth to water table and DEPTH to SATURATED ZONE is the set's restrictive feature. If the depth to water table is less than 45cm (18 inches), then the soil is a complete member of the set. If the depth to water table is greater than 45cm (18 inches) and less than 105cm (42 inches) then the soil is a partial member of the set. A soil that has water table at a depth of more than 105cm (42 inches) is not a member of the set.

Impact of Child Rule: Wet, Ground Water Near the Surface (45 - 100cm)

The shallow depth to water table limits the volume of material suitable for use as landfill cover. Soils that are shallow to water are also difficult to reclaim and revegetated and contamination of ground water and surface waters may create health and environmental hazards.

Use of Soil Interpretations on the Yakama Nation-- *Dr. Stephen G. Wangemann, BIA-Resource Soil Scientist, Washington*

The Yakama Nation is located in south central Washington State and was established by the Treaty of 1855 which was ratified by the Senate of the United States on March 8, 1859. The reservation proper consists of approximately 1.3 million acres. Fishing, hunting and gathering still play an important role in the traditional and spiritual lives of the people of the Yakama Nation but modern agriculture, forestry, and range management have also been promoted.

The forested area consists of 613,201 acres. It is subdivided into the commercial general forest, wildlife winter habitat, the watershed reserve, the primitive area, old growth, and other special use areas. The shrub step rangelands, forest fringe areas, and forest openings occupy an additional 456,000 acres. The commercial agricultural area is located primarily on the valley floor of the lower Yakima Valley. All commercial crops are irrigated, with the exception of some naturally sub-irrigated pasture. The Wapato Irrigation project has the capability of delivering water to over 141,000 acres of cropland with a designated water right. In addition they also provide some rental water to users within the reservation without a water right designation. The value of non-forest agricultural crops grown on the reservation exceeds 100 million dollars annually. The value of forest products exceeds 40 million dollars annually.

The soil survey of the irrigated area was published in 1976 from data that was collected in the late 1960's. This survey is used extensively as a basic resource document to address the many land use issues of the Yakama Nation in the irrigated area. The survey however, has been declared out-of-date by the Natural Resource Conservation Service and is in need of updating in order to keep pace with resource planning needs. Interpretations relating to the use of soil survey on the Yakama Nation take many forms but central to broad planning is the use of thematic maps. Attributes are generally derived or modified from existing survey data. They are then placed into a database, other than NASIS, to be linked to the tribes GIS which is ArcInfo driven. The reservation is divided into two National Cooperative Soil Survey areas. It envisioned, after the completion these soil surveys that NASIS will be populated and the tribe will draw on that data for future planning.

Some current uses of the survey include, but are definitely not limited to, burned area rehabilitation, reclamation of saline-sodic soils, and forest harvest effects resource mitigation measure development. Examples of thematic maps provided to Interdisciplinary Team (IDT) members for forest harvest projects include soils by Available Water Holding Capacity, Soils by Drainage Class, and Soils by Depth Class. IDT members include silviculturists, wildlife and fisheries biologists, road engineers, cultural resource specialists, and hydrologists. Each thematic map, in addition to the soils theme, provides the user with location coordinates, major roads, and hydrography. The maps provide valuable soil information which, is used to expedite the planning process. They also become part of the permanent record of each environmental assessment required by the provisions of the National Environmental Policy Act (NEPA) for each logging unit.

The Yakama Nation is moving into the future with a strong desire to protect resources and maintain its unique identity and connection with traditional and cultural values. In order to do this it has instituted integrated resource management planning and maintains a competent natural resource technical staff. The soil survey has been recognized as one of the primary resource documents required to support informed long range planning decisions.

Testing and Evaluating Soil Interpretation Criteria--*Joyce M Scheyer, NSSC, Lincoln, NE*

Summary and Recommendations of NSSC Criteria Committee

Our team was appointed to address a Soil Survey Division Priority. Our assignment is a response in part to comments received by NSSC from states and other users concerning difficulties in understanding and using the interpretations as they currently exist. Our recommendations will form the basis for updating the rest of the interpretations criteria to meet user needs.

At this time soil survey interpretations do not address interactive effects of soil properties so the resulting ratings reflect the single soil property that dominates soil behavior for a selected land-use. The first soil property that is most suitable (or limiting) has the greatest influence on soil behavior and subsequent properties cannot mitigate the effect of the first.

Recommendations
1: Expand interpretation criteria to address interactive effects of soil properties,
2: Clarify the hierarchy of soil properties and the weight of each in the rating.

There is a need for some nationwide rating systems for resource inventory that use standardized criteria and standardized interpretations for a specific set of soil behaviors. This national need remains central to NRCS programs and is not in conflict with the current question of national or locally tailored criteria, interpretations, and land-uses.

Recommendations
3: Develop a naming system to identify nationwide rating systems for resource inventory (with standardized criteria and standardized interpretations) as independent from local and regional criteria and interpretations for individual land-use decisions.

Testing and Evaluating Soil Interpretation Criteria

In the future there could be a wide variety of thresholds and weightings for each soil property together with many choices of which properties to group together for any number of land-use ratings. Future expansion of the criteria depends on a creative and visionary research program to provide local and regional models of systematic changes in soil behavior.

Recommendations

4: Establish and support a creative and visionary scientific research program to provide local and regional models of systematic changes in soil behavior.

Summary of Process for Reviewing Criteria

We developed seven points to review for each interpretation:

- List influential soil properties and the ranges used in evaluations currently in NASIS.
- Assume that the science behind the choice of properties and ranges is still valid.
- Determine which soil properties are no longer needed in the interpretation and which need to be added (see local interpretations for variations in the properties)
- Compare national "template" for interpretation to examples of locally tailored interpretations (i.e. seepage based on permeability at a certain depth for drainlines). Flag the documentation where local specifications or regulations differ most often.
- Search for "new" criteria. Newer or better criteria may already be identified for specific uses.
- Is the goal for states to borrow and adapt from each other's locally tailored interpretations rather than from a national template? Are national templates still needed for new interpretations to provide a starting set of soil properties and ranges for states to tailor? Do we need a standard naming system so that states can find each other's tailored interpretations on the same subject?

Assess the problems or questionable areas of the whole interpretation criteria process

APPLICATIONS OF SOIL SURVEY DATA

Geochemical Analysis in the USDA-NRCS Soil Survey Laboratory-- *M.A. Wilson, R. Burt, and M.D. Mays, USDA-NRCS, Lincoln, NE*

The current analytical program for major and trace elemental analysis at the USDA-NRCS Soil Survey Laboratory (SSL) originated in 1993 with a request for trace elemental data for soils from a survey area in the western U.S. Since that time, the demand for these data has continued and the laboratory has developed the analytical methodology for these elements.

There is considerable application for these data to the National Cooperative Soil Survey and the soil's community in general. The need for general assessment of the concentration of particular elements is part of the established concept of soil quality. Understanding the background or current concentration of trace elements provides information for evaluation of soils related to the suitability for crop, forage, or livestock production. These data are necessary for determining levels of waste (manure, sludge, and effluent) that may be safely applied to soils. On-going monitoring allows for the evaluation of degree or risk of contaminants moving off-site. Relative to production soil survey (soil characterization and mapping), trace and major elemental data can also be used to help design or define ranges of soils or mapping units. Pedon or landscape genetic processes can be evaluated, such as the direction or extent of weathering or source of parent materials.

Elements in soils can be divided into three sources; lithogenic (from parent materials), pedogenic (redistribution by soil forming processes), or anthropogenic (inputs resulting from mining, agriculture, urbanization, or industrial activities). The first two sources exhibit systematic variability, while the later source typically exhibits random variability across the landscape. Systematic variability is common for many laboratory-measured soil properties that have geologic or pedogenic distribution. The systematic variability of trace elements from natural sources indicates that the soil survey mapping unit delineation, based on the landscape model, can be used to extend the information derived from trace element point data (i.e., analysis of a pedon). Soil survey has identified the most extensive or important soils (and pedons selected from mapping units of those soils) as "benchmark."

Many of the pedons selected for trace element analysis by the SSL have been from soils sampled and correlated as benchmark pedons. Additional information and data must be included with all pedons (benchmark or not) that are analyzed in the laboratory. The minimal data set needed to adequately use and extend the elemental data to represent geographic coverage includes "sampled as" and/or correlated soil name, geo-reference location, morphological description, plus other laboratory characterization data (e.g., pH, total C, particle size, cation exchange capacity, and selective dissolution). Our approach at the SSL is to analyze multiple samples for each pedon to appropriately determine elemental distribution in the soil; at a minimum, the surface, B, and C master horizons. Satellite samples collected around the master pedon are often useful to determine the short range variability of an element, especially those elements derived from anthropogenic sources.

The SSL digests soil samples (ground < 200 mesh) with the use of a microwave oven by two different procedures. One procedure uses a mixture of hydrofluoric, nitric, and hydrochloric acids. This digestion is analyzed for major elements (Si, Al, Fe, Mn, Ca, Mg, Na, P, K, Zr, and Ti). A second digestion involves only nitric and hydrochloric acids, reporting trace elements (Cu, Zn, Cd, Pb, Ni, Mn, Cr, Co, Hg, P, Ba, Be, Sr, Sb, Ag, As, and Se) from the analysis. Thus far, the laboratory has analyzed over 486 pedons (1903 samples) from benchmark, anthropogenically-contaminated, and other important soils. Many of the samples analyzed are from requests by state and MLRA offices on specific projects. Data dissemination has been via project reports to these offices, presentations at meetings, and scientific publications.

Future efforts will extend along several fronts.

(1) The analysis of samples from benchmark pedons currently in the laboratory repository will continue. There are 1,265 pedons in this "benchmark" pool of sampled, previously characterized soils from across the U.S. There are additionally 860 pedons that have been sampled as benchmark soils, characterized in the laboratory, but never correlated. Pending final correlation, these pedons could also be added to the benchmark pool.
(2) We will cooperate with scientists from individual states or MLRA offices to select additional pedons for elemental analysis within their regions. These pedons could be previously-sampled soils with stored samples, pedons selected for sampling for strictly to determine distribution of trace element or pedons that are part of an on-going or update soil survey.
(3) We (Burt and Wilson) are interested in developing field studies of limited geographic extent (e.g., watershed basis) to examine the distribution of trace elements. These studies could be related to natural or anthropogenic distribution of elements. We are willing to come to the study area for initial field work and study design, in addition to sample collection. Any interested states or MLRA offices should submit their requests through the normal channels for NSSC assistance.
(4) A cooperative program with scientists from U.S. Geological Survey is being developed. USGS has historically analyzed trace elements in rock, stream sediments, and, to a lesser degree, soils. There is a new program called "Geochemical Landscapes" within the USGS Mineral Resources Division developed to better understand the geochemistry of soils across the U.S. Initial funding for this project is for initiating and/or completing USGS research projects. Future efforts will be to develop a comprehensive understanding of trace element distribution across the U.S. We believe that a cooperative effort with USGS will benefit both agencies. We have yet to define the roles each agency plays in this process. This will occur over the next few months and may result in a formal agreement. Any activities in which NRCS participates need to be coordinated and also provide benefits for the knowledge of soils in a region as well as for the soil survey program in general. Limited numbers

of samples will likely be collected and analyzed from across the U.S. We must ensure that data produced will represent map able soil areas and this knowledge is usable for future mapping, pedogenetic understanding, and land-use interpretations.

Lead (Pb) Impacts within Urban Soil Interpretations--*Joyce M. Scheyer, NSSC, Lincoln, NE*

1. Soil Pb Content Associated with Measured Soil Properties

Joyce Scheyer[1], David Wilkinson[2], Samantha Langley-Turnbaugh[3]

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ABSTRACT

Our soil characterization study is part of an effort of the Maine Urban Soils Working Group that is a partnership between NRCS, University of Southern Maine, City of Portland, and several other community and neighborhood action groups. The goal of this and future sampling is to gather information concerning urban soils in Portland's Bayside neighborhood and develop interpretations that will be useful in the planning of Bayside's future redevelopment. This area of Portland has a very culturally diverse population of Sudanese, Ethiopians, Cambodian, Vietnamese and others - many of who are recent refugees. The people of this area are using the urban soils for small agricultural systems and they are very involved in helping design the future development of this area including green spaces, recreational areas, and living spaces. The group believes that by gathering information on representative areas in this urban area we will be able to provide valuable assistance and interpretations for future land use. We are committed to continue with our efforts to assist this culturally diverse neighborhood in tying their vision of their future home to the opportunities and limitations of the soil on which they live, work and play.

Soil characterization and trace metals analysis was completed on samples from 60 layers in 8 pedons. Six layers exceeded EPA thresholds for total lead content in soils of residential areas - 1 was a surface layer and 5 were from different subsurface depths at 4 different sites. The spatial distribution of total lead content and the presence of elevated lead levels in subsurface horizons both indicate the need to incorporate soil survey techniques into site-specific environmental risk assessment.

2. Soil Interpretation for Metal Sequestering
Discipline: Urban Soils and Public Health
Draft 5/2001

Metal Sequestering Capacity is high (toxicity for human health is low) when:
Active microbes and enzymes are present
.AND organic carbon is active and present
.AND aerated
AND acidity is in optimal range
.AND toxins are inactive or absent
.AND competitive plant uptake is absent

Rules	Evaluations
1. microbes are active	temperature
	moisture
	energy supply
2. organic carbon is active	OC present
	humic/fulvic active sites open
3. soil is aerated	porosity
4. soil is acid	pH is low
	$CaCO_3$ absent
5.toxins absent	metal amounts are low
	metals present but not available
6. plant competition absent	competitive plants absent
	non-competitive plants present
	competitive plants have needs met

Comments and suggestions are welcome to
Joyce M. Scheyer Joyce.scheyer@nssc.nrcs.usda.gov

Beyond Thematic Maps - Spatial Interpretations--*Steve Peaslee, GIS Specialist, NSSC, Lincoln, NE*

Introduction

Too often we think of GIS as just a cartographic tool used to create pretty, thematic maps for hanging on the wall. How can we modify this kind of thinking? An exercise was developed to show how GIS could be use to generate the exact information required to fill out the form for *Farmland Conversion Impact Rating (AD-1006)*. The AD-1006 is used by NRCS in the implementation of the *Farmland Protection Policy Act*.

Background Information

The Farmland Protection Policy Act (FPPA) came out of the *National Agricultural Land Study of 1980-81*, which found that every year, a tremendous amount of farmland was being converted to other uses. To ensure that the Federal government was not responsible for unnecessarily converting valuable farmland, the FPPA set up guidelines for the NRCS and other Federal Agencies. These guidelines help produce an unbiased, scientific evaluation that can identify the potential site that would be best retained in agricultural production. This two-part evaluation is called the Land Evaluation and Site Assessment System. Information for the Land Evaluation portion of the rating has to be developed by the NRCS. The Federal Agency involved in the potential conversion is responsible for the Site Assessment.

In the past, the AD-1006 was filled out using information obtained by time-honored and time-consuming tools such as dot counters or planimeters. Currently, NRCS software called *CALES (Computer Assisted Land Evaluation System)* is available on-line and can be used to estimate the relative value of each map unit in the soil survey. The AD-1006 is also available on the Internet. In the future, where SSURGO data is available, GIS can be used to develop the remainder of the required information. This will serve to bridge the gap between CALES and the AD-1006.

Fictional Scenario

The Nebraska Department of Transportation is planning to build a rest area, southeast of Lincoln along Highway 2. Four potential sites have been identified in Lancaster County, and the Federal Highway Administration (FHWA) is providing cost-share funds. The FHWA requested an AD-1006 from the NRCS and the Nebraska FPPA coordinator for NRCS was assigned the task of providing technical assistance to them.

The FPPA coordinator had recently received Toolkit and GIS training and thought this might be a good time to test new methods of performing the evaluation.

Normally, NRCS is directly responsible only for the Land Evaluation, but as a test, agreed to assist with the rest of the process. The process was broken down into two steps, the Site Assessment and the Land Evaluation.

Process - Land Evaluation

The CALES program was run for Lancaster County. CALES automatically imported the necessary NASIS data including land capability class and subclass, farm class and acres. Other input data such as major crop, conservation measures and practice costs, were obtained from the FOTG. In an interactive mode, each map unit was assigned to one of eleven different groups. For the final step in CALES, each group was assigned a Relative Value. The results from this on-line worksheet were saved and printed.

The information was then converted for use in the GIS. A new table called RV_table was created using ArcInfo, containing a unique list of all map units in Lancaster County. A new column was added to the table, and manually populated with the Relative Value for each mapunit from the CALES worksheet.

The R_value table was then joined to the SSURGO polygon coverage for Lancaster County, using MUSYM as the relate column. Next, the Relative Value for Part V in the AD-1006 was calculated for each site in the county. This involved clipping each of the sites from the SSURGO coverage into four separate polygon coverages. The Relative Value of the site was calculated as: the sum of the products of each polygon's Relative Value and the polygon's Area, divided by the Total Area of the site.

Process - Site Assessment

The site assessment portion of the procedure was much more involved than the land evaluation. Several days were spent obtaining and preparing the following spatial data: streets, water lines, sewer lines, land use, cadastral, Common Land Unit, Public Land Survey, current FSA digital photography, grain elevators, implement dealerships, and farm supply stores.

Three different departments of county and city government had to be contacted to obtain the required data layers. Because of the terrorist attacks of September 11, access to some information such as water lines, has become even more restricted. Layers for grain elevators, implement dealerships and farm supply stores did not exist and had to be digitized. All of the data had to be re-projected from a custom projection used by the county, to the UTM projection used by NRCS. Some data also had to be converted from CAD to GIS format. A few of the layers, such as cadastral, existing in separate files, tiled by section number. For analysis, these files had to be edge-matched and merged from thirty-eight files into a single file. The project required nearly 400 MB of disk space.

Using the criteria outlined in the instructions for the AD-1006, an ArcInfo® macro was written to perform all of the spatial operations and calculations. The macro was run, and the average processing time for each site was less than six minutes. The macro's final output was in the form of text files, containing each of the elements to be entered on the AD-1006. The text files could be imported into a spreadsheet or used as is.

Summary

GIS works well when generating this type of information because it takes most of the bias out of the process. It forces the development of clearly defined criteria that can be entered into a formula for the GIS to use. Developing new GIS applications for the FPPA may be practical for those areas where data already exists, or there is enough demand to justify the expense of data preparation and development.

Example of output from GIS program, report for Site A. This comma-delimited text file can be imported into a spreadsheet or transferred to Form AD-1006.

```
LESA SCORES FOR, SITE_A, Monday October 07 2002 8:47 AM
SECTION,DESCRIPTION,POINTS
Part II-3, Does site_a contain prime or important farmland?,
YES
Part II-4, Acres Irrigated, 0.0 acres
Part II-5, Average Farm Size, 289.0 acres
Part II-6, Major Crop(s), Corn
Part II-7, Farmable Land in County, 469714.2 acres or 86.7
percent
Part II-8, Amount of Farmland as defined in FPPA, 237778.6
acres or 44 percent
Part II-9, Name of Land Evaluations System Used, LESA_GIS
Part II-10, Name of Local Site Assessment System, GIS_SA
Part III-A, Total Acres to be Converted Directly, 71.3 acres
Part III-B, Total Acres to be Converted Indirectly, 0 acres
Part IV-A, Total Acres Prime and Unique Farmland, 46.4 acres
Part IV-B, Total Acres Statewide and Local Important Farmland,
0.0 acres
Part IV-C, Percentage of Farmland in County to Be Converted,
0.030%
Part IV-D, Percentage of Farmland with Same or Higher Value,
75.3%
Part V, Relative Value of Farmland to be Converted, 49
Part VI-1, Area in Non-urban Use, 6
Part VI-2, Perimeter in Non-urban Use, 1
Part VI-3, Percent of Site Being Farmed, 20
Part VI-4, Protection Provided by State and Local Government, 0
Part VI-5, Distance from Urban Built-up Area, 0
Part VI-6, Proximity to Urban Support Services, 0
Part VI-7, Size of Present Farm Unit compared to Average, 0
Part VI-8, Creation of Nonfarmable Farmland, 0
Part VI-9, Availability of Farm Support Services, 5
Part VII-A, Relative Value of Farmland, 49
Part VII-B, Total Site Assessment, 32
Part VII-C, Total Points, 81
```

Contact Information

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Links

LESA-CALES
http://nasis.sc.egov.usda.gov/cales

Penn State
http://www.gis.psu.edu/outreach/lesa

Ohio
http://www.co.geauga.oh.us/departments/planning/farmland/plan/farmland.htm

Wisconsin
http://www.co.dane.wi.us/landconservation/lesabnd.htm

Revised Universal Soil Loss Equation RUSLE2 Demonstration - Mini Session --- *David T. Lightle Conservation Agronomist and National Database Manager for Erosion Prediction Tools, National Soil Survey Center, Lincoln, NE*

This presentation includes a demonstration of the new Revised Universal Soil Loss Equation (RUSLE2) model that is being implemented in all NRCS field offices during the first part of FY 2003. RUSLE2, which is a Windows based computer model replaces the Universal Soil Loss Equation (USLE) and RUSLE1 materials contained in the NRCS Field Office Technical Guide used for conservation planning activities on lands with sheet and rill erosion problems.

The demonstration includes a discussion of the various screens to which a user may enter or select data to make soil loss runs. The first is the profile screen that is used to pick inputs from dropdown menus for climate location, soil component, slope length and grade, management system used and support practices. Details of the database structure and content of each of these major inputs is briefly discussed and displayed.

The next level is the field worksheet screen that provides a method for developing and displaying various runs for the same profile or slope length "L" for a given field or conservation treatment unit. All of the selected inputs for a run are displayed in spreadsheet format on separate lines for each run or alternative combination of management, support practice and input variables.

The next level is the plan screen to which selected runs or lines from one or more field worksheets can be "posted". This screen is the place to summarize all the alternatives for all fields or treatment units on a farm. It can be used to create a planning alternatives sheet for use during conservation planning or as a documentation sheet for saving in the producer's folder in Customer Service Toolkit.

Next, the database development process for RUSLE2 is discussed detailing the development and flow of data, and the responsibilities for various parts of the database. Included are the climate data, soils data, management templates, support practices and the underlying plant data included in the vegetations database and the data underlying the field and tillage operations database.

The presentation concludes with a demonstration of the process of importing soils data into RUSLE2 from the NASIS SSURGO download files. Included will be a discussion of some of the soils database issues encountered along the way, which specific soil properties are required for RUSLE2 and how the model displays and uses the data.

Importing Soils Data From an External NASIS Download File

Preparing the soils data

Before RUSLE2 can import soils data from NASIS downloads, the data required by RUSLE2 must first be populated in NASIS and a download performed and formatted in a MS ACCESS (SSURGO) template by the soil scientists. The files containing the soils data for each county provided by the soil scientist can be opened in MS ACCESS to verify that the data is there.

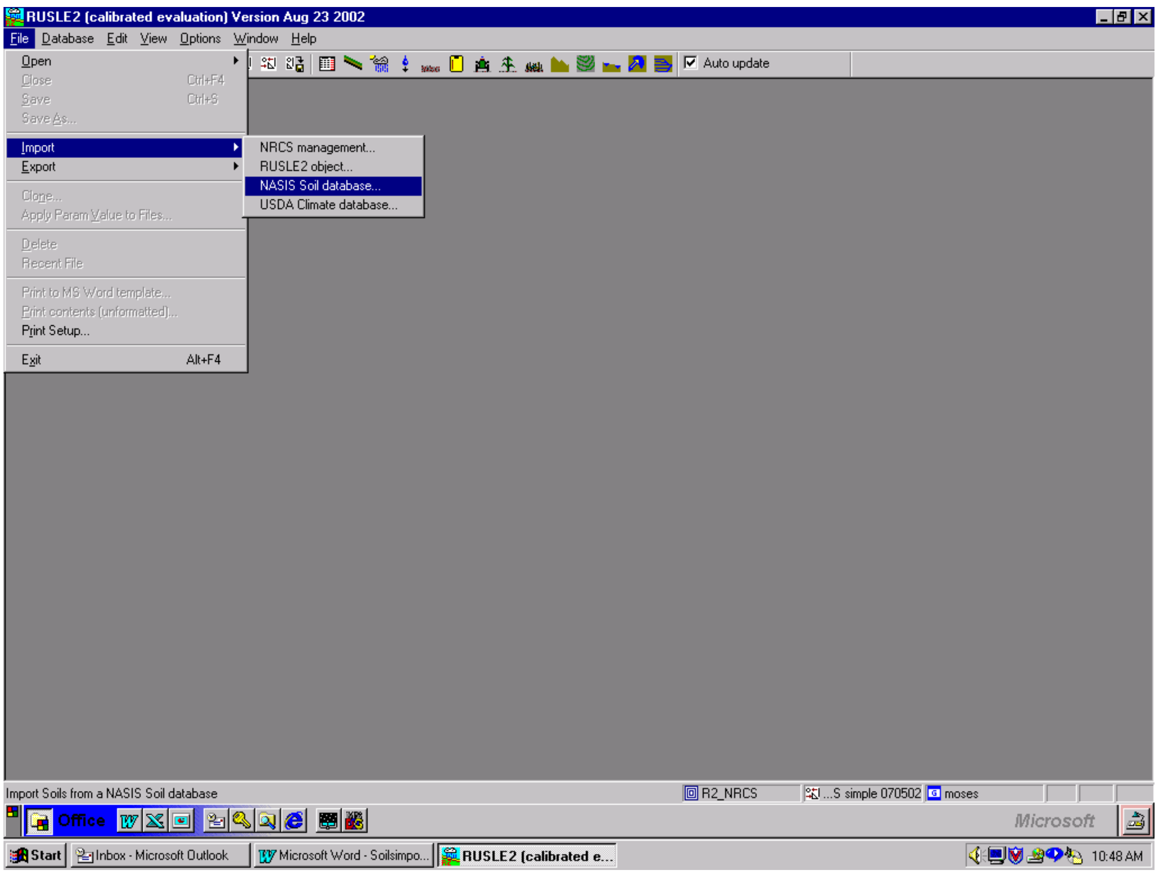
In order to deliver the RUSLE2 soils data on a county by county basis, all data for all map units and components for each county or soil survey area must be contained in a separate SSURGO download file and then separate RUSLE2 imports and exports performed. When the NASIS downloads are created and formatted in the SSURGO template by the soil scientists, the resulting *.mdb file should be named for the county or soil survey area. This same name should be used through out the RUSLE2 import and export process. The RUSLE2 import selects all components of map units composing 15% or more of the map unit. Minor components are not loaded and are ignored. Soils with missing data will have records created but they will not run in a soil loss run in profile or worksheet views.

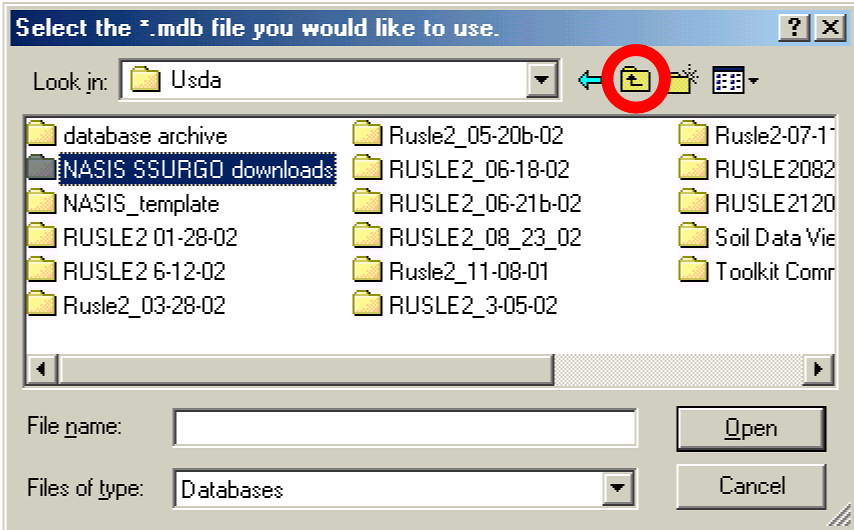
The SSURGO download files should be loaded on the computer and if copied from a CD the read only permissions should be removed.

IMPORTING from the NASIS SSURGO download file.

The RUSLE2 soils data creation is a two step process involving importing from an external SSURGO download file and then exporting in the RUSLE2 file format in order to move the soils data to the National RUSLE2 WEB site and out to Field Office and private consultants computers

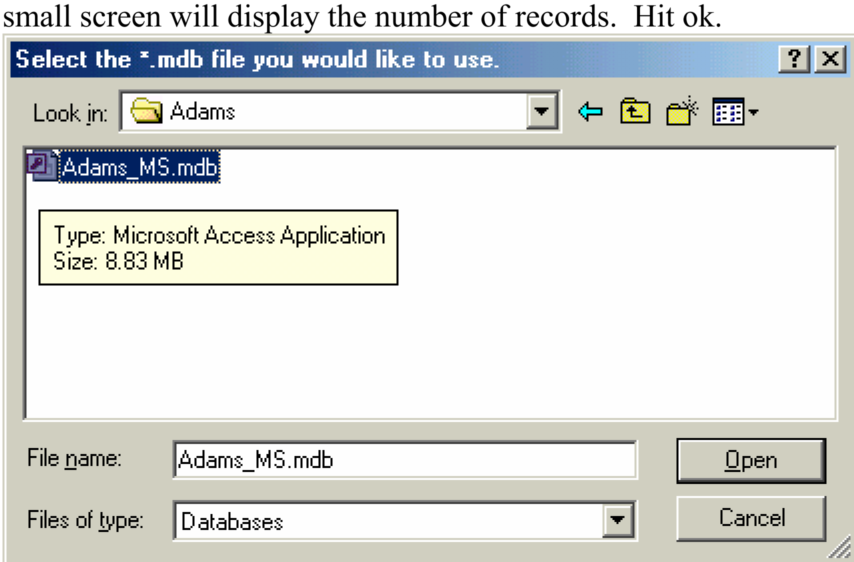
Since the SSURGO file is an external file in a different database format than the RUSLE2 database, one goes to “FILE / IMPORT / NASIS Soils database…..to start the import.


RUSLE2 (calibrated evaluation) Version Aug 23 2002
File
Database
Edit
View
Options
Window
Help
Open
Close Ctrl+F4
Save Ctrl+S
Save As...
Import
Export
Clone...
Apply Param Value to Files...
Delete
Recent File
Print to MS Word template...
Print contents (unformatted)...
Print Setup...
Exit Alt+F4
NRCS management...
RUSLE2 object...
NASIS Soil database...
USDA Climate database...
Auto update
Import Soils from a NASIS Soil database
R2_NRCS
...S simple 070502
moses
Start
Inbox - Microsoft Outlook
Microsoft Word - Soilsimpo...
RUSLE2 (calibrated e...
10:48 AM

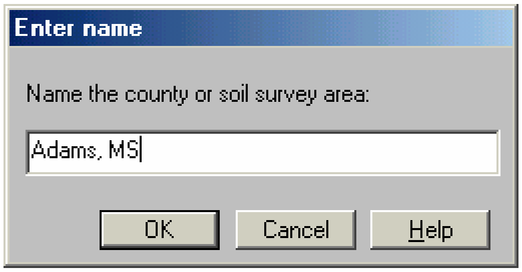


The first screen asks what *.mdb file you wish to use. You must then use the yellow folder with the up arrow to navigate to the directory on the hard drive where the NASIS download files are located. This may require several mouse clicks to open the correct folder to get to the file containing the information, for example:"Adams_MS.mdb".

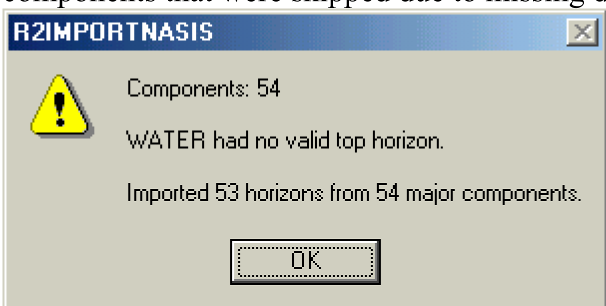
Select the file with one left click and hit "open" in the lower right corner of the screen. A small screen will display the number of records. Hit ok.



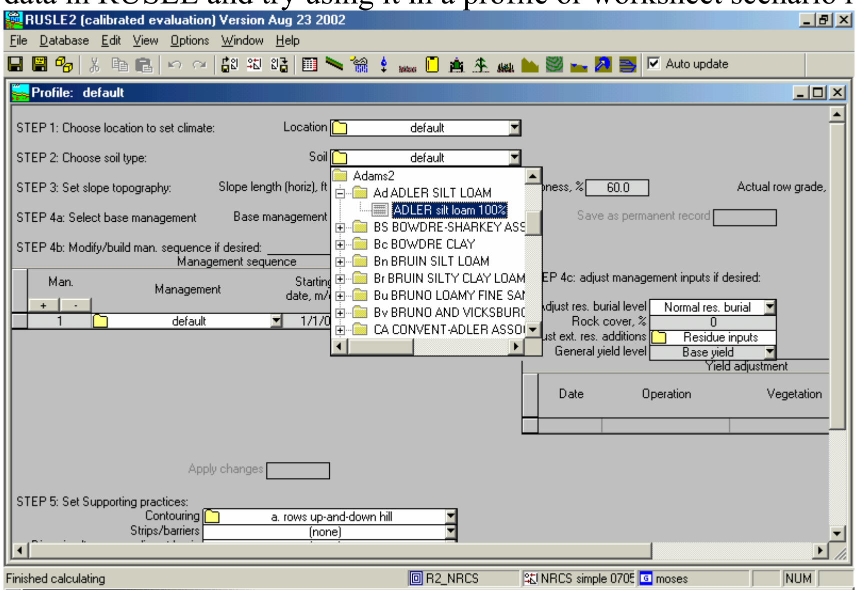
Next you must give a name to the table being created in the RUSLE2 database which will contain the data to be imported. Type the name of the county or soil survey area and hit OK.



The import will begin and take a few seconds while the names of components are rapidly displayed at the bottom of the screen. A report will be displayed indicating any components that were skipped due to missing data.

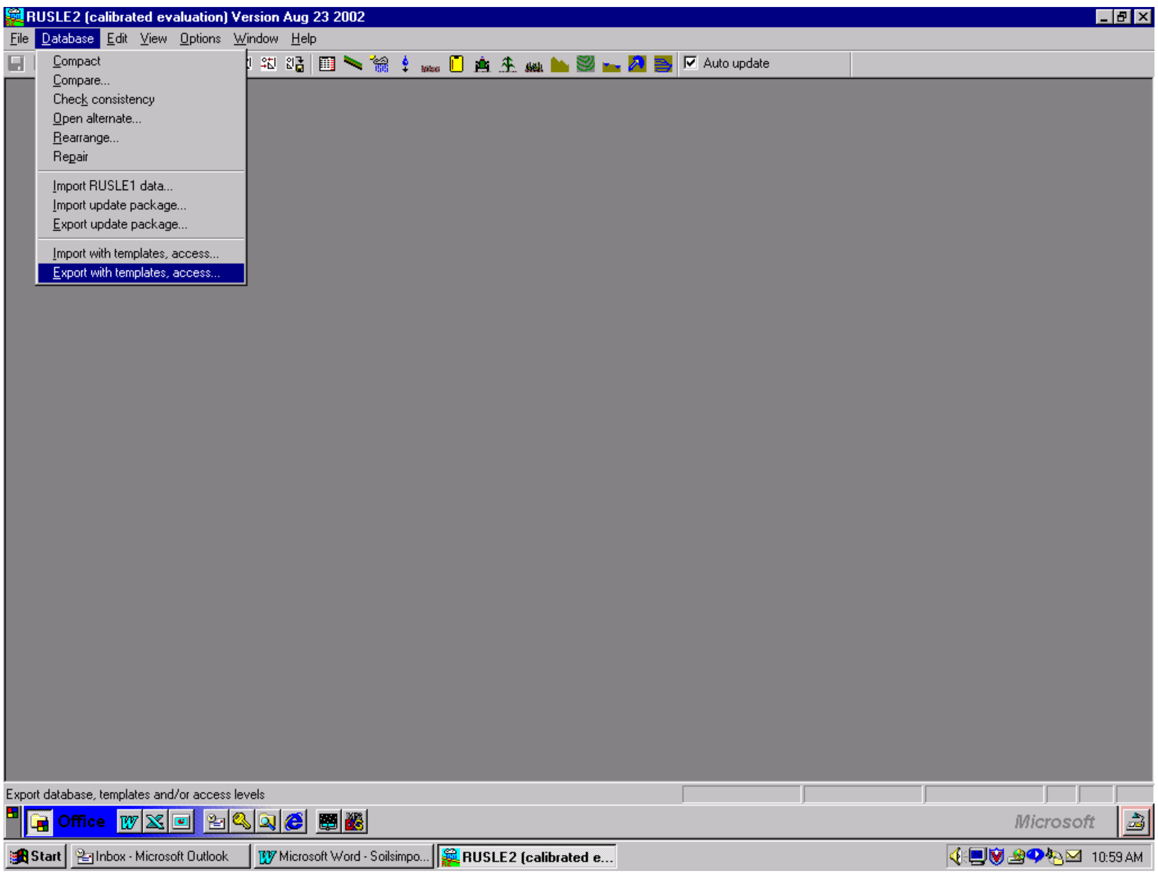


After noting any problems, hit OK. The import is now complete and you can check the data in RUSLE and try using it in a profile or worksheet scenario run.



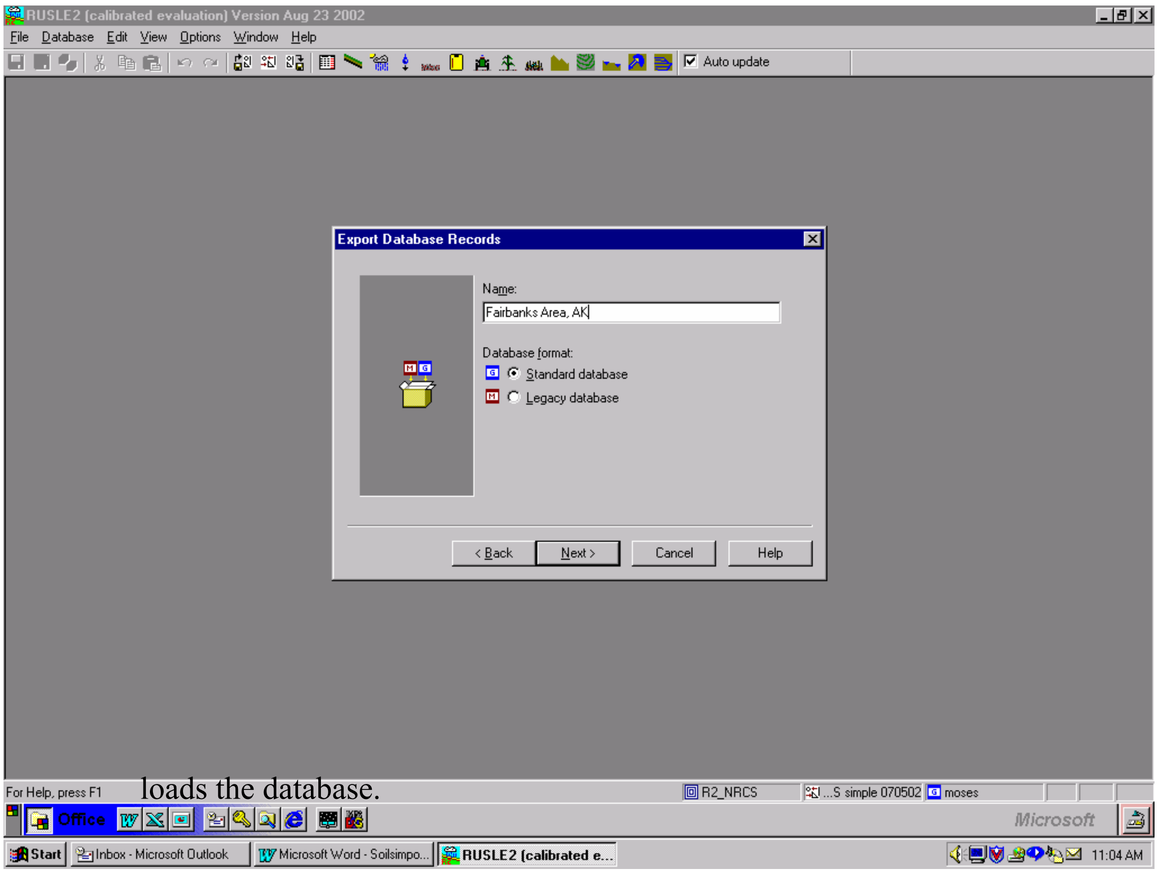
Exporting Soils data from the RUSLE database to a file
Since the RUSLE2 soils import process does not create a separate file for each survey or county, the data is actually contained in tables within the RUSLE2 moses.gdb database file. In order to move this data in useful "chunks' from one computer to another and to the Official RUSLE2 WEB site, we must create an "export file for each soil survey area or county. I strongly encourage you to do the export immediately after you do the soils import into RUSLE2 while you have the county name in mind. Remember this is a two step process and performing the two steps in sequence one right after the other for each county will insure you don't omit anything.

This time, since we are wanting to create a file containing only part of the RUSLE2 data in the RUSLE2 database format, we go to Database \ Export with template, access…..



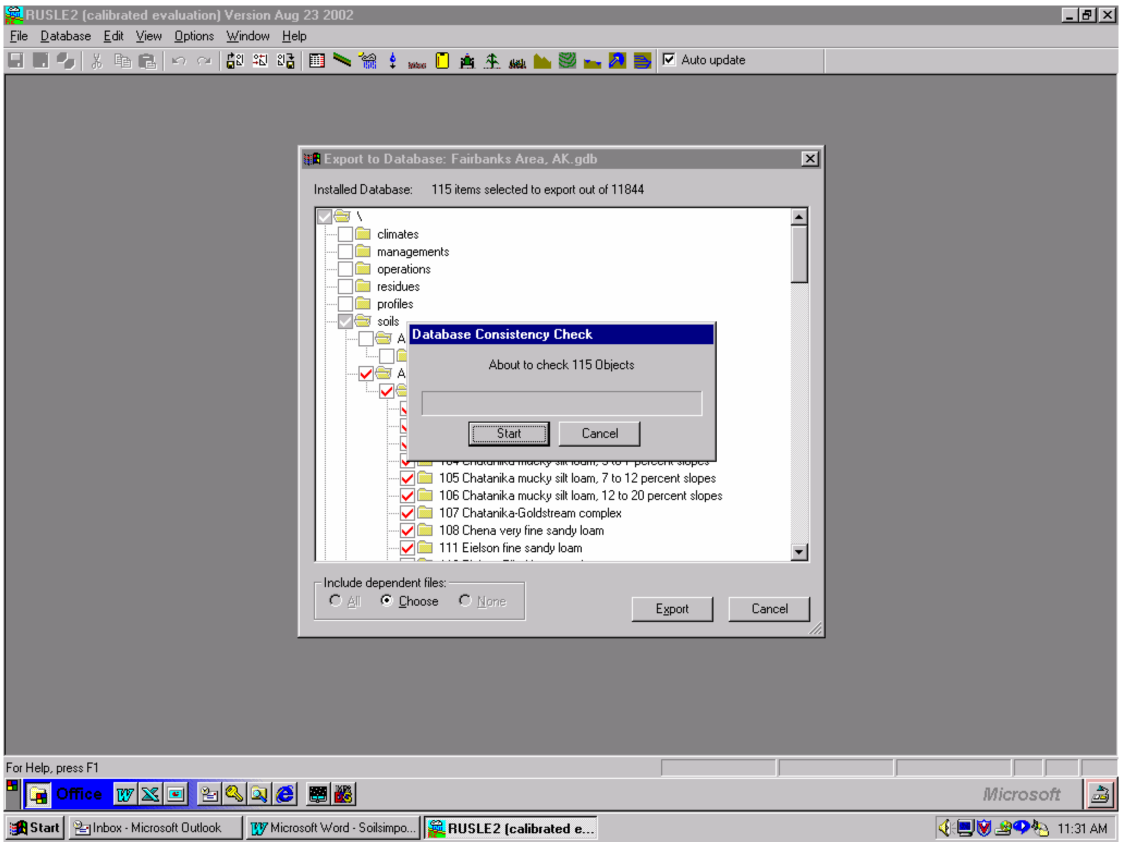
We then select the “G” database records and ignore the other boxes and click **Next**

Next we need to give the export file a name. In this case we use the name of the county or soil survey area followed by a comma, a space and the state abbreviation. Leave the “G” database format checked. Then hit next and Finish and be patient while the program loads the database.

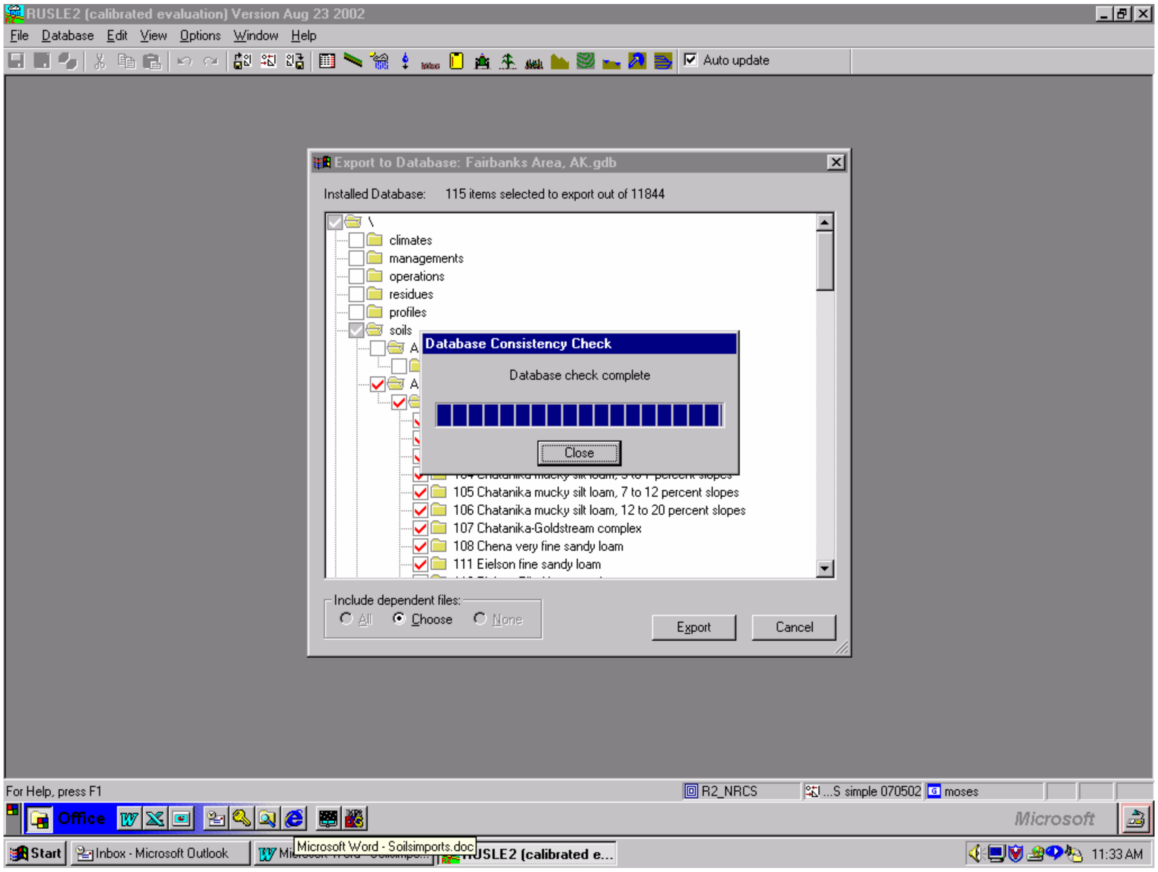


The next screen shows all the various parts of the RUSLE2 database from which we must choose specifically what we want to include in the export file. It is like going shopping and picking items from the grocery store shelf to put in the shopping cart.

Put a check in the box opposite the county folder containing all the map units and components to be exported. Then hit export.



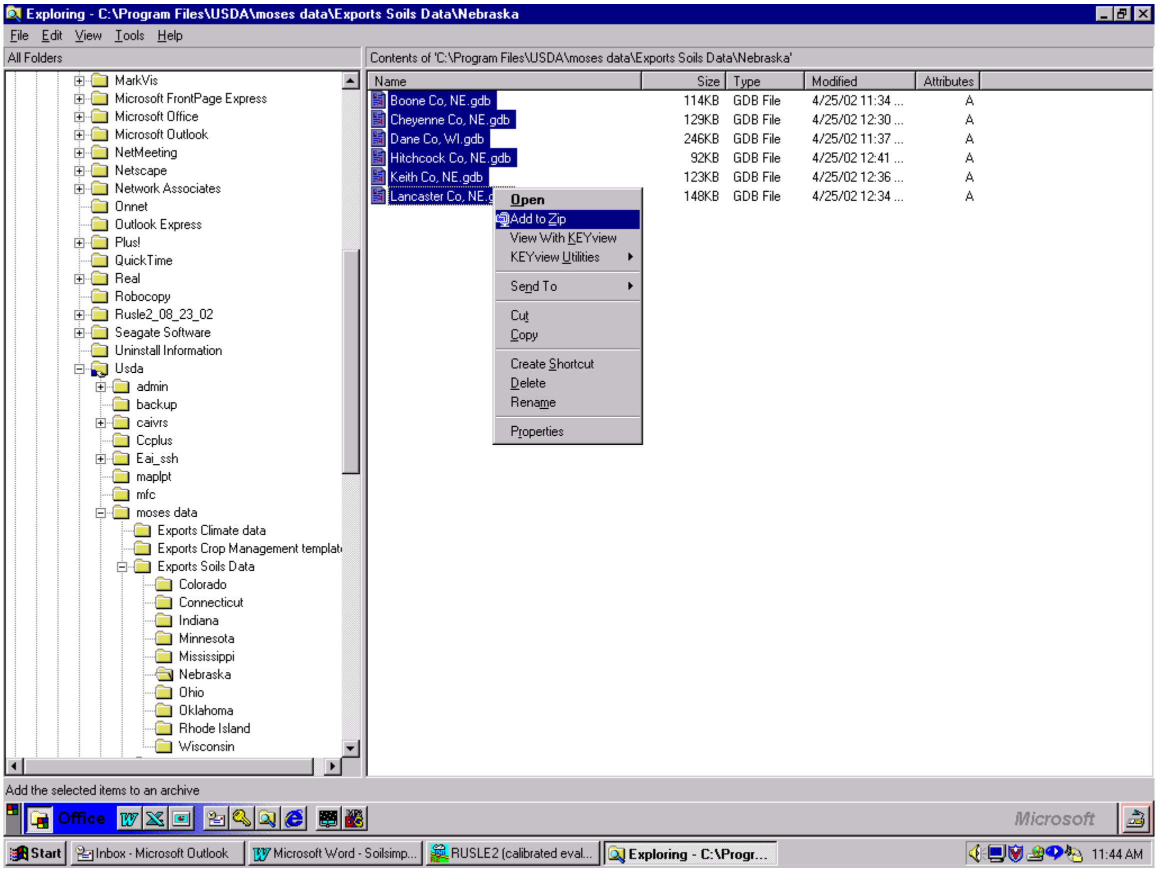
The export will run and then the database consistency check box will be displayed. Hit start and let it run. Then hit close.



The export file is created and saved in the Program files / Rusle2 / Exports folder. You can verify this by opening Windows explorer and looking for it.

You should create a folder using Windows Explorer for the state and move all county soils export files to that folder after completion.

After all the export files are created, they can all be selected and zipped into a zip file using WinZIP in Windows Explorer for sending to the database manager.



Highlight the export files, right click, select add to zip, give it a name and hit ADD and a zip file will be created containing all the individual exports. Send this file to the database manager. dave.lightle@nssc.nrcs.usda.gov .

EBI Criteria (CRP) Seminar—*Russ Kelsea, National Leader, Technical Soil Services, NSSC, Lincoln, NE*

FSA-CRP Data Generation
As Built Documentation
Soil Survey Division
October 2002
Compiled by Dorn Egley, ITC, Ft. Collins, CO

Introduction
As built documentation for a function that creates a file with only 10 attributes per record might be overkill. I decided to do it because a number of the derivation specifications have changed from those described in the original "FY2003 CRP Sign-up" document (data_specs4.doc) that I received from Russ Kelsea. In some cases, additional decisions about how to derive a particular value had to be made.

Since someone may yet end up creating this same process in a NASIS report, I thought that perhaps I should document the derivation rules that I actually implemented. In addition to my explanation of each individual derivation, I have included a copy of my code, as a sort of ultimate "ground truth".

Below is the format of the table/file that is generated from the MS Access SSURGO template database. This table is straight out of Russ' document.

Column Position	Column Label	Definition
1	stcty	Concatenated state code (alpha FIPS) and county code (numeric FIPS) (variable character, maximum length 5). Not NULL.
2	ssaid	Soil survey area ID (variable character, maximum length 5). Not NULL
3	musym	Mapunit symbol (variable character, maximum length 6). Not NULL.
4	mu_lleaf	Partial criteria for long leaf pine suitability (character, maximum length 1). Domain Y, N. Not NULL.
5	mu_leach	Partial N2b criteria – undrained leaching index (integer, maximum length 1). Domain is 1, 2, 3 or null.
6	mu_ifactor	Partial N5a criteria – wind erodibility index (integer, maximum length 3). Domain 0, 38, 48, 56, 86, 134, 160, 180, 220, 250, 310 or null.

7	mu_kfactor	Erodibility factor (floating point, maximum length 1 plus two decimal places). Domain 0.02, 0.05, 0.10, 0.15, 0.17, 0.20, 0.24, 0.28, 0.32, 0.37, 0.43, 0.49, 0.55, 0.64 or null.
8	mu_LS	Topographic factor determined from Agriculture Handbook 703, Table 4-2 (floating point, maximum length 2 plus two decimal places). Domain restricted to values in Table 4-2 or null.
9	mu_tfactor	Soil loss tolerance factor (integer, maximum length 1). Domain 1 – 5 or null.
10	source	Data source flag (character, maximum length 1). Domain (N, S) for records created directly from NASIS or from NASIS export in SSURGO v2 Format. Not NULL

A Note About Representative Values

Many derivations are based in part on one or more derived representative values, or what I refer to as "RV value", i.e. "RV hzdept", "RV om", etc. In every case, the algorithm for deriving the RV value is the same:

```
If value_r is not null then
    return value_r
Else if value_l is not null and value_h is not null then
    return (value_l + value_h)/2
Else
    return Null
End If
```

Whenever a derived RV value is part of the criteria for selecting records, records where the derived RV value is null are always excluded. This is why it is possible that we cannot determine which component to use for a particular map unit.

Data Selection and Output

The FSA-CRP data generation functions always process ALL data that currently resides in the MS Access SSURGO template database. In other words, there is no capability to generate FSA-CRP data for some subset of the data in a template database.

Each output record represents a map unit that occurs in a particular county. The attribute values correspond to the dominant component of that map unit, based on RV percent composition. If there is a tie for dominant component, the component with the lowest key value (cokey) is arbitrarily selected.

If the survey contains more than one map unit with the same map unit symbol, which map unit is selected is based on map unit status, with preference given as follows:

Correlated > Approved > Provisional

Additional symbols are excluded from consideration.

The process of determining what county or counties a map unit occurs in is a multi-part process. If a map unit in a survey area has at least one county record in the Map Unit Area Overlap table (muaoverlap), a record is output for each county corresponding to that map unit.

If a map unit has no county record in the Map Unit Area Overlap table, but the corresponding survey area has at least one county record in the Legend Area Overlap table (laoverlap), a record is output for that map unit for each county corresponding to that survey area.

If a survey area has no corresponding county record in the Legend Area Overlap table, a record is output for that map unit for each record that the corresponding survey area has in the Survey Area-County Geographic Coincidence table (SYSTEM – Survey Area-County Geographic Coincidence).

If a map unit has no county record in the Map Unit Area Overlap table, and the corresponding survey area has no county record in the Legend Area Overlap table, and the corresponding survey area has no record in the Survey Area-County Geographic Coincidence table, NO record for that map unit is output. If this occurs for any map unit, a warning dialog is displayed at the end of the data generation process. Map units for which no corresponding county could be determined are logged in the file named "SYSTEM – FSA-CRP – Warnings and Rejects".

It is also possible that no dominant component for a map unit can be determined. If this occurs for any map unit, a warning dialog is displayed at the end of the data generation process. Map units for which no dominant component can be determined are also logged to the table named "SYSTEM – FSA-CRP – Warnings and Rejects". As long as a corresponding county can be determined, such a map unit is output, but the values of all FSA-CRP criteria attributes will be null.

Derivation of Each Attribute
stcty

If this map unit has at least one corresponding county record in table "muaoverlap", then the value of "stcty" is set to "laoverlap.areasymbol" for each corresponding map unit area overlap record. In other words, if this map unit has more than one county record in table "muaoverlap", more than one record for this map unit will be output.

If this map unit has no corresponding county record in table “muaoverlap”, then the value of “stcty” is set to “SYSTEM - Survey Area-County Geographic Coincidence.stcoid” for each record that the corresponding survey area has in table “SYSTEM - Survey Area-County Geographic Coincidence”. In other words, if the corresponding survey area has more than one record in table “SYSTEM - Survey Area-County Geographic Coincidence”, more than one record for this map unit will be output.

If the map unit has no corresponding county record in table “muaoverlap”, and the corresponding survey area has no corresponding record in table “SYSTEM - Survey Area-County Geographic Coincidence”, no record for this map unit will be output. Map units for which no corresponding county can be determined are logged to table “SYSTEM – FSA-CRP – Warnings and Rejects”, and the user is notified.

ssaid

The value of “ssaid” is always set to the value of “legend.areasymbol” of the legend record corresponding to this map unit.

musym

The value of “musym” is always set to the value of “mapunit.musym” of the corresponding map unit record.

mu_lleaf

All fields used in this derivation are from the selected component of the corresponding map unit.

If longleaf pine is explicitly referenced (“table.plantsym” = “PIPA2”) in any of the following tables for this component, return “Y”:

Component Trees to Manage (cotreestomng)
Component Existing Plants (coeplants)
Component Forest Productivity (coforprod)

Else if all of the following are true, return “Y”:

There is no soil moisture layer where RV moisture layer depth to top is < 30 cm and “cosoilmoist.soimoiststat” = “Wet”.

There is at least one soil layer where RV horizon depth to top is < 30 that has one of the following soil textures:

coarse sand
sand
fine sand

very fine sand
loamy coarse sand
loamy sand
loamy fine sand
loamy very fine sand
coarse sandy loam
sandy loam
fine sandy loam
very fine sandy loam

There is no soil layer where RV horizon depth to top is < 30 cm and (RV pH 1:1 H2O >= 6 or RV pH 1:1 H2O is null).

Else return “N”.

In a final step, upon output, suitability for long leaf pine is automatically reset to “N” unless the corresponding county occurs in the list of counties contained in table “SYSTEM – Long Leaf Pine Counties”.

mu_leach

All fields used in this derivation are from the selected component of the corresponding map unit.

If “component.taxorder” = “Histosols”, return 1.

Else if “component.hydgrp” is not null, and “component.hydgrp” is in (“D”, “A/D”, “B/D”, “C/D”), return 1.

Else if “component.hydgrp” is not null, and derived “kval” (see below) is not null, and derived “calc” (see below) is not null, return Undrained Leaching Index based on the following formula:

```
If (hg = "D" Or hg = "A/D" Or hg = "B/D" Or hg = "C/D") Or
 (hg = "C" And calc <= 10000 And kval >= 280) Or
 (hg = "C" And calc >= 10000) Or
 (hg = "B" And calc >= 35000 And kval >= 400) Or
 (hg = "B" And calc >= 45000 And kval >= 200) Then
   mu_leach = 1
ElseIf (hg = "A" And calc <= 30000) Or
 (hg = "B" And calc <= 9000 And kval <= 480) Or
 (hg = "B" And calc <= 15000 And kval <= 260) Then
   mu_leach = 3
ElseIf (hg = "A" And calc > 30000) Or
 (hg = "B" Or hg = "C") Then
   mu_leach = 2
```

End If

Else return null.

OK, the first line of the formula appears to be redundant with the second if clause. Sue me.

The attribute "calc" is defined as:

RV organic matter * (RV horizon depth to bottom / 2.54) * 1000

The attribute "kval" is defined as:

"chorizon.kwfact" * 1000

RV organic matter, RV horizon depth to bottom and "chorizon.kwfact" are all from the first layer where "chorizon.kwfact" is not null, "chorizon.desgnmaster" <> "O" and RV organic matter <= 35, and layers are sorted by RV horizon depth to top ascending, "chorizon.kwfact" descending. If no layer meets this criteria, RV organic matter, RV horizon depth to bottom and "chorizon.kwfact" are all null, and therefore "calc" and "kval" are null.

mu_ifactor

If "component.wei" for the selected component of the corresponding map unit is not null, return "component.wei".

Else if "component.wei" for the selected component of the corresponding map unit is null, but "component.weg" is not null, return the value of I Factor based on the following lookup table.

WEG	I Factor
1	220
2	134
3	86
4	86
4L	86
5	56
6	48
7	38
8	0

Else if "component.wei" and "component.weg" for the selected component of the corresponding map unit are both null, return null.

mu_kfactor

The intent for K Factor is to return K Factor for the first mineral layer of a soil that is not a Histosol. All fields used in this derivation are from the selected component of the corresponding map unit.

If “component.taxorder” = “Histosols”, return null.

Else select the first layer where either “chorizon.kffact” or “chorizon.kwfact” is not null, “chorizon.desgnmaster” <> “O” and RV organic matter <= 35, and layers are sorted by RV horizon depth to top ascending, “chorizon.kffact” descending and “chorizon.kwfact” descending. If “chorizon.kffact” is not null, return “chorizon.kffact”, else return “chorizon.kwfact”.

If no layer meets the selection criteria, return null.

mu_LS

All fields used in this derivation are from the selected component of the corresponding map unit.

If RV slope is null, return null.

Else establish RV slope length and lookup LS Factor using RV slope and RV slope length using the following table:

Slope Range	Slope Length in feet																
	>= 0 & < 4.5	>= 4.5 & < 7.5	>= 7.5 & < 10.5	>= 10.5 & < 13.5	>= 13.5 & < 20	>= 20 & < 37.5	>= 37.5 & < 62.5	>= 62.6 & < 87.5	>= 87.5 & < 125	>= 125 & < 175	>= 175 & < 225	>= 225 & < 275	>= 275 & < 350	>= 350 & < 500	>= 500 & < 700	>= 700 & < 900	>= 900
>= 0 & < 0.35	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.05	00.06	00.06	00.06
>= 0.35 & < 0.75	00.07	00.07	00.07	00.07	00.07	00.08	00.08	00.08	00.09	00.09	00.09	00.09	00.09	00.10	00.10	00.10	00.10
>= 0.75 & < 1.5	00.11	00.11	00.11	00.11	00.11	00.12	00.13	00.14	00.14	00.15	00.16	00.17	00.17	00.18	00.19	00.20	00.20
>= 1.5 & < 2.5	00.17	00.17	00.17	00.17	00.17	00.19	00.22	00.25	00.27	00.29	00.31	00.33	00.35	00.37	00.41	00.44	00.47
>= 2.5 & < 3.5	00.22	00.22	00.22	00.22	00.22	00.25	00.32	00.36	00.39	00.44	00.48	00.52	00.55	00.60	00.68	00.75	00.80
>= 3.5 & < 4.5	00.26	00.26	00.26	00.26	00.26	00.31	00.40	00.47	00.52	00.60	00.67	00.72	00.77	00.86	00.99	01.10	01.19
>= 4.5 & < 5.5	00.30	00.30	00.30	00.30	00.30	00.37	00.49	00.58	00.65	00.76	00.85	00.93	01.01	01.13	01.33	01.49	01.63
>= 5.5 & < 7	00.34	00.34	00.34	00.34	00.34	00.43	00.58	00.69	00.78	00.93	01.05	01.16	01.25	01.42	01.69	01.91	02.11
>= 7 & < 9	00.42	00.42	00.42	00.42	00.42	00.53	00.74	00.91	01.04	01.26	01.45	01.62	01.77	02.03	02.47	02.83	03.15
>= 9 & < 11	00.46	00.48	00.50	00.51	00.52	00.67	00.97	01.19	01.38	01.71	01.98	02.22	02.44	02.84	03.50	04.06	04.56
>= 11	00.47	00.53	00.58	00.61	00.64	00.84	01.23	01.53	01.79	02.23	02.61	02.95	03.26	03.81	04.75	05.56	06.28

& < 13																	
>= 13 & < 15	00.48	00.58	00.65	00.70	00.75	01.00	01.48	01.86	02.19	02.76	03.25	03.69	04.09	04.82	06.07	07.15	08.11
>= 15 & < 18	00.49	00.63	00.72	00.79	00.85	01.15	01.73	02.20	02.60	03.30	03.90	04.45	04.95	05.86	07.43	08.79	10.02
>= 18 & < 22.5	00.52	00.71	00.85	00.96	01.06	01.45	02.22	02.85	03.40	04.36	05.21	05.97	06.68	07.97	10.23	12.20	13.99
>= 22.5 & < 27.5	00.56	00.80	01.00	01.16	01.30	01.81	02.82	03.65	04.39	05.69	06.83	07.88	08.86	10.65	13.80	16.58	19.13
>= 27.5 & < 35	00.59	00.89	01.13	01.34	01.53	02.15	03.39	04.42	05.34	06.98	08.43	09.76	11.01	13.30	17.37	20.99	24.31
>= 35 & < 45	00.65	01.05	01.38	01.68	01.95	02.77	04.45	05.87	07.14	09.43	11.47	13.37	15.14	18.43	24.32	29.60	34.48
>= 45 & < 55	00.71	01.18	01.59	01.97	02.32	03.32	05.40	07.17	08.78	11.66	14.26	16.67	18.94	23.17	30.78	37.65	44.02
>= 55	00.76	01.30	01.78	02.23	02.65	03.81	06.24	08.33	10.23	13.65	16.76	19.64	22.36	27.45	36.63	44.96	52.70

The above table was derived from table 4-2 in Agricultural Handbook 703, “Values for topographic factor, LS, for moderate ratio of rill to interrill erosion”.

If the derived RV value of "component.slopelenusle" is not null, use that value for RV slope length.

Else if the corresponding survey area IS NOT in the Palouse region, use RV slope to lookup RV slope length using the following table:

Slope Range	RV Slope Length in feet
rvslope >= 0 And rvslope < 0.75	100
rvslope >= 0.75 And rvslope < 1.5	200
rvslope >= 1.5 And rvslope < 2.5	300
rvslope >= 2.5 And rvslope < 3.5	200
rvslope >= 3.5 And rvslope < 4.5	180
rvslope >= 4.5 And rvslope < 5.5	160
rvslope >= 5.5 And rvslope < 6.5	150
rvslope >= 6.5 And rvslope < 7.5	140
rvslope >= 7.5 And rvslope < 8.5	130
rvslope >= 8.5 And rvslope < 9.5	125
rvslope >= 9.5 And rvslope < 10.5	120
rvslope >= 10.5 And rvslope < 11.5	110
rvslope >= 11.5 And rvslope < 12.5	100
rvslope >= 12.5 And rvslope < 13.5	90
rvslope >= 13.5 And rvslope < 14.5	80
rvslope >= 14.5 And rvslope < 15.5	70
rvslope >= 15.5 And rvslope < 17.5	60
rvslope >= 17.5	50

The above table was derived from a table that was originally provided by Lightle and Weesies, 10/1/1996.

Else if the corresponding survey area IS in the Palouse region, use RV slope to lookup RV slope length using the following table:

The following slope lengths for the "Palouse" (MLRA 9) area were determined by Tom Gohlke in consultation with Don McCool, ARS and Harry Riehle. Tom says, "Keep in mind that many real LS's in the field are complex slopes and consist of combinations of these slopes. For instance, it is common to find an "L" beginning on a 2%-5% slope and extending onto and ending on a 21%-25% slope. The total "L" may be less than the sum of the values for these two segments as shown in the following table."

Slope Range	RV Slope Length in feet
rvslope >= 0 And rvslope < 5.5	350
rvslope >= 5.5 And rvslope < 10.5	275
rvslope >= 10.5 And rvslope < 15.5	225
rvslope >= 15.5 And rvslope < 20.5	175

rvslope >= 20.5 And rvslope < 25.5	150
rvslope >= 25.5 And rvslope < 35.5	125
rvslope >=35.5	100

mu_tfactor

The value of “mu_tfactor” is always set to “component.tfact” of the selected component of the corresponding map unit record.

source

Source is used to distinguish the source of a particular FSA-CRP data record. Russ Kelsea wanted to be able to distinguish between data produced from NASIS (source = “N”) and data produced from a SSURGO template database (source = “S”).

The value of “source” is always set to “S”.

Test Plan

My FSA-CRP test data includes three legends, in the transactional NASIS database, for the following three geographic areas:

Area Type NASIS Site	Area Type Name	Area Symbol	Area Name
NSSC Data	Dorn's FSA-CRP Test SSA Type	XX001	Shire, Middle Earth
NSSC Data	Dorn's FSA-CRP Test SSA Type	XX002	Mordor, Middle Earth
NSSC Data	Dorn's FSA-CRP Test SSA Type	XX003	Rohan, Middle Earth

Survey area XX001 contains only one map unit whose symbol is 1. This map unit has no corresponding records in the map unit area overlap table, and this survey area has no corresponding records in the survey area-county geographic coincidence table. The entire purpose of this survey area is to demonstrate that no output record for a map unit is produced when no corresponding county can be determined. In the Access database, such a map unit is logged to table "SYSTEM – FSA-CRP – Warnings and Rejects".

Survey area XX002 contains the bulk of the test data.

Survey XX003 is a survey in the Palouse region. The only map units in this survey are used for testing LS Factor in the Palouse region.

I went with "XX" as the state portion of the area symbol so that these area symbols won't conflict with any real area symbol, as far as adding test records to the survey area-county geographic coincidence table and the Palouse region SSA table.

Map Unit Selection Tests

Map units with non-numeric symbols are used to check that the correct map unit is selected in cases where there is more than one map unit with the same symbol. This set of map units also verifies that a map unit with status "additional" is not output. Because the output file does not contain mustatus, all non-numeric map units that should be selected have a corresponding T Factor of 1, and all non-numeric map units that should not be selected have a corresponding T Factor of 5.

This set of map units also tests that case sensitivity is being taken into account in the Access database. This is not a concern in NASIS, since NASIS is case sensitive by default.

Musym	Mustatus	T factor	Output?
HOA	Approved	5	No
HOA	Correlated	1	Yes

HoA	Provisional	5	No
HoA	Correlated	1	Yes
hoA	Provisional	5	No
hoA	Approved	1	Yes
hoa	Additional	5	No

Corresponding County Related Tests

A map unit should not be output unless a corresponding county or counties can be determined.

Survey area XX001 contains one map unit whose symbol is "1". This map unit has no corresponding county record in the map unit area overlap table, the corresponding survey area has no county record in the legend area overlap table and the corresponding survey area has no corresponding record in the survey area-county geographic coincidence table. Verify that this map unit is not included in the output.

For survey area XX002, only 3 map units have corresponding county records in the map unit area overlap table.

Musym	Corresponding county or counties in map unit area overlap table	Expected number of output records
001	NE001	1
002	NE003	1
003	NE001, NE003	2
004	None	3 (see explanation below)

Map unit 004, like all other map units for survey area XX002, has no corresponding county record in the map unit area overlap table. But survey area XX002 does have 3 county records in the legend area overlap table (NE001, NE003 and NC065). Therefore map unit 004 and all other map units in survey area XX002 that have no corresponding county record in the map unit area overlap table, should have 3 output records, one for NE001, one for NE003 and one for NC065.

Survey area XX003 has no records in the map unit area overlap table, and no records in the legend area overlap table. Survey area XX003 does have 2 records in the survey area-county geographic coincidence table. Therefore every map unit in survey area XX003 should have 2 output records, one for BR549 and one for AB123.

For my testing, I am using a survey area-county geographic coincidence table that contains only the following records:

STSSAID	STCOID
XX002	CO111
XX002	CO333

XX003	BR549
XX003	AB123

In the Access database, any map unit for which no corresponding county can be determined is logged to table "SYSTEM – FSA-CRP – Warnings and Rejects".

Component Selection and T Factor Testing

Map units 101, 102 and 103 are used to test that the correct component is being selected as the "first" component. There isn't any real logic to T Factor selection, so in these tests I'm just setting T Factor so that I know that the correct component was selected.

Musym	Test Scenario	Expected T factor
101	Derived RV comppct based on comppct_r, includes a number of components that should not be selected	1
102	Derived RV comppct based on (comppct_l + comppct_h)/2, includes a number of components that should not be selected	2
103	Derived RV comppct is Null, includes no components that should be selected	Null

In the Access database, any map unit for which no corresponding component can be determined IS output, but a warning is logged to table "SYSTEM – FSA-CRP – Warnings and Rejects".

Long Leaf Pine Suitability Testing

Map units 201 through 221 are used to test the derivation of suitability for long leaf pine. Note that the only county for which a "Y" should ever occur is NC065, which occurs in the list of long leaf pine counties. For map units 201 through 221 in all other counties (NE001 and NE003), suitability for long leaf pine should be "N", since those other counties are not in the list of long leaf pine counties.

Musym	Test Scenario	Expected Suitability
201	PIPA2 found in component existing plants	Y
202	PIPA2 found in component forest productivity	Y
203	PIPA2 found in component trees to manage	Y
204	All 3 aforementioned plant tables contain at least one plant, but never PIPA2	N
205	No explicit reference to PIPA2, fails wetness, fails texture, fails pH	N
206	No explicit reference to PIPA2, fails wetness, passes texture, passes pH	N
207	No explicit reference to PIPA2, passes wetness, fails texture,	N

	passes pH	
208	No explicit reference to PIPA2, passes wetness, passes texture, fails pH (too high)	N
209	No explicit reference to PIPA2, passes wetness, passes texture, fails pH (null)	N
210-221	No explicit reference to PIPA2, passes wetness, passes texture, passes pH, every map unit in this set has a different valid texture	Y

I Factor Testing

Map units 301 through 310 are used to test the derivation of I Factor.

Musym	WEI	WEG	Expected I Factor
301	310	8	310
302	Null	1	220
303	Null	2	134
304	Null	3	86
305	Null	4	86
306	Null	4L	86
307	Null	5	56
308	Null	6	48
309	Null	7	38
310	Null	8	0

K Factor Testing

Map units 401 through 408 are used to test the derivation of K Factor.

Musym	Test Scenario	Expected K Factor
401	Test selection of maximum Kf for multiple layers at same depth	.10
402	Test selection of maximum Kw for multiple layers at same depth	.20
403	Test selection of Kf favored over Kw	.32
404	Test selection of Kw over a greater Kf in a lower layer	.02
405	Test selection of Kf over a greater Kw in a lower layer	.05
406	Test that no K Factor is returned for a Histosol	Null
407	Test that no K Factor is returned for a layer whose master designation is “O”	.24
408	Test that no K Factor is returned for a layer whose RV om is > 35%	.37

LS Factor Testing

Map units in the 500's are used to test the derivation of LS Factor. Survey area XX002 is not in the Palouse region, but survey area XX003 is in the Palouse region. Note that map units where slope is populated but slope length isn't, trigger a slope length lookup in the appropriate table, depending on whether or not the corresponding survey area is in the Palouse region.

SSA	Musym	Slope	Slope length in meters	Expected LS Factor
XX002	501		100	Null
XX002	502	0	0	.05
XX002	503	0	335	.06
XX002	504	61	0	.76
XX002	505	61	335	52.7
XX002	506	10	30	1.38
XX002	507	.5		.09
XX002	508	1		.16
XX002	509	2		.35
XX002	510	3		.48
XX002	511	4		.67
XX002	512	5		.76
XX002	513	6		.93
XX002	514	7		1.26
XX002	515	8		1.26
XX002	516	9		1.71
XX002	517	10		1.38
XX002	518	11		1.79
XX002	519	12		1.79
XX002	520	13		2.19
XX002	521	14		1.86
XX002	522	15		2.20
XX002	523	17		1.73
XX002	524	18		2.22
XX003	525	2		.37
XX003	526	10		2.44
XX003	527	11		2.95
XX003	528	20		5.21
XX003	529	21		4.36
XX003	530	26		5.69
XX003	531	36		7.14

Undrained Leaching Index Testing

Map units 601 through 619 are used to test the derivation of Undrained Leaching Index. Note that there are no specific tests to make sure that the correct Kw was returned. That's because the logic for selecting Kw is virtually identical to the logic for selecting K Factor, except in this case, only Kw is considered. This logic was already verified in the K Factor testing.

Musym	Test Scenario	Expect Undrained Leaching Factor
601	HG=C, calc<=10000, kval>=280	1
602	HG=C, calc>=10000	1
603	HG=B, calc>=35000, kval>=400	1
604	HG=B, calc>=45000, kval>=200	1
605	HG=A, calc<=30000	3
606	HG=B, calc<=9000, kval<=480	3
607	HG=B, calc<=15000, kval<=260	3
608	HG=A, calc>30000	2
609	HG=B and meets no other case where Hg=B	2
610	HG=C and meets no other case where Hg=C	2
611	Like 605 only HG=D	1
612	Like 606 only HG=A/D	1
613	Like 607 only HG=B/D	1
614	Like 608 only HG=C/D	1
615	Like 609 only taxorder=Histosol	1
616	Like 610 only HG is Null	Null
617	Like 601 only Kw is Null	Null
618	Like 602 only RV om is Null	Null
619	Like 603 only rv hzdepb is Null	Null

The Gory Details

Below is the source code for the functions that generate the FSA-CRP data.

Declarations

```
Option Compare Database
Option Explicit
Global LSTable(1 To 19, 1 To 17) As Single
```

CaseSensitiveMusym

```
Function CaseSensitiveMusym(musym As String) As String
'
'This function expands a map unit symbol into a string that permits
'that map unit symbol to be treated as a case sensitive value.
'Each character in the original map unit symbol is expanded to 2
'characters.  The first character is the original character that
'was encountered.  The next character depends on the original character.
'
'A lower case letter is expanded to: lower case letter + "L".
'An upper case letter is expanded to: upper case letter + "U".
'A character that is not a lower case letter and is not an upper
'case letter is expanded to: character + "A".
'
'For example, map unit symbol "HoA21" expands to "HUoLAU2A1A".
'
Dim strMusym As Variant
Dim i As Long

strMusym = ""
For i = 1 To Len(musym)
   strMusym = strMusym & mid(musym, i, 1)
   If InStr(1, "ABCDEFGHIJKLMNOPQRSTUVWXYZ", mid(musym, i, 1), 0) Then
      strMusym = strMusym & "U"
   ElseIf InStr(1, "abcdefghijklmnopqrstuvwxyz", mid(musym, i, 1), 0) Then
      strMusym = strMusym & "L"
   Else
      strMusym = strMusym & "A"
   End If
Next i

CaseSensitiveMusym = strMusym

End Function
```

FSACRP_Create_Data

```
Function FSACRP_Create_Data()
'
'This function derives a set of attributes that are used by
'the Farm Service Agency as part of the criteria as to whether
'or not a particular map unit is eligible for inclusion in the
'Conservation Reserve Program.
'
'This function always operates against ALL data that is currently
'loaded in the database.
'
Dim dbsSSURGO As Database

Dim qdfTemp As QueryDef
Dim strSQL As String

Dim rstFSACRP_Input As Recordset
Dim rstFSACRP_Output As Recordset
Dim rstFSACRP_Rejects As Recordset

Dim stcty As Variant
Dim ssaid As Variant
Dim musym As Variant
Dim mu_lleaf As Variant
Dim mu_leach As Variant
Dim mu_ifactor As Variant
Dim mu_kfactor As Variant
Dim mu_LS As Variant
Dim mu_tfactor As Variant
Dim source As Variant

Dim rstComponent As Recordset
Dim firstcokey As Variant
Dim hydgrp As Variant
Dim wei As Variant
Dim weg As Variant
Dim rvslope As Variant
Dim rvslopelenusle As Variant
Dim taxorder As Variant

Dim current_case_sensitive_musym As Variant
Dim current_area_symbol As Variant
Dim NoCompWarningMsg As String
Dim RejectMsg As String
Dim MapunitsWithNoCounty As Integer
```

```
Dim MapunitsWithNoCandidateComponent As Integer
Dim rstMUAOverlap As Recordset
Dim rstLAOverlap As Recordset
Dim rstSACoGeoCoincidence As Recordset
Dim rstLongLeaf As Recordset
Dim rstWetTopFoot As Recordset
Dim rstRequiredTexturesTopFoot As Recordset
Dim pHCriteriaMet As Boolean
Dim rstpHTopFoot As Recordset
Dim rstKFactorSurfaceMineralHorizon As Recordset
Dim rstULeachSurfaceMineralHorizon As Recordset
Dim hg As Variant
Dim calc As Variant
Dim kval As Variant
Dim blnInPalouse
Dim row As Integer
Dim column As Integer
Dim WarningMsg As String
Dim newline As String

newline = String(1, 13) & String(1, 10)

InitLSTable

RejectMsg = "Reject: This map unit WAS NOT included in the output file because no
corresponding county could be determined."
NoCompWarningMsg = "Warning: This map unit was included in the output file, but no
values could be derived because no candidate component could be determined."

Set dbsSSURGO = DBEngine.Workspaces(0).Databases(0)

'Drop any existing FSA-CRP data
Set qdfTemp = dbsSSURGO.CreateQueryDef("", "Delete from [SYSTEM - FSA-CRP
Data]")
qdfTemp.Execute

'Drop any existing FSA-CRP rejects.
'Rejects are map units where no corresponding county could be determined.
Set qdfTemp = dbsSSURGO.CreateQueryDef("", "Delete from [SYSTEM - FSA-CRP -
Warnings and Rejects]")
qdfTemp.Execute

Set rstFSACRP_Input = dbsSSURGO.OpenRecordset("FSA-CRP - Input",
DB_OPEN_DYNASET)
Set rstFSACRP_Output = dbsSSURGO.OpenRecordset("SYSTEM - FSA-CRP Data",
DB_OPEN_TABLE)
```

```
Set rstFSACRP_Rejects = dbsSSURGO.OpenRecordset("SYSTEM - FSA-CRP -
Warnings and Rejects", DB_OPEN_TABLE)

current_area_symbol = ""
current_case_sensitive_musym = ""
MapunitsWithNoCounty = 0
MapunitsWithNoCandidateComponent = 0

Do Until rstFSACRP_Input.EOF
   'Only process of the first occurrence of a particular map unit symbol, based on sort on
map unit status
   'correlated > approved > provisional
   If rstFSACRP_Input![Case Sensitive Musym] <> current_case_sensitive_musym Then
      current_case_sensitive_musym = rstFSACRP_Input![Case Sensitive Musym]

      If rstFSACRP_Input![areasymbol] <> current_area_symbol Then
         'Area symbol has changed.  Establish whether or not this survey area is in the
Palouse region.
         current_area_symbol = rstFSACRP_Input![areasymbol]
         blnInPalouse = InPalouse(rstFSACRP_Input![areasymbol])
      End If

      'Establish defaults for all output values.
      stcty = Null
      ssaid = rstFSACRP_Input![areasymbol]
      musym = rstFSACRP_Input![musym]
      mu_lleaf = "N"
      mu_leach = Null
      mu_ifactor = Null
      mu_kfactor = Null
      mu_LS = Null
      mu_tfactor = Null
      source = "S"

'*********************************************************************
*********
'**  Select the "first" component for this map unit.
'**  Establish the T Factor for this map unit at this time.
'**  Save some other component level values that are used to derive other
'**  attributes.
'*********************************************************************
*********

      firstcokey = Null
      strSQL = "SELECT RV([comppct_l],[comppct_r],[comppct_h]) AS [rv comppct],
component.cokey, "
```

```
        strSQL = strSQL & "RV([slope_l],[slope_r],[slope_h]) AS [rv slope], "
        strSQL = strSQL & "RV([slopelenusle_l],[slopelenusle_r],[slopelenusle_h]) AS [rv
slopelenusle], "
        strSQL = strSQL & "component.tfact, component.wei, component.weg,
component.hydgrp, component.taxorder, component.mukey "
        strSQL = strSQL & "FROM component "
        strSQL = strSQL & "WHERE (((RV([comppct_l], [comppct_r], [comppct_h])) Is
Not Null) And ((component.mukey) = '" & rstFSACRP_Input![mukey] & "')) "
        strSQL = strSQL & "ORDER BY RV([comppct_l],[comppct_r],[comppct_h])
DESC , component.cokey;"
        Set rstComponent = dbsSSURGO.OpenRecordset(strSQL)
        If rstComponent.RecordCount <> 0 Then
           mu_tfactor = rstComponent![tfact]
           firstcokey = rstComponent![cokey]
           rvslope = rstComponent![rv slope]
           rvslopelenusle = rstComponent![rv slopelenusle]
           hydgrp = rstComponent![hydgrp]
           wei = rstComponent![wei]
           weg = rstComponent![weg]
           taxorder = rstComponent![taxorder]
        Else
           'Log this map unit to the warnings and rejects table and increment the map units
with no candidate component warning count.
           rstFSACRP_Rejects.AddNew
           rstFSACRP_Rejects![areasymbol] = rstFSACRP_Input![areasymbol]
           rstFSACRP_Rejects![areaname] = rstFSACRP_Input![areaname]
           rstFSACRP_Rejects![musym] = rstFSACRP_Input![musym]
           rstFSACRP_Rejects![muname] = rstFSACRP_Input![muname]
           rstFSACRP_Rejects![mustatus] = rstFSACRP_Input![mustatus]
           rstFSACRP_Rejects![message] = NoCompWarningMsg
           rstFSACRP_Rejects.Update
           MapunitsWithNoCandidateComponent = MapunitsWithNoCandidateComponent
+ 1
        End If
        rstComponent.Close

'**********************************************************************
*********
'**  Establish the LS Factor for this map unit.
'**********************************************************************
*********

        If Not IsNull(firstcokey) And Not IsNull(rvslope) Then
           If Not IsNull(rvslopelenusle) Then
              'Convert slope length in meters to feet.
              rvslopelenusle = rvslopelenusle * 3.28
```

```
End If
If IsNull(rvslopelenusle) Then
    'Establish slope length via table lookup.
    'In both lookup tables, slope length is in feet.
    If Not blnInPalouse Then
        'Use Lightle and Weesies 1966 slope length lookup table.
        If rvslope >= 0 And rvslope < 0.75 Then
            rvslopelenusle = 100
        ElseIf rvslope >= 0.75 And rvslope < 1.5 Then
            rvslopelenusle = 200
        ElseIf rvslope >= 1.5 And rvslope < 2.5 Then
            rvslopelenusle = 300
        ElseIf rvslope >= 2.5 And rvslope < 3.5 Then
            rvslopelenusle = 200
        ElseIf rvslope >= 3.5 And rvslope < 4.5 Then
            rvslopelenusle = 180
        ElseIf rvslope >= 4.5 And rvslope < 5.5 Then
            rvslopelenusle = 160
        ElseIf rvslope >= 5.5 And rvslope < 6.5 Then
            rvslopelenusle = 150
        ElseIf rvslope >= 6.5 And rvslope < 7.5 Then
            rvslopelenusle = 140
        ElseIf rvslope >= 7.5 And rvslope < 8.5 Then
            rvslopelenusle = 130
        ElseIf rvslope >= 8.5 And rvslope < 9.5 Then
            rvslopelenusle = 125
        ElseIf rvslope >= 9.5 And rvslope < 10.5 Then
            rvslopelenusle = 120
        ElseIf rvslope >= 10.5 And rvslope < 11.5 Then
            rvslopelenusle = 110
        ElseIf rvslope >= 11.5 And rvslope < 12.5 Then
            rvslopelenusle = 100
        ElseIf rvslope >= 12.5 And rvslope < 13.5 Then
            rvslopelenusle = 90
        ElseIf rvslope >= 13.5 And rvslope < 14.5 Then
            rvslopelenusle = 80
        ElseIf rvslope >= 14.5 And rvslope < 15.5 Then
            rvslopelenusle = 70
        ElseIf rvslope >= 15.5 And rvslope < 17.5 Then
            rvslopelenusle = 60
        Else
            rvslopelenusle = 50
        End If
    Else
        'Use Palouse region slope length lookup table.
        If rvslope >= 0 And rvslope < 5.5 Then
```

```
            rvslopelenusle = 350
          ElseIf rvslope >= 5.5 And rvslope < 10.5 Then
            rvslopelenusle = 275
          ElseIf rvslope >= 10.5 And rvslope < 15.5 Then
            rvslopelenusle = 225
          ElseIf rvslope >= 15.5 And rvslope < 20.5 Then
            rvslopelenusle = 175
          ElseIf rvslope >= 20.5 And rvslope < 25.5 Then
            rvslopelenusle = 150
          ElseIf rvslope >= 25.5 And rvslope < 35.5 Then
            rvslopelenusle = 125
          Else
            rvslopelenusle = 100
          End If
      End If
    End If
    'Establish row and column for LS Factor table lookup.
    'Determine row index based on slope gradient.
    If rvslope >= 0 And rvslope < 0.35 Then
      row = 1
    ElseIf rvslope >= 0.35 And rvslope < 0.75 Then
      row = 2
    ElseIf rvslope >= 0.75 And rvslope < 1.5 Then
      row = 3
    ElseIf rvslope >= 1.5 And rvslope < 2.5 Then
      row = 4
    ElseIf rvslope >= 2.5 And rvslope < 3.5 Then
      row = 5
    ElseIf rvslope >= 3.5 And rvslope < 4.5 Then
      row = 6
    ElseIf rvslope >= 4.5 And rvslope < 5.5 Then
      row = 7
    ElseIf rvslope >= 5.5 And rvslope < 7 Then
      row = 8
    ElseIf rvslope >= 7 And rvslope < 9 Then
      row = 9
    ElseIf rvslope >= 9 And rvslope < 11 Then
      row = 10
    ElseIf rvslope >= 11 And rvslope < 13 Then
      row = 11
    ElseIf rvslope >= 13 And rvslope < 15 Then
      row = 12
    ElseIf rvslope >= 15 And rvslope < 18 Then
      row = 13
    ElseIf rvslope >= 18 And rvslope < 22.5 Then
      row = 14
```

```
ElseIf rvslope >= 22.5 And rvslope < 27.5 Then
   row = 15
ElseIf rvslope >= 27.5 And rvslope < 35 Then
   row = 16
ElseIf rvslope >= 35 And rvslope < 45 Then
   row = 17
ElseIf rvslope >= 45 And rvslope < 55 Then
   row = 18
Else
   row = 19
End If
'Determine column index based on slope length.
If rvslopelenusle >= 0 And rvslopelenusle < 4.5 Then
   column = 1
ElseIf rvslopelenusle >= 4.5 And rvslopelenusle < 7.5 Then
   column = 2
ElseIf rvslopelenusle >= 7.5 And rvslopelenusle < 10.5 Then
   column = 3
ElseIf rvslopelenusle >= 10.5 And rvslopelenusle < 13.5 Then
   column = 4
ElseIf rvslopelenusle >= 13.5 And rvslopelenusle < 20 Then
   column = 5
ElseIf rvslopelenusle >= 20 And rvslopelenusle < 37.5 Then
   column = 6
ElseIf rvslopelenusle >= 37.5 And rvslopelenusle < 62.5 Then
   column = 7
ElseIf rvslopelenusle >= 62.6 And rvslopelenusle < 87.5 Then
   column = 8
ElseIf rvslopelenusle >= 87.5 And rvslopelenusle < 125 Then
   column = 9
ElseIf rvslopelenusle >= 125 And rvslopelenusle < 175 Then
   column = 10
ElseIf rvslopelenusle >= 175 And rvslopelenusle < 225 Then
   column = 11
ElseIf rvslopelenusle >= 225 And rvslopelenusle < 275 Then
   column = 12
ElseIf rvslopelenusle >= 275 And rvslopelenusle < 350 Then
   column = 13
ElseIf rvslopelenusle >= 350 And rvslopelenusle < 500 Then
   column = 14
ElseIf rvslopelenusle >= 500 And rvslopelenusle < 700 Then
   column = 15
ElseIf rvslopelenusle >= 700 And rvslopelenusle < 900 Then
   column = 16
Else
   column = 17
```

```
      End If
      mu_LS = LSTable(row, column)
   End If

'***********************************************************************
*********
'** Establish the I Factor for this map unit at this time.
'***********************************************************************
*********

   If Not IsNull(firstcokey) Then
      If Not IsNull(wei) Then
         mu_ifactor = CInt(wei)
      ElseIf Not IsNull(weg) Then
         If weg = "1" Then
            mu_ifactor = 220
         ElseIf weg = "2" Then
            mu_ifactor = 134
         ElseIf weg = "3" Or weg = "4" Or weg = "4L" Then
            mu_ifactor = 86
         ElseIf weg = "5" Then
            mu_ifactor = 56
         ElseIf weg = "6" Then
            mu_ifactor = 48
         ElseIf weg = "7" Then
            mu_ifactor = 38
         ElseIf weg = "8" Then
            mu_ifactor = 0
         End If
      End If
   End If

'***********************************************************************
*********
'** Establish suitability for long leaf pine for this map unit.
'***********************************************************************
*********

   If Not IsNull(firstcokey) Then
      'First look for plant symbol PIPA2 in the component trees to manage, component
existing vegetation
      'and component forest productivity tables.
      strSQL = "SELECT cotreestomng.plantsym, cotreestomng.cokey "
      strSQL = strSQL & "FROM cotreestomng "
      strSQL = strSQL & "WHERE (((cotreestomng.plantsym)='PIPA2') AND
((cotreestomng.cokey)='" & firstcokey & "')) "
```

```
        strSQL = strSQL & "UNION "
        strSQL = strSQL & "SELECT coeplants.plantsym, coeplants.cokey "
        strSQL = strSQL & "FROM coeplants "
        strSQL = strSQL & "WHERE (((coeplants.plantsym)='PIPA2') AND
((coeplants.cokey)='" & firstcokey & "')) "
        strSQL = strSQL & "UNION "
        strSQL = strSQL & "SELECT coforprod.plantsym, coforprod.cokey "
        strSQL = strSQL & "FROM coforprod "
        strSQL = strSQL & "WHERE (((coforprod.plantsym)='PIPA2') AND
((coforprod.cokey)='" & firstcokey & "')); "
        Set rstLongLeaf = dbsSSURGO.OpenRecordset(strSQL)
        If rstLongLeaf.RecordCount <> 0 Then mu_lleaf = "Y"
        rstLongLeaf.Close
        If mu_lleaf = "N" Then
          'No explicit reference to long leaf pine was found.  See if this component meets
general suitability
          'requirements for long leaf pine.
          'First determine if soil moisture status is "wet" in any layer < 30cm at any time
during the year.
          strSQL = "SELECT RV([soimoistdept_l],[soimoistdept_r],[soimoistdept_h])
AS [rv soimoistdept], cosoilmoist.soimoiststat, comonth.cokey "
          strSQL = strSQL & "FROM comonth INNER JOIN cosoilmoist ON
comonth.comonthkey = cosoilmoist.comonthkey "
          strSQL = strSQL & "WHERE
(((RV([soimoistdept_l],[soimoistdept_r],[soimoistdept_h]))<30) AND
((cosoilmoist.soimoiststat)='wet') AND ((comonth.cokey)='" & firstcokey & "'));"
          Set rstWetTopFoot = dbsSSURGO.OpenRecordset(strSQL)
          If rstWetTopFoot.RecordCount = 0 Then
            'OK, there is no wetness problem in the top foot at any time of the year.
            'Determine if any of the required textures ever occur in the top foot.
            strSQL = "SELECT RV([hzdept_l],[hzdept_r],[hzdept_h]) AS [rv hzdept],
chtexture.texcl, chorizon.cokey "
            strSQL = strSQL & "FROM (chorizon INNER JOIN chtexturegrp ON
chorizon.chkey = chtexturegrp.chkey) INNER JOIN chtexture ON chtexturegrp.chtgkey
= chtexture.chtgkey "
            strSQL = strSQL & "WHERE (((RV([hzdept_l],[hzdept_r],[hzdept_h]))<30)
AND ((chtexture.texcl)='coarse sand' Or (chtexture.texcl)='sand' Or
(chtexture.texcl)='fine sand' Or (chtexture.texcl)='very fine sand' Or
(chtexture.texcl)='loamy coarse sand' Or (chtexture.texcl)='loamy sand' Or
(chtexture.texcl)='loamy fine sand' Or (chtexture.texcl)='loamy very fine sand' Or
(chtexture.texcl)='coarse sandy loam' Or (chtexture.texcl)='sandy loam' Or
(chtexture.texcl)='fine sandy loam' Or (chtexture.texcl)='very fine sandy loam') AND
((chorizon.cokey)='" & firstcokey & "'));"
            Set rstRequiredTexturesTopFoot = dbsSSURGO.OpenRecordset(strSQL)
            If rstRequiredTexturesTopFoot.RecordCount <> 0 Then
              'OK, at least one of the required textures was found in the top foot.
```

```
            'Determine if the pH of every layer < 30cm is less than 6.0.
            'Note that the existence of any layer < 30cm where pH cannot be
determined
            'results in a not suitable rating.
            pHCriteriaMet = False
            strSQL = "SELECT RV([hzdept_l],[hzdept_r],[hzdept_h]) AS [rv hzdept],
RV([ph1to1h2o_l],[ph1to1h2o_r],[ph1to1h2o_h]) AS [rv ph1to1h2o], chorizon.cokey "
            strSQL = strSQL & "FROM chorizon "
            strSQL = strSQL & "WHERE
(((RV([hzdept_l],[hzdept_r],[hzdept_h]))<30) AND ((chorizon.cokey)='" & firstcokey &
"'));"
            Set rstpHTopFoot = dbsSSURGO.OpenRecordset(strSQL)
            If rstpHTopFoot.RecordCount <> 0 Then
              pHCriteriaMet = True
              Do Until rstpHTopFoot.EOF
                If IsNull(rstpHTopFoot![rv ph1to1h2o]) Or rstpHTopFoot![rv
ph1to1h2o] >= 6 Then pHCriteriaMet = False
                rstpHTopFoot.MoveNext
              Loop
            End If
            If pHCriteriaMet Then mu_lleaf = "Y"
            rstpHTopFoot.Close
          End If
          rstRequiredTexturesTopFoot.Close
        End If
        rstWetTopFoot.Close
      End If
    End If
    '
    'Note than when data is output, suitability for long leaf pine is automatically reset to
"N" if the
    'corresponding county code does not occur in table "SYSTEM - Long Leaf Pine
Counties".
    '

'*******************************************************************
*********
'**  Establish the Undrained Leaching Factor for this map unit.
'**  The logic for determining Kw factor is virtually the same as the logic for
'**  determining the K Factor that is derived by this function, except that
'**  in this case, only Kw is considered.
'*******************************************************************
*********

    If Not IsNull(firstcokey) And taxorder = "Histosols" Then
      mu_leach = 1
```

```
    ElseIf Not IsNull(firstcokey) And Not IsNull(hydgrp) Then
      If hydgrp = "D" Or hydgrp = "A/D" Or hydgrp = "B/D" Or hydgrp = "C/D" Then
        mu_leach = 1
      Else
        strSQL = "SELECT RV([hzdept_l],[hzdept_r],[hzdept_h]) AS [rv hzdept],
RV([hzdepb_l],[hzdepb_r],[hzdepb_h]) AS [rv hzdepb], chorizon.kwfact,
chorizon.desgnmaster, RV([om_l],[om_r],[om_h]) AS [rv om], chorizon.cokey "
        strSQL = strSQL & "FROM chorizon "
        strSQL = strSQL & "WHERE (((chorizon.kwfact) Is Not Null) And
((chorizon.desgnmaster) <> 'O' Or (chorizon.desgnmaster) Is Null) And ((RV([om_l],
[om_r], [om_h])) <= 35 Or (RV([om_l], [om_r], [om_h])) Is Null) And ((chorizon.cokey)
= '" & firstcokey & "')) "
        strSQL = strSQL & "ORDER BY RV([hzdept_l],[hzdept_r],[hzdept_h]),
chorizon.kwfact DESC;"
        Set rstULeachSurfaceMineralHorizon = dbsSSURGO.OpenRecordset(strSQL)
        If rstULeachSurfaceMineralHorizon.RecordCount <> 0 Then
          If Not IsNull(rstULeachSurfaceMineralHorizon![kwfact]) And Not
IsNull(rstULeachSurfaceMineralHorizon![rv om]) And Not
IsNull(rstULeachSurfaceMineralHorizon![rv hzdepb]) Then
            hg = hydgrp
            calc = rstULeachSurfaceMineralHorizon![rv om] *
(rstULeachSurfaceMineralHorizon![rv hzdepb] / 2.54) * 1000
            kval = rstULeachSurfaceMineralHorizon![kwfact] * 1000
            If (hg = "D" Or hg = "A/D" Or hg = "B/D" Or hg = "C/D") Or _
             (hg = "C" And calc <= 10000 And kval >= 280) Or _
             (hg = "C" And calc >= 10000) Or _
             (hg = "B" And calc >= 35000 And kval >= 400) Or _
             (hg = "B" And calc >= 45000 And kval >= 200) Then
               mu_leach = 1
            ElseIf (hg = "A" And calc <= 30000) Or _
             (hg = "B" And calc <= 9000 And kval <= 480) Or _
             (hg = "B" And calc <= 15000 And kval <= 260) Then
               mu_leach = 3
            ElseIf (hg = "A" And calc > 30000) Or _
             (hg = "B" Or hg = "C") Then
               mu_leach = 2
            End If
          End If
        End If
        rstULeachSurfaceMineralHorizon.Close
      End If
    End If

'**********************************************************************
*********
'**  Establish the K Factor for this map unit.
```

```
'**  The idea is to return the K Factor for the first mineral layer of a
'**  non-histosol soil.  If the soil is a histosol, no K Factor is returned.
'**  This function is looking for the shallowest layer where either Kf or Kw
'**  is not null, the horizon master designation is not "O", and RV organic
'**  matter is <= 35%.  If data is not populated correctly, this approach can
'**  result in a K Factor not associated with the first mineral layer.  We felt
'**  that this was the best that we could do.  Note that we do not exclude
'**  layers from consideration when rv om or master designation cannot be
'**  determined.
'*****************************************************************************

    If Not IsNull(firstcokey) And (taxorder <> "Histosols" Or IsNull(taxorder)) Then
        strSQL = "SELECT RV([hzdept_l],[hzdept_r],[hzdept_h]) AS [rv hzdept], chorizon.kffact, chorizon.kwfact, chorizon.desgnmaster, RV([om_l],[om_r],[om_h]) AS [rv om], chorizon.cokey "
        strSQL = strSQL & "FROM chorizon "
        strSQL = strSQL & "WHERE (((chorizon.kffact) Is Not Null) And ((chorizon.desgnmaster) <> 'O' Or (chorizon.desgnmaster) Is Null) And ((RV([om_l], [om_r], [om_h])) <= 35 Or (RV([om_l], [om_r], [om_h])) Is Null) And ((chorizon.cokey) = '" & firstcokey & "')) Or (((chorizon.kwfact) Is Not Null) And ((chorizon.desgnmaster) <> 'O' Or (chorizon.desgnmaster) Is Null) And ((RV([om_l], [om_r], [om_h])) <= 35 Or (RV([om_l], [om_r], [om_h])) Is Null) And ((chorizon.cokey) = '" & firstcokey & "')) "
        strSQL = strSQL & "ORDER BY RV([hzdept_l],[hzdept_r],[hzdept_h]), chorizon.kffact DESC , chorizon.kwfact DESC;"
        Set rstKFactorSurfaceMineralHorizon = dbsSSURGO.OpenRecordset(strSQL)
        If rstKFactorSurfaceMineralHorizon.RecordCount <> 0 Then
            If Not IsNull(rstKFactorSurfaceMineralHorizon![kffact]) Then
                mu_kfactor = CSng(rstKFactorSurfaceMineralHorizon![kffact])
            ElseIf Not IsNull(rstKFactorSurfaceMineralHorizon![kwfact]) Then
                mu_kfactor = CSng(rstKFactorSurfaceMineralHorizon![kwfact])
            End If
        End If
        rstKFactorSurfaceMineralHorizon.Close
    End If

'*****************************************************************************
'**  Output one record for this map unit for each corresponding county or parish,
'**  if any.
'*****************************************************************************

    'Figure out if we can determine the corresponding county or counties.
    'First look for corresponding county records in the map unit area overlap table.
```

```
    'If we can't find any county overlaps for this map unit in the map unit area overlap
table,
    'see if this survey has any corresponding county records in the legend area overlap
table.
    'If we can't find any county overlaps for this survey in the legend area overlap table,
    'see if this survey has any corresponding records in the survey area-county
coincidence table.
    'If we cant find any county overlaps for this survey area in the survey area-county
coincidence
    'table, log the problem and increment the map units with no county error count.

    'Check for county coincidences in the map unit area overlap table.
    strSQL = "SELECT laoverlap.areatypename, laoverlap.areasymbol,
muaoverlap.mukey "
    strSQL = strSQL & "FROM laoverlap INNER JOIN muaoverlap ON
laoverlap.lareaovkey = muaoverlap.lareaovkey "
    strSQL = strSQL & "WHERE (((laoverlap.areatypename)='county or parish') AND
((muaoverlap.mukey)='" & rstFSACRP_Input![mukey] & "'));"
    Set rstMUAOverlap = dbsSSURGO.OpenRecordset(strSQL)
    If rstMUAOverlap.RecordCount <> 0 Then
      'Output a record for this map unit for each corresponding county or parish record
in the map unit area overlap table.
      Do Until rstMUAOverlap.EOF
        rstFSACRP_Output.AddNew
        rstFSACRP_Output![stcty] = rstMUAOverlap![areasymbol]
        rstFSACRP_Output![ssaid] = ssaid
        rstFSACRP_Output![musym] = musym
        rstFSACRP_Output![mu_lleaf] =
IIf(IsLongLeafPineCounty(rstMUAOverlap![areasymbol]), mu_lleaf, "N")
        rstFSACRP_Output![mu_leach] = mu_leach
        rstFSACRP_Output![mu_ifactor] = mu_ifactor
        rstFSACRP_Output![mu_kfactor] = mu_kfactor
        rstFSACRP_Output![mu_LS] = mu_LS
        rstFSACRP_Output![mu_tfactor] = mu_tfactor
        rstFSACRP_Output![source] = source
        rstFSACRP_Output.Update
        rstMUAOverlap.MoveNext
      Loop
      rstMUAOverlap.Close
    Else
      rstMUAOverlap.Close
      'Check for county coincidences for this SSA in the legend area overlap table.
      strSQL = "SELECT laoverlap.areatypename, laoverlap.areasymbol,
laoverlap.lkey "
      strSQL = strSQL & "FROM laoverlap "
```

```
            strSQL = strSQL & "WHERE (((laoverlap.areatypename)='County or Parish')
AND ((laoverlap.lkey)='" & rstFSACRP_Input![lkey] & "'));"
            Set rstLAOverlap = dbsSSURGO.OpenRecordset(strSQL)
            If rstLAOverlap.RecordCount <> 0 Then
               'Output a record for this map unit for each corresponding county or parish
record in the legend area overlap table.
               Do Until rstLAOverlap.EOF
                  rstFSACRP_Output.AddNew
                  rstFSACRP_Output![stcty] = rstLAOverlap![areasymbol]
                  rstFSACRP_Output![ssaid] = ssaid
                  rstFSACRP_Output![musym] = musym
                  rstFSACRP_Output![mu_lleaf] =
IIf(IsLongLeafPineCounty(rstLAOverlap![areasymbol]), mu_lleaf, "N")
                  rstFSACRP_Output![mu_leach] = mu_leach
                  rstFSACRP_Output![mu_ifactor] = mu_ifactor
                  rstFSACRP_Output![mu_kfactor] = mu_kfactor
                  rstFSACRP_Output![mu_LS] = mu_LS
                  rstFSACRP_Output![mu_tfactor] = mu_tfactor
                  rstFSACRP_Output![source] = source
                  rstFSACRP_Output.Update
                  rstLAOverlap.MoveNext
               Loop
               rstLAOverlap.Close
            Else
               rstLAOverlap.Close
               'Check for county coincidences for this SSA in the survey area-county
geographic coincidence table.

'************************************************************************
*****
               'What if the access database contains more than one instance of the same SSA?

'************************************************************************
*****
               strSQL = "SELECT [SYSTEM - Survey Area-County Geographic
Coincidence].stssaid, [SYSTEM - Survey Area-County Geographic Coincidence].stcoid "
               strSQL = strSQL & "FROM [SYSTEM - Survey Area-County Geographic
Coincidence] "
               strSQL = strSQL & "WHERE ((([SYSTEM - Survey Area-County Geographic
Coincidence].stssaid)='" & rstFSACRP_Input![areasymbol] & "'));"
               Set rstSACoGeoCoincidence = dbsSSURGO.OpenRecordset(strSQL)
               If rstSACoGeoCoincidence.RecordCount <> 0 Then
                  'Output a record for this map unit for each corresponding county or parish in
the survey area-county geographic coincidence table.
                  Do Until rstSACoGeoCoincidence.EOF
                     rstFSACRP_Output.AddNew
```

```
                        rstFSACRP_Output![stcty] = rstSACoGeoCoincidence![stcoid]
                        rstFSACRP_Output![ssaid] = ssaid
                        rstFSACRP_Output![musym] = musym
                        rstFSACRP_Output![mu_lleaf] =
IIf(IsLongLeafPineCounty(rstSACoGeoCoincidence![stcoid]), mu_lleaf, "N")
                        rstFSACRP_Output![mu_leach] = mu_leach
                        rstFSACRP_Output![mu_ifactor] = mu_ifactor
                        rstFSACRP_Output![mu_kfactor] = mu_kfactor
                        rstFSACRP_Output![mu_LS] = mu_LS
                        rstFSACRP_Output![mu_tfactor] = mu_tfactor
                        rstFSACRP_Output![source] = source
                        rstFSACRP_Output.Update
                        rstSACoGeoCoincidence.MoveNext
                    Loop
                    rstSACoGeoCoincidence.Close
                Else
                    rstSACoGeoCoincidence.Close
                    'Log this map unit to the warnings and rejects table and increment the map
units with no county error count.
                    rstFSACRP_Rejects.AddNew
                    rstFSACRP_Rejects![areasymbol] = rstFSACRP_Input![areasymbol]
                    rstFSACRP_Rejects![areaname] = rstFSACRP_Input![areaname]
                    rstFSACRP_Rejects![musym] = rstFSACRP_Input![musym]
                    rstFSACRP_Rejects![muname] = rstFSACRP_Input![muname]
                    rstFSACRP_Rejects![mustatus] = rstFSACRP_Input![mustatus]
                    rstFSACRP_Rejects![message] = RejectMsg
                    rstFSACRP_Rejects.Update
                    MapunitsWithNoCounty = MapunitsWithNoCounty + 1
                End If
            End If
        End If
    End If
    'Fetch the next input map unit record.
    rstFSACRP_Input.MoveNext
Loop

rstFSACRP_Input.Close
rstFSACRP_Output.Close
rstFSACRP_Rejects.Close

If MapunitsWithNoCounty <> 0 Or MapunitsWithNoCandidateComponent <> 0 Then
    WarningMsg = ""
    If MapunitsWithNoCounty Then
        WarningMsg = "Rejects: Number of map units not output because no corresponding
county or parish could be determined: " & MapunitsWithNoCounty & newline & newline
    End If
```

```
    If MapunitsWithNoCandidateComponent Then
        WarningMsg = WarningMsg & "Warnings: Number of map units for which values
could not be derived because no candidate component could be determined: " &
MapunitsWithNoCandidateComponent & newline & newline
    End If
    WarningMsg = WarningMsg & "See table ""SYSTEM - FSA-CRP - Warnings and
Rejects"" for the complete list of map units for which valid data could not be derived."
    MsgBox WarningMsg, vbOKOnly + vbExclamation, "FSA-CRP Data Generation -
Warnings"
End If

FSACRP_Create_Data = 0

End Function

InitLSTable

Function InitLSTable()
'
'This function initializes table 4-2 from Ag. Handbook
'703.  This table is used to derive topographical factor, LS,
'for moderate ratio of rill to interrill erosion.  The lookup
'is based on slope gradient and USLE slope length.
'
'Dim i, j As Integer
'Dim record As String
'
LSTable(1, 1) = 0.05
LSTable(1, 2) = 0.05
LSTable(1, 3) = 0.05
LSTable(1, 4) = 0.05
LSTable(1, 5) = 0.05
LSTable(1, 6) = 0.05
LSTable(1, 7) = 0.05
LSTable(1, 8) = 0.05
LSTable(1, 9) = 0.05
LSTable(1, 10) = 0.05
LSTable(1, 11) = 0.05
LSTable(1, 12) = 0.05
LSTable(1, 13) = 0.05
LSTable(1, 14) = 0.05
LSTable(1, 15) = 0.06
LSTable(1, 16) = 0.06
LSTable(1, 17) = 0.06
LSTable(2, 1) = 0.07
LSTable(2, 2) = 0.07
```

LSTable(2, 3) = 0.07
LSTable(2, 4) = 0.07
LSTable(2, 5) = 0.07
LSTable(2, 6) = 0.08
LSTable(2, 7) = 0.08
LSTable(2, 8) = 0.08
LSTable(2, 9) = 0.09
LSTable(2, 10) = 0.09
LSTable(2, 11) = 0.09
LSTable(2, 12) = 0.09
LSTable(2, 13) = 0.09
LSTable(2, 14) = 0.1
LSTable(2, 15) = 0.1
LSTable(2, 16) = 0.1
LSTable(2, 17) = 0.1
LSTable(3, 1) = 0.11
LSTable(3, 2) = 0.11
LSTable(3, 3) = 0.11
LSTable(3, 4) = 0.11
LSTable(3, 5) = 0.11
LSTable(3, 6) = 0.12
LSTable(3, 7) = 0.13
LSTable(3, 8) = 0.14
LSTable(3, 9) = 0.14
LSTable(3, 10) = 0.15
LSTable(3, 11) = 0.16
LSTable(3, 12) = 0.17
LSTable(3, 13) = 0.17
LSTable(3, 14) = 0.18
LSTable(3, 15) = 0.19
LSTable(3, 16) = 0.2
LSTable(3, 17) = 0.2
LSTable(4, 1) = 0.17
LSTable(4, 2) = 0.17
LSTable(4, 3) = 0.17
LSTable(4, 4) = 0.17
LSTable(4, 5) = 0.17
LSTable(4, 6) = 0.19
LSTable(4, 7) = 0.22
LSTable(4, 8) = 0.25
LSTable(4, 9) = 0.27
LSTable(4, 10) = 0.29
LSTable(4, 11) = 0.31
LSTable(4, 12) = 0.33
LSTable(4, 13) = 0.35
LSTable(4, 14) = 0.37

LSTable(4, 15) = 0.41
LSTable(4, 16) = 0.44
LSTable(4, 17) = 0.47
LSTable(5, 1) = 0.22
LSTable(5, 2) = 0.22
LSTable(5, 3) = 0.22
LSTable(5, 4) = 0.22
LSTable(5, 5) = 0.22
LSTable(5, 6) = 0.25
LSTable(5, 7) = 0.32
LSTable(5, 8) = 0.36
LSTable(5, 9) = 0.39
LSTable(5, 10) = 0.44
LSTable(5, 11) = 0.48
LSTable(5, 12) = 0.52
LSTable(5, 13) = 0.55
LSTable(5, 14) = 0.6
LSTable(5, 15) = 0.68
LSTable(5, 16) = 0.75
LSTable(5, 17) = 0.8
LSTable(6, 1) = 0.26
LSTable(6, 2) = 0.26
LSTable(6, 3) = 0.26
LSTable(6, 4) = 0.26
LSTable(6, 5) = 0.26
LSTable(6, 6) = 0.31
LSTable(6, 7) = 0.4
LSTable(6, 8) = 0.47
LSTable(6, 9) = 0.52
LSTable(6, 10) = 0.6
LSTable(6, 11) = 0.67
LSTable(6, 12) = 0.72
LSTable(6, 13) = 0.77
LSTable(6, 14) = 0.86
LSTable(6, 15) = 0.99
LSTable(6, 16) = 1.1
LSTable(6, 17) = 1.19
LSTable(7, 1) = 0.3
LSTable(7, 2) = 0.3
LSTable(7, 3) = 0.3
LSTable(7, 4) = 0.3
LSTable(7, 5) = 0.3
LSTable(7, 6) = 0.37
LSTable(7, 7) = 0.49
LSTable(7, 8) = 0.58
LSTable(7, 9) = 0.65

LSTable(7, 10) = 0.76
LSTable(7, 11) = 0.85
LSTable(7, 12) = 0.93
LSTable(7, 13) = 1.01
LSTable(7, 14) = 1.13
LSTable(7, 15) = 1.33
LSTable(7, 16) = 1.49
LSTable(7, 17) = 1.63
LSTable(8, 1) = 0.34
LSTable(8, 2) = 0.34
LSTable(8, 3) = 0.34
LSTable(8, 4) = 0.34
LSTable(8, 5) = 0.34
LSTable(8, 6) = 0.43
LSTable(8, 7) = 0.58
LSTable(8, 8) = 0.69
LSTable(8, 9) = 0.78
LSTable(8, 10) = 0.93
LSTable(8, 11) = 1.05
LSTable(8, 12) = 1.16
LSTable(8, 13) = 1.25
LSTable(8, 14) = 1.42
LSTable(8, 15) = 1.69
LSTable(8, 16) = 1.91
LSTable(8, 17) = 2.11
LSTable(9, 1) = 0.42
LSTable(9, 2) = 0.42
LSTable(9, 3) = 0.42
LSTable(9, 4) = 0.42
LSTable(9, 5) = 0.42
LSTable(9, 6) = 0.53
LSTable(9, 7) = 0.74
LSTable(9, 8) = 0.91
LSTable(9, 9) = 1.04
LSTable(9, 10) = 1.26
LSTable(9, 11) = 1.45
LSTable(9, 12) = 1.62
LSTable(9, 13) = 1.77
LSTable(9, 14) = 2.03
LSTable(9, 15) = 2.47
LSTable(9, 16) = 2.83
LSTable(9, 17) = 3.15
LSTable(10, 1) = 0.46
LSTable(10, 2) = 0.48
LSTable(10, 3) = 0.5
LSTable(10, 4) = 0.51

LSTable(10, 5) = 0.52
LSTable(10, 6) = 0.67
LSTable(10, 7) = 0.97
LSTable(10, 8) = 1.19
LSTable(10, 9) = 1.38
LSTable(10, 10) = 1.71
LSTable(10, 11) = 1.98
LSTable(10, 12) = 2.22
LSTable(10, 13) = 2.44
LSTable(10, 14) = 2.84
LSTable(10, 15) = 3.5
LSTable(10, 16) = 4.06
LSTable(10, 17) = 4.56
LSTable(11, 1) = 0.47
LSTable(11, 2) = 0.53
LSTable(11, 3) = 0.58
LSTable(11, 4) = 0.61
LSTable(11, 5) = 0.64
LSTable(11, 6) = 0.84
LSTable(11, 7) = 1.23
LSTable(11, 8) = 1.53
LSTable(11, 9) = 1.79
LSTable(11, 10) = 2.23
LSTable(11, 11) = 2.61
LSTable(11, 12) = 2.95
LSTable(11, 13) = 3.26
LSTable(11, 14) = 3.81
LSTable(11, 15) = 4.75
LSTable(11, 16) = 5.56
LSTable(11, 17) = 6.28
LSTable(12, 1) = 0.48
LSTable(12, 2) = 0.58
LSTable(12, 3) = 0.65
LSTable(12, 4) = 0.7
LSTable(12, 5) = 0.75
LSTable(12, 6) = 1
LSTable(12, 7) = 1.48
LSTable(12, 8) = 1.86
LSTable(12, 9) = 2.19
LSTable(12, 10) = 2.76
LSTable(12, 11) = 3.25
LSTable(12, 12) = 3.69
LSTable(12, 13) = 4.09
LSTable(12, 14) = 4.82
LSTable(12, 15) = 6.07
LSTable(12, 16) = 7.15

LSTable(12, 17) = 8.11
LSTable(13, 1) = 0.49
LSTable(13, 2) = 0.63
LSTable(13, 3) = 0.72
LSTable(13, 4) = 0.79
LSTable(13, 5) = 0.85
LSTable(13, 6) = 1.15
LSTable(13, 7) = 1.73
LSTable(13, 8) = 2.2
LSTable(13, 9) = 2.6
LSTable(13, 10) = 3.3
LSTable(13, 11) = 3.9
LSTable(13, 12) = 4.45
LSTable(13, 13) = 4.95
LSTable(13, 14) = 5.86
LSTable(13, 15) = 7.43
LSTable(13, 16) = 8.79
LSTable(13, 17) = 10.02
LSTable(14, 1) = 0.52
LSTable(14, 2) = 0.71
LSTable(14, 3) = 0.85
LSTable(14, 4) = 0.96
LSTable(14, 5) = 1.06
LSTable(14, 6) = 1.45
LSTable(14, 7) = 2.22
LSTable(14, 8) = 2.85
LSTable(14, 9) = 3.4
LSTable(14, 10) = 4.36
LSTable(14, 11) = 5.21
LSTable(14, 12) = 5.97
LSTable(14, 13) = 6.68
LSTable(14, 14) = 7.97
LSTable(14, 15) = 10.23
LSTable(14, 16) = 12.2
LSTable(14, 17) = 13.99
LSTable(15, 1) = 0.56
LSTable(15, 2) = 0.8
LSTable(15, 3) = 1
LSTable(15, 4) = 1.16
LSTable(15, 5) = 1.3
LSTable(15, 6) = 1.81
LSTable(15, 7) = 2.82
LSTable(15, 8) = 3.65
LSTable(15, 9) = 4.39
LSTable(15, 10) = 5.69
LSTable(15, 11) = 6.83

LSTable(15, 12) = 7.88
LSTable(15, 13) = 8.86
LSTable(15, 14) = 10.65
LSTable(15, 15) = 13.8
LSTable(15, 16) = 16.58
LSTable(15, 17) = 19.13
LSTable(16, 1) = 0.59
LSTable(16, 2) = 0.89
LSTable(16, 3) = 1.13
LSTable(16, 4) = 1.34
LSTable(16, 5) = 1.53
LSTable(16, 6) = 2.15
LSTable(16, 7) = 3.39
LSTable(16, 8) = 4.42
LSTable(16, 9) = 5.34
LSTable(16, 10) = 6.98
LSTable(16, 11) = 8.43
LSTable(16, 12) = 9.76
LSTable(16, 13) = 11.01
LSTable(16, 14) = 13.3
LSTable(16, 15) = 17.37
LSTable(16, 16) = 20.99
LSTable(16, 17) = 24.31
LSTable(17, 1) = 0.65
LSTable(17, 2) = 1.05
LSTable(17, 3) = 1.38
LSTable(17, 4) = 1.68
LSTable(17, 5) = 1.95
LSTable(17, 6) = 2.77
LSTable(17, 7) = 4.45
LSTable(17, 8) = 5.87
LSTable(17, 9) = 7.14
LSTable(17, 10) = 9.43
LSTable(17, 11) = 11.47
LSTable(17, 12) = 13.37
LSTable(17, 13) = 15.14
LSTable(17, 14) = 18.43
LSTable(17, 15) = 24.32
LSTable(17, 16) = 29.6
LSTable(17, 17) = 34.48
LSTable(18, 1) = 0.71
LSTable(18, 2) = 1.18
LSTable(18, 3) = 1.59
LSTable(18, 4) = 1.97
LSTable(18, 5) = 2.32
LSTable(18, 6) = 3.32

```
LSTable(18, 7) = 5.4
LSTable(18, 8) = 7.17
LSTable(18, 9) = 8.78
LSTable(18, 10) = 11.66
LSTable(18, 11) = 14.26
LSTable(18, 12) = 16.67
LSTable(18, 13) = 18.94
LSTable(18, 14) = 23.17
LSTable(18, 15) = 30.78
LSTable(18, 16) = 37.65
LSTable(18, 17) = 44.02
LSTable(19, 1) = 0.76
LSTable(19, 2) = 1.3
LSTable(19, 3) = 1.78
LSTable(19, 4) = 2.23
LSTable(19, 5) = 2.65
LSTable(19, 6) = 3.81
LSTable(19, 7) = 6.24
LSTable(19, 8) = 8.33
LSTable(19, 9) = 10.23
LSTable(19, 10) = 13.65
LSTable(19, 11) = 16.76
LSTable(19, 12) = 19.64
LSTable(19, 13) = 22.36
LSTable(19, 14) = 27.45
LSTable(19, 15) = 36.63
LSTable(19, 16) = 44.96
LSTable(19, 17) = 52.7
'
'The following code was used to create a hard copy table that
'I could use to check against the original copy that was provided.
'
'Open "d:\tmp5\table.txt" For Output As #1
'record = ""
'For i = 1 To 19
'   For j = 1 To 17
'      record = record & Format(LSTable(i, j), "00.00") & "  "
'   Next j
'   Print #1, record
'   record = ""
'Next i
'Close #1

End Function

InPalouse
```

```
Function InPalouse(areasymbol As Variant) As Boolean
'
'This function determines if the area symbol that is passed to
'this function is a member of the set of soil survey areas contained
'in table "SYSTEM - Palouse Soil Survey Areas".
'
'This function returns either True or False.
'
Dim dbsSSURGO As Database
Dim qdfTemp As QueryDef
Dim strSQL As String
Dim rstPalouse As Recordset

InPalouse = False

If Not IsNull(areasymbol) Then
   strSQL = "SELECT [SYSTEM - Palouse Soil Survey Areas].STSSAID "
   strSQL = strSQL & "FROM [SYSTEM - Palouse Soil Survey Areas] "
   strSQL = strSQL & "WHERE ((([SYSTEM - Palouse Soil Survey
Areas].STSSAID)='" & areasymbol & "'));"
   Set dbsSSURGO = DBEngine.Workspaces(0).Databases(0)
   Set rstPalouse = dbsSSURGO.OpenRecordset(strSQL)
   If rstPalouse.RecordCount <> 0 Then InPalouse = True
   rstPalouse.Close
End If

End Function
```

IsLongLeafPineCounty

```
Function IsLongLeafPineCounty(varCountyCode As Variant) As Boolean
'
'This function determines if the argument passed in occurs in column
'"countycode" of table "SYSTEM - Long Leaf Pine Counties".
'
Dim dbsSSURGO As Database
Dim strSQL As String
Dim rstLongLeafPine As Recordset

IsLongLeafPineCounty = False
If Not IsNull(varCountyCode) And Len(varCountyCode) <> 0 Then
   strSQL = "SELECT [SYSTEM - Long Leaf Pine Counties].countycode "
   strSQL = strSQL & "FROM [SYSTEM - Long Leaf Pine Counties] "
   strSQL = strSQL & "WHERE ((([SYSTEM - Long Leaf Pine
Counties].countycode)='" & varCountyCode & "'));"
```

```
    Set dbsSSURGO = CurrentDb()
    Set rstLongLeafPine = dbsSSURGO.OpenRecordset(strSQL)
    If rstLongLeafPine.RecordCount <> 0 Then IsLongLeafPineCounty = True
    rstLongLeafPine.Close
End If
End Function
```

RV

```
Function RV(value_l As Variant, value_r As Variant, value_h As Variant) As Variant
'
'This function returns a derived representative value for a low, rv, high attribute.
'
'If the rv value is not null, the rv value is returned.
'If the rv value is null, but the low and high values are not null,
'(low value + high value)/2 is returned.
'If the rv value is null, and either the low value is null, or the
'high value is null, Null is returned.
'
If Not IsNull(value_r) Then
    RV = value_r
ElseIf Not IsNull(value_l) And Not IsNull(value_h) Then
    RV = (value_l + value_h) / 2
Else
    RV = Null
End If
End Function
```

Soil Conditioning Index: A Field Office Tool for Assessing Soil Carbon Trends in Conservation Systems—*Lee Norfleet, Soil Quality Institute (SQI), Auburn, AL*

The Soil Conditioning Index (SCI) is a tool for organic matter prediction used by the Natural Resources Conservation Service that utilizes the effects of climate, tillage, and erosion on organic matter decomposition at various geographic locations. Currently the SCI is a component of several practice standards in NRCS technical guides. The three components of the SCI include (1) the amount of organic material returned to the soil, (2) the effects of tillage and field operations on soil organic matter decomposition, and (3) the effect of predicted erosion associated with the management system. The SCI gives an overall rating based on these components.

The Soil Quality Institute (SQI) and National Soil Survey Center staffs have made several revisions to the SCI over the last few months. The model has been adjusted to be more sensitive to soil type. The model's output has been tested against soil carbon research data from throughout the country. Index values from long-term experiments nationwide have been developed and compared to reported changes in carbon percentages. Results show favorable potential for the SCI to predict trends in organic matter content for conservation planning and carbon sequestration.

The direct link to research provides scientific merit to the carbon trends and a more quantitative estimate of potential gains. It also allows for the accurate estimation of improvements in soil, water, and air quality. The estimation of gains in nitrogen, phosphorus, and water cycling can be enhanced through the use of integrative models such as EPIC or its user-friendly version CROPMAN.

The SCI has also been linked to NRI cropland points through the C factors and USLE erosion as reported in the NRI. This linkage will allow NRCS to track and report trends in soil quality and carbon on much of the nation's cropland. It can also be reported at the filed level and be used as a decision tool for the Tier system described in the current farm bill.

SOIL BUSINESS AND DATA DELIVERY

Soil Business Area Analysis Group (SBAAG) Issues ---*Ken Scheffe, Chair, SBAAG, Albuquerque, NM*

SBAAG Issues In Progress
These items are in progress. Work is being done by SBAAG or others on analysis, design, development or implementation. SBAAG reviews priorities and progress for these items at each SBAAG meeting.

1. Ability to create perfect joins where interpretive criteria vary (stored interps in DMU).
2. Interpretations – getting them done and documenting the criteria and the logic behind them.
3. Need to look at the impact of populating sub-horizons (splitting many layers out) on interpretation and other models
4. Improve remote access and standardized telecommunications from project offices to NASIS.
5. Public Distribution – defining business rules for publishing data, archiving, versioning, and access (new paradigm).
6. Standards and guidance for the use of NASIS – implementing, training, technical assistance
7. Communicate the way we do business under the new Soil Survey Business concepts
8. NASIS Spatial Analysis & GIS Integration.
9. Transition from frozen soils data to NASIS data for resource inventories (NRI).
10. Replacement functionality for "mission critical" existing functionality that goes away.
11. Soil Survey Schedule long-term analysis team.
12. NASIS as a resource tool for resource soil scientists. More flexible, easy access to interpretations, easy access to the data for on-site projects, special studies, tailored interface. Tools specific for the resource soil scientists; need to gather requirements for basic soil services.
13. Lack of support for reader software (JAWS) within X Windows & browsers
14. Public Access Warehouse functions
15. Aggregation tool for data mapunits, to build series standards or new DMUs. (Need a tool to populate/create standards based on data in the database.)
16. Compare tool for data mapunits to compare DMUs against OSDs or other DMUs.
17. Ecological Site Description & NASIS integration (eliminate duplicate data, coordinate data element definitions/naming, etc.)
18. Initial ESD population (requires a National NASIS database to create unique names).
19. Analyze the integration of OSDs, taxonomy, and series classification file (include TUD).

20. Include standard interps not now in NASIS.

21. Interps metadata and process development; policy/procedure/official data, default and customizable (minimum documentation requirements).
22. Import, manage, & integrate point/site/Laboratory data.
23. ESI / soils data model integration and data sharing (point/site data analysis).
24. Site/pedon data aggregation tool to auto-populate DMU's
25. Calculate various data elements (Kw, Kf, T, WEG, WEI, potential hydric soils, prime farmland, sieve separates, AWC, LEP, permeability, hydrologic group, CEC, Unified, AASHTO).
26. Improve on-line help for data population. Provide links to NSSH for information on data elements.
27. Better training delivery (timely) – training capabilities.
28. Report to show what properties are used in an interpretation
29. Graphics in reports (ability to display data graphically)
30. NASIS and ECIMIS (old SORIS, new TERRA) coordination between USFS and FGDC
31. Shared object change control and impact analysis (things that mess up or break interp rules, reports, queries, especially when the data model changes).
32. Ramifications of linking
33. A means for providing dual interpretations for similar map unit components. (For example, a component that has a temporal property such as drained or not drained that is not separated on the maps, but we want to show both interps).
34. List of attributes used by National program application. With this we also need the ability to add state or other level of application
35. Soil data viewer status/Explorer – soil survey GIS on CD-ROM, need 3 levels of digital products (advanced GIS user, mid, & novice) that allow querying and reporting of data
36. Current status of developing Soil Information System - development and maintenance of an Information Systems Plan for the Soil Survey Division
37. User interface enhancements (a long list)
38. Step by step task list for specific jobs
39. Include TSS requirements in Soil Data Warehouse development
40. Provide training for RSS in use of existing tools (e.g., NASIS, Soil Data Viewer) and new tools as developed
41. Identify programmatic and customer requests and provide the ability to support them
42. Continue analysis on development of a use-dependent soil database

SBAAG Issues Prioritized for Consideration

These items are prioritized and queued for consideration by SBAAG. In most cases work on these issues needs to begin with analysis.

1. Create a National Standard.
2. Criteria for National interpretations in NASIS need to be reviewed.
3. Field data recorder
4. Soil survey manuscript analysis to automate manuscript development & generation.
5. Ability to store images in the database (photos, block diagrams, scanned documents).
6. Develop an easier report generation tool / more user friendly.
7. Run multiple reports at a time.
8. Edit capability for calculated data elements.
9. Identification of data elements changed as a result of running a calculation
10. Data completeness checking tool
11. Calculations that populate the database or export with the results (create non-tech descriptions, create correlation history for a map unit)
12. Soil Survey Schedule data within Legend object and the security issues of who needs access to manage just a few data elements.
13. Permissions.
14. Re-assess security requirements within an object (row or column ownership)
15. Generalized export of MUR (customizable exports)
16. Improve multiple county soil survey download options. You cannot get the correct mapunit acreage for multiple county soil surveys easily with a single county download.
17. Ability to generate a narrative description from data in the database and exported for use in CST (build on-the-fly)
18. Exporting spatial data in ArcInfo coverage format with SDV-type links to tabular data
19. Ability to create a hydric soils list in a NASIS export while excluding interpretations for components without attribute data and/or minor components.
20. We need to re-think how we handle non-technical descriptions in NASIS
21. Simplified data entry that is separate from the complexity of the actual data model (such as forms based entry).
22. Status window that would show what is loaded into the edit tables (objects, target tables, rows, etc.).
23. Grouping reports, queries, and interps
24. Load related (transitive) for object and all related objects, etc. (rule, evaluation, property)
25. Recursive copy (get all links when you copy something, i.e., interps)
26. Method of sharing soils-related Access reports
27. Reliability of data - how to determine/record, how to inform users
28. Provide the capability nation-wide of locating and sharing TSS tools and expertise including reports, queries, and interps in NASIS, and web-based interfaces to same

29. Develop a multi-discipline data collection system to include RSS requirements
30. Provide users of soil data the limitations on the use of the data, the reliability and source of the data, and better information on remediation required to overcome soil problems

SBAAG Other Issues Under Consideration

1. These issues are not ordered in priority and are not queued for being worked on by SBAAG at this time.
2. Run interps against Pedon data.
3. Query soils by interpretative results and load into a selected set
4. Interps – HEL & PHEL
5. Joe Moore issue regarding data entry and having an export function using ACCESS software for rapid data entry
6. Different levels of NASIS interface preferences (novice users get all the prompts, advanced users can turn them off). Profile preferences.
7. Undo button. Levels of undo.
8. Dynamic default down table function; down table traverses links (like find related button, down table on correlation moves to DMU)
9. Having named clipboards, multiple clipboards
10. More edit setup control – control the stacking of tables, the ones that show up with a down table button.
11. Mixed case issue when entering data and finding data in choice lists; validation requires an exact match to mixed case stored in choice list. Would like data entry to be case insensitive.
12. Dynamically handle printers
13. Counter indicating row in table
14. Metric/english data entry
15. Search & replace specific strings in a column
16. Auto entry of user that is changeable
17. Retain current cursor position if find related fails
18. Target table and progeny reunion
19. Select more than 1 column to global assign
20. Show which row of rows displayed
21. Insert/delete buttons on button bar
22. Status bar showing how much of a process is complete
23. Discontinuous selection of rows
24. Bookmark – mark / goto mark
25. Capability for multiple reports for each editor (in addition to "where used" report).
26. Adding interps and vegetation information to Series Data Record report.

SBAAG Issues that are Complete or Resolved

These are issues that have been addressed by SBAAG and have been completed or resolved.

1. Ecosites vs. soils on Seward Peninsula
2. Resolve permafrost recording in NASIS.
3. Provide enhanced word processing capabilities within NASIS for OSD editing and other items (reports, queries).
4. Need for a blank DMU form for new series or phase, either paper or electronic form based data entry.
5. Add Pedon reports to NASIS
6. Make user managed domains in structure guide
7. Correlate mapunits and link data mapunits between MLRA Offices.
8. Centralized data to meet business needs – change ownership, sharing data across MO boundaries.
9. Forest survey area in two counties across the state line, handle as one area.
10. Interps generator needs a way to recognize the O horizons so that the interps can start at the top of the mineral horizon. Need a standard way to do this.
11. Import Pedons into NASIS. Pedon 3.x data conversion into NASIS data structure.
12. Support & maintenance – hotline, NASIS development team – tend to deal with a lot of issues really outside the scope of their area (USDA backbone issues)
13. Need someone to diagnose local performance problems with project offices – is it a local telephone issue or what? Includes site visits.
14. Export from NASIS to SSURGO (define new structure).
15. Soil data available for download from Ames web site is out of date
16. Hotline User Support
17. Facilitate trading reports and queries between MLRA Offices.
18. Need one official source of instructions.
19. Generate interps as previously available (national rating guides & criteria). There is a feeling that we all do not need to generate unique interps even though it is possible, or that it would be easier to tweak national interps than it would be to write interps from scratch.
20. Field personnel need to edit soil properties and then have the computer make the ratings for the new interpretations (populate the old stored interps).
21. Prime Farmland Interps, for components & map units – need to develop an interpretation (dmu level in NASIS, component level in STATSGO)
22. Edit capability for interps/calcs after generation (business view on how interps work and are used)
23. Do we need to store/override Interps in NASIS
24. Portable windows data entry for Pedon data (desktop)
25. Produce standard reports for manuscript tables (includes PWM).
26. Assistance with NASIS MUG development. Report that meets needs for manuscript.

27. Need new pre-written material for new tables in NASIS. Need to match PWM with new NASIS tables.
28. Table format in reports for manuscripts, need to include the pre-written material (PWM)
29. A report editor of some kind
30. Modify the local plants table so that it is easier to use. It is taking a lot of time to clean up the duplicate plant names and it is difficult to edit over a modem.
31. Ability to display calculation routine
32. Improve NASIS 5.0 printing capability
33. SSURGO download from NASIS that is decodified and understandable by the population at large. Simplified.
34. Download data in formats easily linked to spatial data.
35. Where used report for properties, evaluations, and rules.
36. Convert STATSGO to NASIS analysis.
37. Windows NT version of the STATSGO browser.
38. NASIS version synchronization/update automated across sites.
39. Woodland data report ability as previously available (thaw the frozen woodland data).
40. Allow edits in woodland data now hidden (unhide).
41. Maintain existing functionality to complete ongoing work.
42. Wildlife Interps – need National templates
43. Validations and calculations for acres
44. Response time on creating edit setups
45. Retain current cursor position after save
46. Make user configurable default site = Pangaea for queries, reports
47. Make environment variables available to reports and queries
48. Remove Unix functions from reports (security issue)
49. Mouse-overs (pop-up help on buttons)
50. R-acquire locks and identify who has record locked
51. Gather initial requirements for resource soil scientists/basic soil services (ISR)
52. Prototype Web interfaces to soil data (ISU/NASIS & Lighthouse/Warehouse)

SBAAG ISSUES UNKNOWN

The original meaning of the following Issue(s) has been lost. If one of the following issue(s) is yours, please provide SBAAG with any information to help clarify the original meaning and intent.

1. population examples in help

SBAAG
Soil Business Area Analysis Group
Organization, Background and Charges
October 2002

Executive Sponsor:
Berman Hudson, Director, Soil Survey Division, NRCS, Washington, DC

Group Members:
Rotating Members
Kenneth F. Scheffe, State Soil Scientist, NRCS, Albuquerque, NM (chair)
Lindsay Hodgman, Soil Scientist (GIS), Bangor, ME
Douglas Slabaugh, Data Quality Specialist, NRCS, Alexandria, LA
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Liaisons to SBAAG:
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Robert Dayton, Agronomist, Resources Inventory Division, NRCS, Ames, IA
Jennifer Sweet, SSURGO Support, NCGC, NRCS, Ft. Worth, TX

Background:

The Soil Business Area Advisory Group (SBAAG) is a cross-section of soil scientists and other technical experts who act as a sounding board and advisor to the Soil Survey Division Leadership on issues related to the soil survey business area. Members of the group are knowledgeable of the agency's data management needs and in the Soil Survey Program operations and function areas.

The group's primary function is to analyze the overall need for automation of soil survey technical and operational processes and to provide recommendations to the Division Leadership for that automation. The group's objectives are improving the quality and delivery of soil information and the processes by which that information is collected, managed, and developed.

The primary focus of the group has been and will remain The National Soil Information System (NASIS), since that system embodies most of the program's technical and operational data and processes.

NASIS is being developed incrementally, and it is essential that a group having an overall understanding of the system and of the soil survey program, prepare the project slate and develop the priorities for that development in a manner that best serves the needs of field and management.

SBAAG Charges:

1. Define an integrated soils application system by developing a Soil Business Area Analysis Plan.

2. Develop and maintain the priority slate of projects for the Soils Business Area Analysis Plan.

3. Address issues brought to the Group and identify other issues relating to the Soils Business Area automation.

4. Understand relationships and guide interaction of NASIS with other agency automation efforts.

5. Recommend individuals necessary to develop application requirement statements.

6. SBAAG may at times function as the group most appropriate for developing draft requirements for a particular application.

Soil Data ---Focused Delivery of Soil Survey Information-- *Gary Muckel, NSSC, Lincoln NE*

We deliver soil information is a variety of styles to a variety of customers. This statement applies to soil survey information as well as other soil information that we provide. We do not reach every man, woman, or child in the US, nor should we be trying to do so.

We focus our information, resources, and energies toward those who can help accomplish our mission to help people conserve, maintain, and improve our natural resources and environment. Our niche in soil survey is in helping these people to understand soils. We do this by providing soil information in a format they can use, we work with them to clarify their needs, and tailor the information to them.

Our tools are the highly versatile soil information system, the soil interpretations generator, the soil data viewer, the data warehouse, the Web, the publications, the CDs, and most importantly the soil scientist to work with these customers.

Marketing is a way of focusing the delivery of soil information to those who can make a difference. It is a way of extending our reach, utilizing the leadership, communication tools, and involvement of others.

The following resource issues are significant to the United States and require a soil component.

- Food and fiber production
- Wind and water erosion
- Important farmland loss
- Sedimentation of lakes and streams
- Excess runoff
- Water conservation
- Soil quality
- Soil contamination
- Waste management
- Carbon sequestration
- Biological diversity
- Wildlife habitat
- Hydric soils and wetlands
- Construction materials
- Risks and hazards in using soils
- National aesthetics

Instead of spreading our resources, the National Cooperative Soil Survey at the National Conference developed a five year plan directed toward specific goals and various client groups so that we could each year concentrate on materials and delivery to these groups. The five year marketing plan resulted.

The goal for 2001 and continuing was incorporation of soil science into natural resource education at all grade levels. To help us we targeted the NSTA, SSSA, NASA, SWCS, conservation education groups such as NACD and PLT. Publications, Web materials and a soil education CD have resulted. We are well on the way to a soil display in the Smithsonian Institution. State soils, developed during the centennial, are playing well as an intro to more understanding. Lewis and Clark with involve states from Virginia to Washington. Preparations are being made to equip hundreds of NRCS offices with materials.

This year improved soil management (the FARM BILL) is the goal with land managers and consultants as target groups. Our field offices of NRCS, FSA, conservation districts, and other technical services providers are our clients.
Focused delivery is through the eFOTG, tailored data for FSA, RUSLE2, and the customer service toolkit, hopefully, all from official soil data within the National Soil Information System. All efforts towards data population and digitizing fit within this marketing goal.

Reducing loss of life and property, creating an understanding of the function of soil in using and protecting wildlands, and illustrating the role of soils in international development and trade are goals for the next three years. We plan to expand our partnerships, reach into new arenas with our soil information through these goals.

Your new National soils Web site http://soils.usda.gov is functioning well. Leaving Iowa State Statistical Laboratory and Harvey Terpstra with their 30 years experience has not been easy. We average 60,000 unique visitors a month at the site. NRCS is a big user, however, ".gov" is the fifth dominant user, meaning we are also reaching private consultants, businesses, city and counties, educators, and students with soil information.

I want to ask for your help to ensure we provide accurate information. The list of published soil surveys always worries me because we do not get enough feed back from you. The only way we update the list is through you telling us when a survey is out of print or publish or available on CD. We do not add a survey as published unless we receive a copy and we only get them if you send it to us. Please review the list and send us corrections and the latest publications, hard copy or CD. This is the only national list. Many libraries depend on this list.

Also with the change to the new soils web site, remember that you have many links on your MLRA and state Web sites that are not current. Please update them.

Overall, data delivery to me means focusing our delivery mechanisms for specific users groups to tailor the format and content of information from what hopefully is our nationally consistent, seamless database.

Soils Data and Information – the Public Interface

Panel—
Ken Harward, Project Manager, NRCS Information Technology Center, Fort Collins, CO
Terry Aho, Soil Business NSSC Liaison, NRCS Information Technology Center, Fort Collins, CO
Rick Bigler, NASIS Manager, NSSC, Lincoln, NE
Bob Nielsen, Soil Scientist, Soil Interpretations, NSSC, Lincoln, NE
Jim Fortner, Soil Scientist, Soil Interpretations, NSSC, Lincoln, NE

1. Web Farm and CCE activities

- Migrating state pages to the web farm.
  - Follow steps outlined on http://www.info.usda.gov/nrcs/webhandbook/.
- Storage requirements for the web farm and data centers.
  - An Enterprise Data Storage Architecture task is underway to gather requirements and procure storage for the 3 web farms, and all data warehouses.
  - New storage is scheduled for implementation by August 2003.
- CCE upgrade to Windows XP and Office XP.
  - Currently set to begin March 2003.

2. Telecommunication Upgrades

- Changes to current connections.
  - Moving from frame relay to Virtual Private Network (VPN) encrypted tunnels hosted by UUNET.
  - Allows for many different connection strategies depending on what fits the local office (wired, wireless, satellite, cable, DSL, etc.).
- Upgrades for almost all offices.
  - Almost all offices will be bumped to a T-1 connection (1.5 Mbps) including soil survey offices.
  - Offices not getting a T-1 will have a minimum of 256 Kbps (up from 56 Kbps).
- Schedule for roll-out.
  - All new routers are in hand, ordering new circuits will begin in November.
  - Expected to be completely rolled out by mid-summer.
- Cutoff access to state web sites (ftp, data download, etc.).
  - At some point the OCIO will stop allowing traffic into the USDA network.
  - All web pages and data will have go through the web farm to get outside of USDA.

3. Soils related software and database development

- Current release of NASIS is version 5.1.1.
  - Big change with NASIS 5.1 is how interpretations are handled with a new result of NR or not rated where required data is missing.

  - Includes new validations for FOTG data element requirements.
  - New processes for integrating Ecological Site Information Systems (ESIS) and NASIS.
- NASIS Secure Access 2.0 is now available.
  - Improved performance, lowered resource overhead, unlimited downloads
  - Password is only required once per session.
  - Only one DOS window pop-up to show status while downloading files.
  - Allows use of HTML help with NASIS through a web browser.
- Windows Pedon 2.0 is going through a Beta test.
- Laboratory Information Management System (LIMS) is moving the web site for access to Lab/Characterization data to the NRCS Web Farm (currently on a Nebraska state mainframe).
- Soil Data Warehouse and Data Mart are currently being piloted under the Geospatial Data Warehouse (GDW) project.
  - GDW pilot project involves NCGC (Fort Worth), APFO (Salt Lake City), and Fort Collins Web Farm.
  - GDW pilot project purchased Soil Data Warehouse and Data Mart servers.
  - Developing processes for moving data from NASIS to a staging server (to merge tabular and spatial data) to the warehouse (all data is versioned) to the data mart (for distribution).
  - Beta test of Warehouse environment this winter.
  - Ready for production summer of FY03 (tied to implementation of enterprise data storage).
  - **Soil Data Warehouse will be the single source for all soil survey products.**
  - **Soil Data Warehouse will serve as the corporate repository for all NCSS data.**

Overview:

Soil Data Viewer – Version 4, updated to run on Windows XP and Office XP. Version 4 includes code changes to run on Windows XP, it does not include any additional functionality or enhancements. Release target date (coordinated with service center OS upgrades) – February-March 2003.

Microsoft Access Soil Template – A new updated MS Access template version 1.24 is available (**http://nasis.nrcs.usda.gov/downloads**/). Reports have been modified to better handle new null (not rated) interpretations, Hydric Soil report as been fixed to handle null data, and the addition of FSA-CRP data create and export. Also 1.24 has been updated with functionality to access external soil databases for combining soil survey data for a FO with more than one SSA or attaching to an older soil database and use the function for FSA-CRP data creation and export.

Some states have modified the template to include local reports. The approach you take in modifying and creating a local state template has a direct impact on your support and maintenance workload to keep your local template updated. Guidance for modifying the template is available (**http://nasis.nrcs.usda.gov/downloads**/); this will help ensure that your modifications are more easily migrated to new templates.

Web Access to soil data – The soil data mart part of the soil data warehouse development will provide public access to download official soil survey data and provide eFOTG connections for reporting soil information for Section II of FOTG. This will reduce State workloads for maintaining Section II of eFOTG by allowing them to focus on data quality and not have to continually spend time trying to update documents to provide the current official data. The soil data warehouse and soil data mart will be the first time we've been able to achieve a single source of official data in a corporate database. Release target date – summer 2003.

Prime Farmland and CALES—*H. Raymond Sinclair, NSSC, Lincoln, NE*

A Brief Explanation of CALES.

The Computer-Aided Land Evaluation Systems (CALES) is an outgrowth of two NRCS activities, the Soil Potential Rating System and the Agricultural land Evaluation and Site Assessment (LESA) system. Both of these systems are designed to determine the relative quality of land for agricultural uses including economic viability. The CALES program does the land evaluation (LE) part of LESA. The soil potential for an indicator crop can be determined using CALES. In agricultural evaluation, soils are rated from the best to the worst for a specific agricultural use based on an indicator crop. A relative value is determined for each group based on the cost of overcoming soil production limitations. The group of soils with the highest relative value is assigned a value of 100 and all other groups are assigned lower values. The land evaluation is based on soils data from the National Cooperative Soil Survey, local conservation practice and economic information. For CALES to work, the necessary soils data must be available. Soils must be mapped as NRCS soil mapping units, and soil data must be in the current soil survey database unless someone wants to enter the soil data into worksheet one.

Need for CALES.

Many political units need to update their LE part of LESA to accurately complete Form AD-1006 entitled "Farmland Conversion Impact Rating." There are requests to use CALES to generate the LE for new or updated soil surveys. The use of CALES assures procedural consistency in the determination of LE between political units. This consistency is not always happening today. The LE information should be part of the Field Office Technical Guide. CALES not only assures procedural consistency between political units, but the use of CALES reduces the time and saves money to generate LE for political units.

A Brief Explanation of Computer-Assisted Checks for Coordination of Prime Farmland, Capability Classification, and Productivity Ratings.

Farmland criteria have been programmed to produce tables that should help States and Major Land Resource Areas (MOs) coordinate soil map units that qualify as prime farmland, evaluate placement of soil map units into the Land Capability Classification System, and develop productivity ratings.

Many of the same soil and environmental characteristics that are prime farmland criteria are used to place soils into the Land Capability Classification system and also influence soil productivity ratings. The prime farmland criteria contained in the Federal Code of Regulations are used as the basis for the farmland criteria table.

Need for Computer-Assisted Checks for Coordination of Prime Farmland, Capability Classification, and Productivity Ratings.

For coordination purposes, it is useful to look at all the soils within a Major Land Resource Area (MLRA). MLRA's should have rather uniform geomorphology, climate, water resources, natural vegetation, and land uses. Thus, many environmental differences are suppressed and differences among soils become more apparent.

The computer can produce farmland criteria tables of all the soils within an MLRA. Tables can also be prepared for counties/soil surveys/parishes, but a list of soils/soil survey used in the county/soil survey/parish must be in the current soil survey database.

Evaluation of Prime and Statewide Important Farmland for New York 10/02

Narrative:

The Code of Federal regulation (Title 7, Volume 6, Parts 657.1 and 657.2) states that:

" *NRCS is concerned about any action that tends to impair the productive capacity of American agriculture. The Nation needs to know the extent and location of the best land for producing food, feed, fiber, forage, and oilseed crops. In addition to prime and unique farmlands, farmlands that are of statewide and local importance for producing these crops also need to be identified.*

It is NRCS policy to make and keep current an inventory of the prime farmland and unique farmland of the Nation. This inventory is to be carried out in cooperation with other interested agencies at the National, State, and local levels of government. The objective of the inventory is to identify the extent and location of important rural lands needed to produce food, feed, fiber, forage, and oilseed crops."

Due to increasing pressures from urbanization, along with the fact that the prime and important farmland lists for New York were becoming somewhat outdated, a decision was made to update the lists prior to the scheduled release of soils' data electronically as part of the Electronic Field Office Technical Guide (EFOTG) initiative.

In being consistent with the MLRA approach to soil survey, the general consensus among participants in a 4/2/02 teleconference regarding the updating of NewYork's prime and important farmland lists, was that similar soil map units for a soil series should have similar farmclass ratings (prime / statewide important farmland designations) statewide.

A computer program entitled "Computer-Assisted Checks for Coordination of Prime Farmland Soils, Capability Classification and Productivity Ratings" and the Excel spreadsheet program, were discussed as a means of evaluating map unit data against prime farmland criteria, and developing more consistent and accurate "Prime", "Prime, where Drained" and "Farmland of Statewide Importance" lists for the soils in New York. This Program, developed largely by Ray Sinclair of NCSSC in cooperation with Iowa State University Statlab, compares map unit data in NASIS against established prime farmland criteria, and produces a calculated farmclass rating. It also gives the previously assigned farmclass rating for the map unit, which can be used for comparison and evaluation purposes.

It is recognized that there is a certain amount of variability in soil properties (range of characteristics) allowable within any given soil series, which often results in slightly different soil properties being described for the same soil series in different counties or survey areas. When these slight differences in soil properties overlap the boundaries established as criteria to evaluate prime farmland, it can cause entirely different farmclass rankings for very similar soils. It is for this reason we chose not to develop the list based solely on the Calculator Program's generated ratings, but rather to use the Calculator Program and Excel spreadsheet as tools to evaluate the predominant conditions of our soil map units on a statewide basis. It was then possible to incorporate the knowledge and experience of current and former Soil Scientists in NY to develop the final lists.

Procedure:

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1. Run the Prime Farmland Calculator program (available to NRCS employees via web site listed below) on all survey areas under consideration.. This Calculator Program compares map unit data in NASIS against established prime farmland criteria.

Details:

a) access prime farmland calculator web site at: http://www.statlab.iastate.edu/soils/primeray/

b) click on "Create Prime Farmland Report for a Survey"

c) click on "Survey Area"- process

d) select State

e) select Survey Area- process

f) select "Components with percentage greater than or equal to <u>15</u>%- process

g) choose:

-format- #2-"generate report in pipe-delimited format with header line"

-moisture regime ("udic" for NY)

-wind erosion C-factor ("0.0" for NY)

-crop ("corn silage" for NY)

-min. AWC (3.5"- MLRA 140 and 127 portions of NY; 3.0"- rest of NY)

- process

List is generated, then:

2. Collate the results into an Excel spreadsheet.

Details:

a) save results from the Calculator output as "filename.txt"; type = All Files (*.*)

b) open Excel; scroll down to "All Files (*.*) in "Files of Type"

c) when text import wizard screen comes up, click "Next"; in Delimiters box, click "Other" and enter a pipe symbol (|); click "next"; click "finish"; then when data goes to Excel change file type to: "Microsoft Excel Workbook (*.xls)"; then save

d) click on row 2 (below headers) in spreadsheet and "Insert – Row", so you have one space between headers and data for sorting purposes

e) place cursor in box F2, the click on "window- freeze panes", which will allow you to keep header row and first 5 columns fixed in order to know what map unit you're looking at while viewing data at the far right side of spreadsheet

3. Name this worksheet containing all the remaining map units: "Primediscrepancy". Add additional worksheets to this spreadsheet, and label and defined as follows:

"Allprime"- Calculated Value = "Yes" and NASIS Farmclass = "All areas Prime" for majority of mapunits of the same series and slope class

"Where Drained" - Calculated Value and NASIS Farmclass = "where dr" for majority of mapunits of the same series and slope class

"Nonprime"- Calculated Value and NASIS Farmclass = "No" for majority of mapunits of the same series and slope class

4. Sort by: slope (column D). Map units with slope RV (or mean, if no RV entered) >/= 12% are cut from the initial list and pasted into "Nonprime" worksheet.

5 Re-sort the remaining list by capability class (column E). Map units in class 6, 7 or 8 are cut from the list and pasted into "Nonprime" worksheet.

6. Re-sort by series (column C) and slope class (column D) so similar map units are grouped for evaluation. Map units remain here until they were evaluated and placed into appropriate worksheets (listed above).

7. Highlight, cut and paste similar soil map units with similar ratings on "Prime Discrepancy" list into appropriate worksheet until all soils on "PrimeDiscrepancy" list have been categorized. A split screen may be used throughout this entire process, with one screen being the Excel spreadsheet, the other being NASIS. As soils are categorized and shifted to the appropriate worksheets in Excel, the farmclass can be checked and, if necessary, adjusted in NASIS. Likewise, if errors/omissions in NASIS data are identified during the process, these can be corrected at this time.

Notes:
--All changes made to NASIS database should be noted in DMU or Component text notes, as appropriate. (In New York, a side record of changes was also maintained.)
--The main NASIS query used to bring in desired selected set (all components of a given series in the state of NY) was the MO-12 query: "Component data by area, name and % (>/=) (NY)", then selecting "legend" and "DMU", and setting query parameters: Area Symbol IMATCHES = ny*, Component Name IMATCHES = series desired, Comp % = 15.
--Published Soil Survey reports for nearly all counties in NY were available and used extensively for evaluating units, allowing us to take into account the knowledge of the field Soil Scientists' who mapped these areas.
--A link to the NCSSC OSD database was kept open (minimized screen until needed) so official series info. was readily available.

8. Review capability subclasses of the map units remaining in "nonprime" lists (In NY, the flowchart guide proposed at the 1982 NE Soil Survey Conference, was used), to make sure units on the line between making or not making the "Statewide Important" list had reasonable and consistent subclasses; then sorted these nonprime lists by capability subclass (column E), series (column C) and slope (column D), to help develop "Statewide Important" list according to criteria shown below.

9. Assign "Statewide Important" designations in NASIS. In New York, as per 1984 criteria Statewide Important soils are: 1) mineral soils; 2) not prime or unique; 3) in land capability classes 2e, 2w, 2s, 3e, 3w, 3s and 4w.

Some Evaluation Criteria Used in Developing New York's Lists:

a. Used min. AWC = 3.5 inches in 40 inches for MLRA 140 (roughly the Southern Tier and Catskills region of NY), and min. AWC = 3.0 inches in 40 inches for the rest of the state, as per 1984 Prime Farmland criteria for New York
b. 5 Boroughs of New York City not considered in developing this list
c. If most all map units of a given series and slope class were assigned a farmclass that contradicted the predominant calculated rating, reasons for the discrepancy were evaluated and, in most cases, went with the historically assigned rating, since presumably these ratings were based on the field knowledge of a number of soil scientists in the past (in many cases, a lot of the discrepancies were based on the available water capacity of the soil, which often seemed to be close to the line between being adequate or not)
d. Multitaxa units with "Urban" or "Graded" as a named component ="Not Prime"
e. Fine- and very fine textured soils = prime or prime where drained if permeability >/= 0.06 in/hr and other criteria met (this decision is in contrast to 1984 NY prime criteria, in which fine and very fine soils were not considered to be prime or prime where drained apparently due to permeability, and issues regarding soil tilth and workability; decision to now include these soils on the lists based on consensus between the two current MLRA PL's in NY, Ted Trevail and Paul Puglia)
f. Poorly drained or very poorly drained soils = nonprime
g. Slope RV set at 4% for lacustrine soils on B-slopes (3-8%)
h. Slope RV set at 4% for lake plain (MLRA 101) soils on B-slope (3-8%)
i. Slope RV set at 7% for colluvial soils on B-slope (3-8%)
j. Slope RV set at 5-6% for rest of soils in NY on B-slope (3-8%)
k. Map units where capability class of dominant component > 2 = nonprime
l. Eroded phases = nonprime
m. Dual drainage (somewhat poorly drained/ poorly drained)- keep similar map units for a series consistent- go with the farmclass that was dominantly assigned across the state to the unit in the past, as this is an indicator of the way the unit has been predominantly mapped/ interpreted in NY in the past
n. Rocky (0.01-2.0% rock outcrop) could make prime; very rocky (2.0 + % rock outcrop) not prime

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Regional Technology Coordination in Implementing the Farm Bill--
Craig Derickson, Northern Plains Region,USDA-NRCS, Lincoln, NE

One of the largest issues facing NRCS in implementing the new Farm Bill is getting all of our technical references and tools up to date for use by NRCS, our partners and now third party providers. For several months States and National offices have been scurrying to get Tech Guides, Handbooks and Manuals up to date and re-distributed. In several instances the newly revised material is being made available on the Internet, such as the electronic Field Office Technical Guide, or eFOTG.

NRCS is a turning point in the way we develop, distribute and use technical information, including training, reference materials and technology tools. The movement is toward a web-based storage and access system, and private industry has been heading this direction for a number of years. Now, NRCS must figure out what all can be housed and delivered from the web, and do it quickly to respond to the needs of our evolving customer base. Someone once said: "Nothing is as predictable and constant as change."

Other Technology priorities and RTS issues related to soils and soil data management:

- **Need data warehouse operational for soils and other info, common NASIS database usable for the public and field offices.**

- **States are asking program developers to program their tools to automatically access and update soil databases on a monthly or quarterly basis for the data they rely upon**

- **Need to find a way to speed up digitizing of soils surveys - field really need them for use with Toolkit and GIS applications**

- **Recommend that State Soil Scientist should be completely involved with the development and display of information in Sec. II – eFOTG. The movement toward eTechnology is driving the need to have all resource inventory data available online. This task will require planning and coordination with IT folks, Program managers, and Technical leaders.**

- **Ideally, there should be common soils interpretation site (like South Carolina) on national server to assure updated information is being displayed. States could then link Sec. II to site. Apparently, NSSC in Lincoln is trying to secure the software to do this.**

- **State Soil Scientists and MO Leaders should network more with Regional Technology Work Groups (RTWG's) and RTS's. We all should be emphasizing in states that soils is part of the planning process. All too often soils info is skimmed over and left as an optional component of the conservation plan.**

We need Soil Scientist input and knowledge to create and transfer technology as well as identify technology needs related to soils. The RTWG's, MO's and State Soil Scientists should be cooperating on identifying the priorities and what is need to get the job done.

NEW TECHNOLOGY IN SOIL SURVEY MAPPING AND DELIVERY

Use-Dependent/Dynamic Soil Properties—Algorithms & New NASIS Calculations and Validations--*Cathy Seybold, NSSC, Lincoln, NE*

Use-dependant Properties-Soil properties that change with land use and management

- Projects--measuring use-dependant properties under different land use and management
- Soil Survey report
  - added value
- No consistency
  - Properties
  - Methods

SSSA Symposium, Indianapolis, 2002

- Title: Dynamic Soil Properties, Pedology and Soil Function.
- Purpose: Foster education, communication and research on dynamic soil properties.
- Sponsored by S-5, S-3 and S-7
  - 8 invited speakers, 6 volunteer speakers and 12 posters

The objectives of symposium are to: Apply pedological and ecological perspectives to the investigation, understanding and transfer of information about daily to centurial changes in soil properties. Encourage thinking and dialogue about near surface soil properties that change in response to natural cycles, management and climate change. Describe the dynamic nature of near surface soil properties and their role in soil functions and ecological processes.

Aspects of Incorporating Use-dependant data into Soil Survey

- **Objectives**
  - Give an example of differences in near-surface properties between two contrasting land uses within the same map unit component, using on-site methods.
  - Provide possible frameworks for incorporating use-dependant property information into Soil Survey.

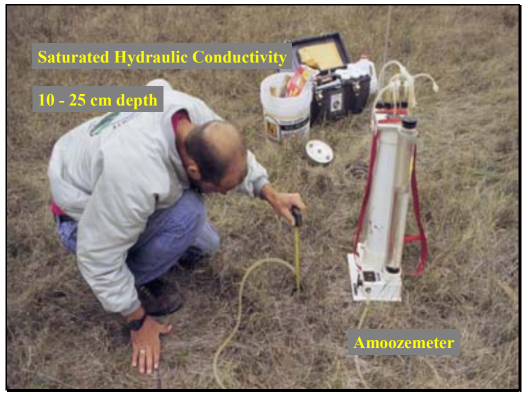
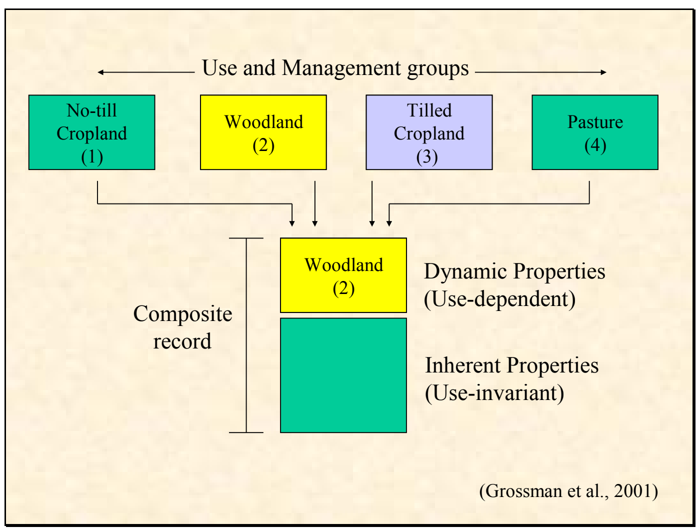


Illustration of the Amoozemeter, which measures the soil's ability to transmit water. Water movement is expressed as a saturated hydraulic conductivity (flux of water per unit of hydraulic potential).
Emphasize the difference between permeability and infiltration.
How can management effect permeability?



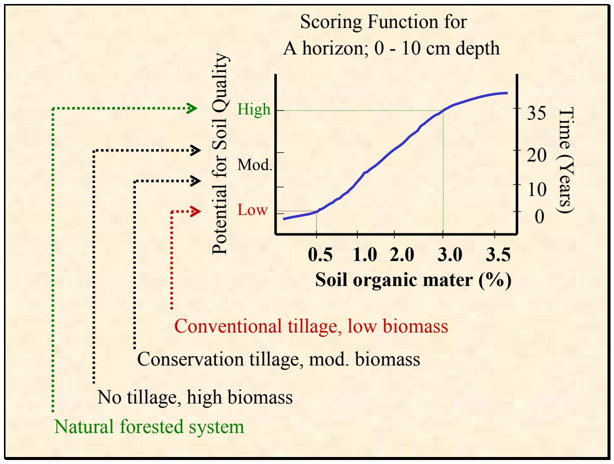
Use and Management Groups

- degree & intensity of soil disturbance
- crop rotation and vegetation diversity
- biomass production
- fertilization, amendments
- time
- soil resilience
- climate

Database Options

- Use-dependant database, separate from NASIS
  - linked through the map unit component
- Incorporate use-dependant data into NASIS
  - measured or estimated

- Incorporate use-dependant information into NASIS
  - no data is entered



Validation/Calculation Committee
- Purpose:
  - Evaluate and recommend validations and calculations for NASIS
- Members:
  - Cathy Seybold (Chair), Ricky Bigler, Bob Grossman, Joyce Scheyer, Tom Reinsch, Curtis Talbot, Jim Fortner, Karl Hipple
- 41 calculations and validations
  - Algorithms (pedotransfer functions)
- Recent releases
  - Atterberg limits
  - Particle size estimator - version 2
  - Correct case for component name and map unit name

Solving Val/Calc Problems
- Description for Val/calc
- Documentation
  - Soil Survey technical notes
    - Pedotransfer functions
      - how calculation works in NASIS
      - limitations and reliability
- Program script in NASIS
- Contact NSSC

Calculations - In Progress
- Unified and Aashto
- Percent Passing Sieves
- Atterberg Limits - Enhancements
  - Spodisols and Andisols
- CEC
- ECEC
- Bulk density

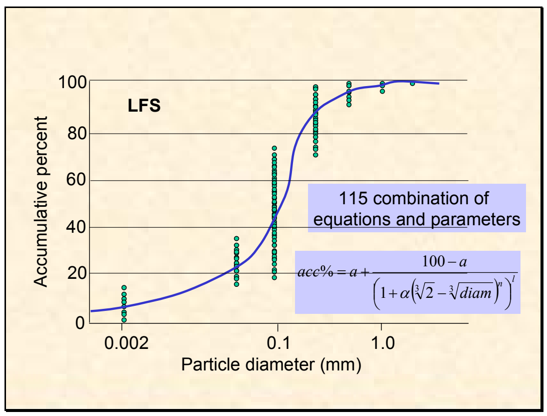
- LEP, Kf, Kw, AWC,

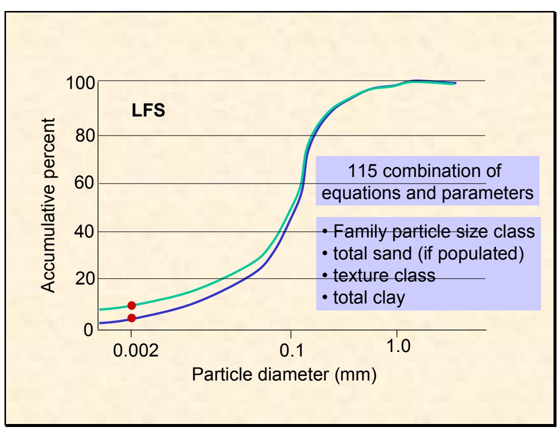
Validations

- In Progress
  - Bulk density
  - CEC and ECEC
- Current validations
  - Particle size class vs. particle size separates
    - enhancements
  - Unified

Particle Size Estimator

- Input parameters
  - % clay
  - texture class
  - Family particle size
  - % sand (if available)
  - Estimates (vcos, cos, ms, fs, vfs, total sand, total silt)





Particle Size Estimator

- Tested on 145,435 particle-size distributions
  - less than 0.001% failure rate

- Estimated values do not represent the range of values possible for a particle size class.
- Provides an estimate around a central tendency for a particle size class.
- Is not reliable to estimate the particle separates for a given sample.

Geophysical Initiative within the Natural Resources Conservation Service—*Wes Tuttle, NSSC, Wilkesboro, NC*

The USDA-NRCS uses geophysical methods for site and resource assessments. In recent years, three noninvasive geophysical methods, ground-penetrating radar (GPR) and electromagnetic induction (EMI), and towed array resistivity units have gained acceptance and have witnessed dramatic expansions of applications within NRCS. These geophysical methods have been used to support soil, archaeological, engineering, and geologic site assessments.

Ground-penetrating radar has been used to determine the depths to soil horizons, bedrock, water table, and geologic strata; locate natural hazards including karst features, cavities, soil piping, voids under and within earthen structures; profile geomorphic or stratigraphic features, river and lake bottoms, and peat; and estimate rates of sedimentation. The use of GPR is highly site specific and interpreter dependent. Observation depths have ranged from < 1 to about 40 meters.

Electromagnetic induction has been used to support high-intensity soil surveys and site-specific farming, estimate areas of ground water recharge or discharge, and salinization; map areas affected by salt water intrusion or oil brine; determine the presence and extent of seepage from animal waste-holding facilities, filter strips, landfills, and mine tailing ponds; and locate the most appropriate sites for the placement of sampling sites in complex environments. Results of EMI surveys have been used as supporting documentation in a lawsuit, and as justification for the relocation of a public school site by FEMA. Present equipment allows interpretations to be made from theoretical depths of 0.75 to 60 m.

With the support of the National Office, the soil staff in Illinois purchased the Veris Technologies 3100 Soil EC Mapping System (towed array resistivity). This mobile system integrates GPS, computer-graphics, and resistivity to assess and map apparent conductivity within the upper 30 and 90 cm of the soil profile. This system has been used to map the spatial variability of soils and soil properties and to support site-specific farming initiatives.

Advantages of these geophysical methods include continuous spatial coverage, speed of operation, flexible observation depths, and high to moderate resolution of subsurface features. Results of EMI or GPR surveys are interpretable in the field. These methods can provide in a relatively short time the large number of observations needed for site characterization and resource assessments. Maps prepared from correctly interpreted data provide the basis for evaluating site conditions and for planning further investigations.

Ground-penetrating radar and electromagnetic induction are being used by a large group of customers, in diverse settings, to resolve a variety of problems. Customers have diverse needs and include: agronomists, archaeologists, biologists, engineers, hydrologists, foresters, geologists, range specialists, sanitary engineers, soil scientists, and urban and watershed planners.

Present Disposition

Presently, NRCS has five GPR systems. These systems are in Florida (2), Massachusetts (1), New York (1), and the National Soil Survey Center (1). The systems in Florida and Massachusetts were bought by these states in the early to mid-1980's and upgraded in the late 1990's. New York received its unit in the late 1990's. These systems were bought principally to support soil survey operations. However, as the number of on-going soil surveys declined, GPR has been used to support a wider variety of NRCS activities in these states.

The use of electromagnetic induction is more wide spread in NRCS. Compared to a GPR system, EMI meters are less expensive and easier to operate. In conductive mediums, electromagnetic induction is a more appropriate tool than ground-penetrating radar. The EM38 meter, was developed for salinity appraisal and mapping. As a consequence, some western states bought EM38 meters in the 1980's. Unfortunately, many of these EM38 meters were bought for a singular purpose and are used infrequently.

Since the early 1990's, the National Soil Survey Center has pursued an aggressive program of training NRCS personnel on the uses of the EM38, EM31, EM34-3 meters, and more recently, the GEM300 sensor (multifrequency electromagnetic induction sensor). Training on the use of the EMI meters and data interpretation has been provided to over four hundred, NRCS staff personnel (conservationists, engineers, geologists, and soil scientists). In addition, a program of lending EMI meters to interested states has been pursued by the National Soil Survey Center. This program allows states to use EMI meters and evaluate the compatibility of EMI with their programs at no cost. This program has resulted in the purchase of EM31 and EM38 meters by NRCS staffs in Colorado, Illinois, South Dakota, and Virginia.

This past fiscal year, as part of the Geophysical Initiative Program sponsored by NHQ and after extensive field tests, the MO6 staff in Lakewood, Colorado, purchased a GEM 300 sensor and Dualem2-4 meters. To satisfy the expanding number of requests for field assistance, a new position, Soil Scientist (Geophysical), was added to the National Soil Survey Center's Investigation Staff. This position is located in North Carolina and though this soil scientist will provide expanded geophysical services to states and MO offices throughout the United States, special emphasis will be placed on providing field assistance to MO13 (Morgantown, WV), MO14 (Raleigh NC), and MO18 (Lexington, KY).

The Future

The use of geophysical techniques within the Soil Survey Division and NRCS is expanding. While gains have been made, the expanded use of geophysical methods within NRCS remains modest. The Soil Survey Division of the Natural Resources Conservation Service is an acknowledge leader in the use of GPR and EMI techniques for the investigation of soils. An expanding need for geophysical field assistance exists and has been demonstrated within NRCS. It is impractical to have specialists in each state. A regional approach is recommended. This approach would enable individual states to have access to these geophysical tools, associated technologies, and a specialist. It would be more cost effective for NRCS to staff several MO offices with a specialist and to keep this person well equipped with the necessary tools. A regional approach would decrease unnecessary expenditures by individual states, and would improve the expertise and technological edge of NRCS. A regional approach would also increase the availability of geophysical services to states. While the acquisitions of the Veris Technologies 3100 Soil EC Mapping System in Illinois and EMI tools in MO6 have expanded the use and applications of geophysical methods into the mid-west and west, staffing and equipping with suitable tools the far west, southern and northern plains are high priority goals. Recently, multiple uses of EMI in support of on-going programs have been successfully demonstrated. Several of these states are actively seeking equipment of their own.

3dMapper—*Ken Lubich, USDA-NRCS, Madison, WI*

3d Mapper

- By product of SoLIM Project. Free version developed with project funds available on FTP site
- Dr. Jim Burt was funded by the project the first two years, but has continued developing 3dMapper on his own during the past year.
- Now planning to market a commercial version with several enhancements
- This is a better alternative than trying to get more funding for further development.
- 3dMapper allows user to view and digitize data in 3d.

This program contains a test version of 3dMapper. The test version has a number of new features not present in the public-domain version, including:

Shapefiles import and export
Polygon topology
Slope breaks as vectors
Cut and paste arcs between layers
Generalize (simplify) arcs
Spline-fit (smooth) arcs
Palette construction when importing raster files
Save local 3d view as jpeg or gif image

This test version will stop working on January 1, 2003.

For more information contact Jim Burt or A-xing Zhu (jburt@geography.wisc.edu, axing@geography.wisc.edu).
Please note, the public-domain version of 3dMapper is available at http://solim.geography.wisc.edu.

Landscape Analysis Applications For Field Soil Survey—Panel Presentations—*Sheryl Kunickis, NRCS, Washington, DC*

A PANEL PRESENTATION

Duane Simonson - Wisconsin
Toby Rodgers - Washington
Suzann Kienast - Utah
Davis Howell - California
Anthony Khiel - Tennessee

- What kind of training will be required?
- What are the best ways to equip offices? For example, do we buy the equipment and provide it to offices, or should we have specialists in specific areas that provide support?
- With regard to the specific technology in which you are working, explain how it can improve the soil surveys that are produced. Who is the customer of this technology (internal or external)?
- What are the roadblocks in implementing new technologies in the field?
- What recommendations do you have that would assist the Soil Survey Division in its plan to implement new technologies?
- What can we do *now*?

Towards the Implementation of Automated GIS Soil Mapping Techniques—*Toby Rodgers, NRCS, Okanogan,WA*

T.M. Rodgers, USDA-NRCS, 1251 South Second Ave., Okanogan, WA 98841; A.J. Busacca, B.E. Frazier, Dep. of Crop & Soil Sciences 6420, Pullman, WA 99164-6420; P.E. Gessler, Dep. of Forest Resources, University of Idaho, PO Box 441133, Moscow, ID 83844-1133

Wilderness areas in the western United States have historically been excluded from soil inventories due to the huge investment of time and resources required to map them. Computer-based models of remote areas lessen the need for intensive field transecting and may provide a cost-efficient alternative to traditional mapping and cartographic techniques.

We constructed a fourth-order soil survey of the Pasayten River watershed in the Pasayten and Sawtooth Wilderness Areas of northern Washington State using field studies, remote sensing data, and Geographic Information System (GIS) technology. With a GIS we were able to parameterize soil-landscape relationships using digital elevation topographic indices, remotely sensed vegetation classifications, and climatic data in conjunction with knowledge gained during three consecutive field seasons. We used a command-line system within the GIS environment to query the data layers in a hierarchical sequence based on relative importance of consecutive data layers. Map unit designations based on documented soil-landscape relationships were then assigned to computer-based geographic delineations. Soil components of each map unit were classified at the subgroup level of Soil Taxonomy.

Twenty-one map units were created to represent the mix of Andisols, Inceptisols, and Spodosols observed in the project area. Cross-validation revealed an eighty percent agreement between model and field classifications of individual pedons. Forty-seven percent of the wilderness area is represented by just three mapping units; Typic Vitricryands - Andic Haplocryods complex (18 %), Typic Vitricryands - Andic Dystrocryepts - Rock outcrop complex (16 %), and Lithic Eutrocryepts - Andic Eutrocryepts complex (13 %).

GIS-Based Landscape Analysis for Advancing Soil Survey--*S. Kienast, USDA-NRCS, J.L. Boettinger, Utah State University*

Phase I -Circle Cliffs project
Exploration of GIS landscape analysis for soil survey
Phase II-Protocol for applying GIS landscape analysis to traditional soil survey

Examples from current projects
- Why GIS-based analysis for soil survey?
- Improve efficiency and quality of traditional soil survey methods
- Fewer soil scientists, same workload and quality expected
- Visualize landscape patterns at multiple spatial scales
- Allows information used to create soil map to be preserved in GIS layers
- Allows quantitative descriptions of map unit concepts

Phase I - Circle Cliffs Project
- Objectives
- Conduct a soil survey using traditional methods
- Develop GIS-based methods to improve efficiency and quality of soil survey
- Increase efficiency and quality of soil survey documentation
- Quantify and validate soil map unit concepts

Circle Cliffs Soils
Documentation Analysis
- Question-How does the soil scientist know when a map unit has adequate documentation?
- Objective-Develop a simple method to represent and analyze soil map unit documentation using GIS

Documentation Analysis
- Method compares percent of total area covered by each map unit to the percent of total points occurring in each map unit
- Method assumes that a map unit is accurately represented if:
- % of soil data collection points = % of the total area covered by the map unit
- Method can be adjusted for map unit complexity as needed
- Analyzed in ArcView

Results
Discussion-Perform analysis during different mapping stages
Pre-mapping-Determine minimum number of data points
- Field mapping
- Track progress
- Allocate resources efficiently
- Refine data collection according to map unit complexity

Conclusion
- This rapid GIS method is relatively simple to complete
- Method would provide--
  - Accurate representation of the soils in a survey area
  - Consistency
    - between soil scientists in data collection
    - between their respective areas of the survey

Landscape Analysis for Defining and Validating Map Unit Concepts
Questions--
- How can the landscape characteristic degree of dissection (drainage density), low or high, be defined quantitatively?
- Can map unit concepts be validated using landscape analysis?

Moenkopi Soils
Moenkopi – Landscape Analysis
Objective-Test and develop methods that employ GIS as a landscape analysis tool for quantitatively defining and validating Moenkopi map unit concepts
- Average slope and slope distribution by map unit as a proxy for degree of dissection
- Drainage density as a measure of degree of dissection

Methods
- Create a slope grid from DEMs
- Calculate average slope and slope distribution histogram for each map unit
- Create plan curvature grid from DEMs
- Separate area in drainages for each map unit
- Calculate percent area in drainages
- Compare average slope and slope distribution between map units
- Assign low or high degree of dissection to map units
- Compare results to initial degree of dissection determination from aerial photography
- Compare drainage density between map units
- Assign low or high degree of dissection to map units
- Compare results to those from aerial photography analysis and slope analysis

Conclusion – Moenkopi Landscape Analysis
- Landscape analysis useful for quantitatively defining and validating Moenkopi soil map unit concepts
- Average slope and slope distribution are a valid proxy for degree of dissection
- Drainage density valid measure of degree of dissection

Phase II - Protocol
- Developed as a result of Circle Cliffs project
- Combines traditional soil survey methods with GIS landscape analysis methods
- Uses simple GIS analyses and resources currently available
- Guideline for soil scientists
- Allows creative freedom

Protocol
- Compile data
- Analyze data
- Digitize initial soil lines
- Collect field observations
- Develop and refine map unit concepts

Iteration of steps as needed:
Compile digital data
Digital elevation models (DEMs)
Digital orthophoto quads (DOQs)
Geology
Bedrock and/or surficial
Vegetation
Remotely sensed spectral data
Complete initial analyses
- DEMs
- Slope, aspect
- Hydrological properties
- Flow accumulation, direction, curvature, etc.
- Combinations plus many other possibilities!
- Remotely sensed spectral data
- Unsupervised and supervised classifications for vegetation, wetness, salts, etc.

Heads-up digitizing
- Create initial soil lines from information gained from initial analyses

Run documentation analysis
Allocation of resources in field

Create maps from steps 1 and 2 for use in the field
Develop and refine map unit concepts
Define, validate, and quantify concepts throughout mapping process
Store data and map unit concepts in GIS layers
Iteration of steps as needed
Examples From Current Projects:
- Johnson County, WY
- New soil survey area
- Sedimentary rocks
- Siltstone vs. sandstone
- Wide range: topography and vegetation
- Analyses
- Slope
- Aspect
- Combine slope, aspect, and DEM
- Enhance landscape features
- Digitize initial soil lines
- Provides map for use in field
- Initial analyses and field observations prompt more questions and ideas
- Iteration of steps for refining lines and developing map unit concepts
- Use 10m DEMs (recently available!)

More analyses
- Curvature: degree of dissection
- Quantify landscape characteristics and map unit concepts
- Update soil survey
- Mainly concerned with refining map units with wet and saline components
- Soil/ecologic
- Site/hydrologic
- Lake plain sediments
- Very little topography
- DEMs will not provide information needed for refining map units
- Resolution
- Topography
- Remotely sensed spectral data
- Unsupervised and supervised classification
- Wet areas
- Salt crusts
- Vegetation

Use as TOOL for soil survey
- Incorporate GIS work and field work
- Iterative process
- Provides better sense of landscape characteristics prior to field work
- Larger spatial scale
- Increase efficiency in the field

Summary
GIS-Based Landscape Analysis
- Provides a better product more efficiently
- Develop digital product through mapping process
- Document tacit knowledge
- Soil-landscape model
- Quantify map unit concepts
- Storage of information; Easy to revise

GIS and Soil Distribution Modeling--*David Howell, Soil Scientist – State Soil Survey GIS Specialist, NRCS, Arcata, CA*

Introduction

Geographic Information Systems (GIS) and statistical modeling methods provide the tools to allow progress toward the goals of Dokuchaev and Jenny. Each of them felt that geographic information about the distribution of soil-forming factors would support pedological research (Dokuchaev, 1899)(Jenny, 1941). Soil scientists will develop the appropriate use of these new geographic tools for soil science processes. But, new geographic tools should not be mistaken for new soil science knowledge.

Soil distribution modeling research is occurring in many countries. The Netherlands, Australia, England, and France have been actively developing these methods, along with some activity in the United States, Russia, and many other countries. Early work in England established the use of computers in estimating the distribution of soil properties (Webster and Burrough, 1972). Most of the work uses functional relationships between soil-forming factors and the resulting soil properties, as described by Jenny. Jenny felt that these relationships should be quantitatively solved in as many places as possible (Jenny, 1941). Soil scientists have been involved in this work (e.g., McSweeney et al., 1994), but other disciplines have been drawn to these subjects as well.

There have been some misunderstandings of NCSS soil survey publications by some of the modelers who are not soil scientists. Some of these misunderstandings have been repeated by subsequent workers. The most common misunderstandings are that: polygons enclose homogenous areas; polygons enclose soil series; polygons show areas that all have the same properties as the modal profile; and that soil scientists would be able to show the location of nearly all soils if the scale was large enough. Some modelers also prefer continuous raster soil maps, rather than polygon maps. There has been much discussion of continuous soil attributes or fuzzy values, so that the soil condition at a particular location can have partial membership in several classes, rather than having single discrete class assignments.

NCSS publications and SSURGO data state that there is a range of characteristics for each component; that there are similar soils present; and that there are minor components within the mapped areas. This information is not utilized by modelers when evaluating NCSS soil mapping. The high, low, and representative values for each soil property could easily be used in raster analysis. Simple multiple grid queries or the use of grid stacks could provide more appropriate analysis. In truth, at any particular point on the earth soil scientists do not know what the value of each soil property is. But through field investigations they develop ranges in characteristics that represent dominant conditions. The entire range of characteristics is our estimation for each point within a map unit. Our knowledge and our field data may not support more specific soil property information. This is an example of distinguishing between new geographic tools and new soil science knowledge.

It is important to carefully plan what to model. Soil Taxonomy applies to soil individuals. We use the taxonomic system to classify individual soil pedons. We can not classify populations using a taxonomic key. The taxonomic system provides a useful way to characterize dominant soils so that we can communicate information about individual soils. But the taxonomic system does not provide an appropriate system for modeling continuously varying soil properties. We map map units - so that we know what the dominant components are - so that we know what the dominant soil properties are - so we can interpret the soil property information for users.

Models should be developed to directly estimate the distribution of important individual soil properties or soil genetic horizons. The outputs should be generalized classes or fuzzy membership values. The application of separate models for important soil characteristics provides estimates that allow each characteristic or property to vary independently and continuously across landscapes. “The explicit prediction of individual properties is advantageous because soil properties usually display contrasting scales of variation” (McKenzie et al., 2000).

It is also important to decide what the models will be used for. At the present time model outputs are best suited to helping soil scientists as pre-mapping tools. They should be treated as estimations of trends in the distribution of soil properties. They should be designed to help soil scientists learn about the influences of the soil-forming factors. They can be used to help with sampling design with a goal of increasing efficiency, enhancing quality of field documentation, and increasing the depth of understanding of soil-landscape relationships.

The models can not replace the need for field soil data collection. They can not replace the need for a soil map prepared by a soil scientist based on field data. At this time digital data about the geographic location of soil-forming factors is a limitation for model estimations. Short-range variation of soil properties is much finer than the resolution of most soil-forming factor data. In particular, geologic information is inadequate. In many areas geologic information describes entire formations rather than individual rock types. Geologic information usually has very little field documentation and very little attribute data. In addition, the original development scale is often too small for detailed soil modeling. Geologic data are usually represented as polygons.

Current Work

In California efforts are underway by NRCS in collaboration with Humboldt State University, National Park Service, and the Bureau of Land Management to develop methods for soil distribution modeling. There are several reasons for this work. There are vast areas (>10,000,000 acres) of unmapped soils on public lands. Some of these lands have widely dispersed land use that requires only low resolution soil information. One goal is to increase speed of soil mapping. Another goal is to reduce cost. Many GIS and remote sensing techniques are being evaluated.

In addition to the unmapped public lands, there are unmapped private lands (>4,000,000 acres), and other areas that need to be updated. There is a need for regional coordination of soil mapping when updates are completed. There is a need to develop methods for extracting soil-forming factor relationships from current SSURGO data adjacent to areas when they are updated. But most of the current attention will be focused on supporting ongoing first-time soil survey work.

In areas that have not been previously mapped and correlated to NCSS standards, NRCS is developing the use of point data and statistical models to estimate the soil-forming factor relationships to soil properties. The goal is to develop pre-mapping tools. Primary support for development of the statistical models will come from Yoon Kim, Ph.D., Associate Professor, Statistics, Humboldt State University. Soil science concepts, GIS modeling, and model development and tuning will be provided by NRCS soil scientists and soil science GIS staff.

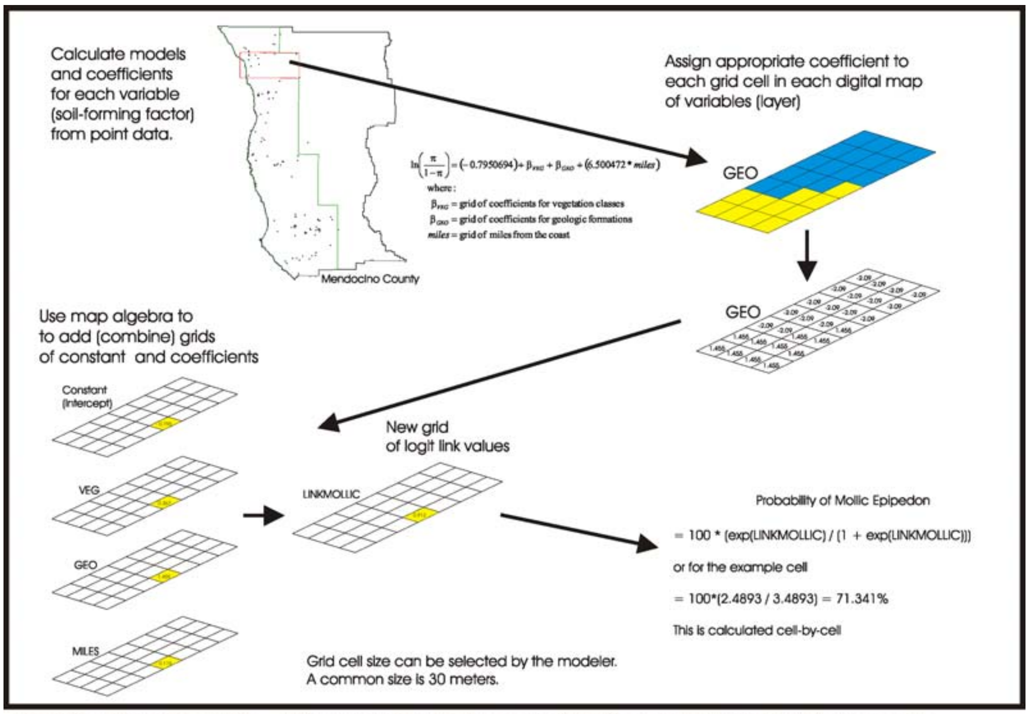
Each soil profile description (point) provides an inventory of the pertinent independent variables (soil-forming factors) and the resulting dependent variables (soil properties or horizons to be estimated). The relationships between the soil-forming factors and the resulting soil properties will be estimated through regression modeling methods (e.g., generalized linear model, generalized additive model, or regression tree model). Only independent variables that statistically significantly improve the fit of the model will be included. After the models are developed the mathematical relationships are applied to the soil-forming factor spatial data (GIS raster maps of the soil-forming factors) through the use of grid map algebra.

The point data are extracted from NASIS using data dump queries. So it is important that these NASIS point data are entered during the ongoing soil surveys. Accurate location coordinate information is also critical to the modeling work. Additional variable data or class assignments (e.g., compound slope shape, slope position, or distance from the coast) are added using GIS calculations for the geographic coordinates of each point.

The current capabilities of field data recording will also be evaluated. There may be practical solutions to one-time data entry with the development of tablet computers and a specific tablet computer operating system. The use of the stand-alone Pedon program on a tablet computer could provide the tools to capture point data. Also, GIS software (ArcPad) and GPS capabilities could be implemented on the tablet computer. This coalescence of technologies could finally meet the field data recording needs of soil scientists.

The current work in California is developmental. We are evaluating methods and techniques. Two areas will be used for trials. Redwood National Park in coastal northern California and the Mojave Desert area in southeastern California represent very different soil-forming environments. The methods and techniques may be adaptable to other areas, but the specific models will have limited geographic applicability. We will keep an open mind during this phase. Some of these methods may need a great deal of development and adaptation. Some of these methods may not be successful. As the soil survey program develops these digital tools we should consider many different approaches.

We will focus on developing soil science processes using geographic tools, rather than developing geographic processes using soil science tools. According to Tandarich and Sprecher (1994) C.S. Sprengel was one of the first scientists to speak of the study of soils as a separate field. The German word he used to describe this field was Bodenkunde. This means soil knowledge (Sprengel, 1837).The German word Erdkunde means knowledge of the world, or geography. The two words could be roughly translated to mean similar things but are different fields of study. The soil survey program is involved in the development and dissemination of soil knowledge. Soil scientists should be very involved in the development of these soil distribution models.



Modeling Process Example – This is an example of a generalized linear model using logistic regression. Other types of models will be evaluated.

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SOIL DISTRIBUTION MODELING
USING STATISTICAL MODELS AND
GEOGRAPHIC INFORMATION SYSTEM METHODS
SELECTED LITERATURE

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AUG7NAL1 Date not needed after: September 30, 2001
David Howell
NRCS, USDA
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Agriculture, ecosystems & environment.Oct 2, 2000. v. 81 (1)
Lagacherie, P.
A spatial approach using imprecise soil data for modelling crop yields over vast areas.

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SoLIM in Dane County Wisconsin--*Duane Simonson, Project Leader, USDA-NRCS, Richland Center,WI*

SoLIM,Soil-Land Inference Model, is a GIS/export knowledge-based fuzzy soil inference. The scheme consists of three major components: a model employing a similarity representation of soils, a set of inference techniques for deriving the similarity representation, and use of the similarity representation. The similarity representation allows the soil landscape to be considered as a continuum, and thereby overcomes the generalization of soils in conventional soil mapping. The set of inference techniques is based on the soil factor equation and the soil-landscape model.

The soil-landscape concept contends that if one knows the relationships between each soil and its environment for an area, then one is able to infer what soil might be at each location on the landscape by assessing the environmental conditions at that point. Under the SoLIM scheme soil environmental conditions over an area are characterized using GIS/remote sensing techniques. The relationships between soils and their formative environmental conditions are extracted from local soil experts or from field observations using a set of artificial intelligence techniques. The characterized environmental conditions are then combined with the extracted relationships to derive a similarity representation of soils over an area.

It is demonstrated through two case studies that the SoLIM scheme for soil survey has many advantages over the conventional soil survey approach. Soil information products derived through the SoLIM approach are of high quality in terms of both level of spatial detail and degree of attribute accuracy. In addition, the scheme shows promise for improving the efficiency of soil survey and subsequent updates through reducing time and costs of conducting a survey. However, the degree of success of the SoLIM approach highly depends on the availability and quality of environmental data and the quality of knowledge on soil-environmental relationships over the study area.

Using Remote sensing Techniques on the Great Smoky Mountains National Park Soil Mapping Project--*Anthony Khiel, Roy Mathis and Doug Thomas, USDA-NRCS, TN & NC*

The making of a soil map layer for the Great Smoky Mountains National Park's geographic information system (GIS) is in process. Historically soils maps in other places have been made with many on-site observations. The patterns of soils were often well understood. We continued to do on-site observations to improve line placement between map units. However, access in the Park is very limited and the terrain is rugged. Alternative methods for making soil maps are needed. One of the remote sensing techniques is the SoLIM process.

So how does map-making relate to remote sensing techniques? Map-making is determining which map units you want identified and then placing lines between them on some map base. The quality of the product is dependent on the purity of the map unit and the accuracy of line placement.

Remote sensing is when maps are made of a survey area with limited on-site observations.

- What kinds of remote sensing techniques are we using?
- Signatures from a photographic base,
- Other data layers or set boundaries, and
- Model building.

Signatures from a photographic base.

- An image on the photobase can be a signature for a map unit or a group of map units. It may represent a particular geology, landscape position, vegetative cover or micro-climate.
- The signature defines the boundaries of a map unit or group of map units and makes the line placement possible.
- The signature is verified by on-site observations where map units are accessible.

Other data layers or boundaries

- Often these are very general boundaries like on a general soil map
- Examples are: Geology layers and elevation boundaries for temperature regimes
- The starting points for model development in the park are geology and temperature regimes

Model building

- Model building can be applied manually or with the SoLIM process. Careful on-site observations are made in accessible areas with some factors held constant. Such as geology and temperature regime.
- Map units are located by landscape position, vegetative cover, micro-climate, and the movement of soil material and rock fragments by gravity and/or water over the landscape.
- Patterns of map units are developed for each geologic and temperature regime combination used.

SoLIM

The SoLIM process is a cartographic tool that employs the use of inferences designed by the field soil scientist. Once the inferences are set up and field tested, they can then be applied to remote areas that are difficult to investigate in the field. Use and management issues must drive the model design and not the limitations of the software that is being used. The SoLIM process should only be applied where the GIS data layer set is as complete as possible.

Soil Survey Programmatic Issues—*Jim Ware, USDA-NRCS, Washington, DC*

SOIL SURVEY SCHEDULE (and PRMS)

THE NASIS SOIL SURVEY SCHEDULE IS A PROGRAM MANAGEMENT TOOL FOR PLANNING, MANAGING, AND TRACKING STATUS, MILESTONE EVENTS, AND PROGRESS OF THE NATIONAL COOPERATIVE SOIL SURVEY (NCSS)

Schedule is used to report progress of the NCSS, track milestone events, assess workloads, plan and manage business area operations, develop schedules and budgets, and for soil survey status graphics.

Schedule is designed primarily to track soil survey processes and progress for production survey activities. It is the official NRCS reporting tool for soil survey mapping performance.

THE SOIL SURVEY SCHEDULE CAN BE CONSIDERED A *"BLUEPRINT"* OF OUR **SOIL BUSINESS MODEL** FOR **TRACKING PROCESSES AND PROGRESS** TOWARD COMPLETION OF A **FINAL PRODUCT(S) FOR SOIL SURVEY AREAS**.
It should be emphasized that "Soil Survey Progress" includes inventory of the Nation's soil resources (mapping), development of related databases, and production of related products and interpretative materials. Progress, in the broadest sense, involves completion of all processes and steps to achieve a final soil survey product.

In addition to mapping progress, soil survey performance measures include digitizing (SSURGO), publications, and distribution of digital data (SSURGO and STATSGO). Except for distribution of digital data, all of these performance measures can be extracted from Schedule.

The existing Schedule functionality continues to meet the basic needs of the Soil Survey Program - however, legend management and acreage accountability for soil survey areas is a continuing challenge under the current platform. Adherence to protocols outlined in NSSH Part 608 and vigilance by Soil Survey Data Stewards are keys to maintaining viable and reliable data in Schedule.

A notable use of data in Schedule recently has been to address a Congressional inquiry for the status of mapping and mapping needs for Range Land across the Nation. The designation of acres by Land Categories, as well as mapping progress, status, correlation dates, and other metrics will serve as the basis for the final congressional report that was mandated to USDA and USDI.

A link is still pending between Schedule and PRMS. As resources and priorities of PRMS personnel permit, this link will be programmed.

Additionally, as resources and priorities of the Soil Survey Division permit, enhancements will be made to Schedule to reflect the long term business model for the National Soil Survey Program.

LIMITED AND DENIED ACCESS AREAS

Provisions dealing with "denied access" in Part 608.04 of the NSSH were recently revised and distributed in a memo. The revision simplifies the administrative process and allows for denied access areas to be identified on maps and in the manuscript, as well as accounting for acreage as part of the survey area defined by the MOU. It should be emphasized, however, that all efforts should be made to map all areas of the Nation, where possible.

IMAGERY AND ORTHOPHOTOGRAPHY

Quality imagery and orthophotography are keys to efficient field operations and quality soil survey maps.

NAPP (National Aerial Photography Program) continues to be the primary source of imagery for soil survey operations. For the last couple of years, imagery production has diminished because of reduced funding by some NAPP partners (NRCS being one). However, NAPP continues to be a viable national program involving many Federal and State partners.

NDOP (National Digital Orthophotography Program) continues to be the primary source of ortho for soil survey operations, with NAPP as the primary imagery source to produce the ortho. Like NAPP, NDOP production of ortho has diminished over the last couple of years due to reduced funding support. With that said, the "first generation" of digital ortho coverage for the "Lower 48" is essentially complete. The new focus of NDOP will be to produce "second generation" ortho.

NAIP (National Agricultural Imagery Program) is the new kid on the block. NAIP is a Farm Service Agency initiative which is intended to fly cropland for compliance. It will gradually replace the "35 mm slide" imagery. NAIP will be flown with crops in the field, primarily from mid June through mid August. NAIP may be useful for soil survey where NAPP imagery has traditionally been flown as "open season".

NAIP may well replace NAPP flights in many states. As such, supplemental funding may be necessary to fly counties where "leaf-off" imagery is essential for soil survey field operations.

SMITHSONIAN SOILS EXHIBIT

In November of 2001 the Outreach Committee of the Soil Science Society of America (SSSA) approved "A Proposal to Place the State Soil Monoliths into the National Museum of Natural History".

The initial grant from SSSA, along with FY 2002 funding support by NRCS through an MOU, has resulted in a funding initiative that will be "officially" kicked off at the SSSA annual meeting in Indianapolis in November.

Plans are to raise sufficient funds to place all State Soil Monoliths in the Smithsonian as part of the "Forces of Change" Exhibit. Approximately $300,000 is needed, initially, to place the monoliths on exhibit. This exhibit is expected to extend for the next 5 to 8 years, as a minimum. Additional soils themes will be added, as funding permits.

Visitors to the Smithsonian total 6 to 9 million annually. This is an excellent opportunity to market soil survey and promote the soils profession to the public.

Innovations in Soil Survey Publications and Publication Status--*Nathan McCaleb and Mike Kortum, NCGC, Fort Worth, Texas*

Many changes and innovations are happening in the realm of soil survey publications. The driving force behind these changes is the needs of our customers.

Our customer needs are obviously trending toward the digital formats. Or is it? The more we talk about digital products the more I hear from states and cooperators that we must continue to publish hard copy soil surveys. Soil Surveys are still being published in hard copy. However, new ways of publishing are being explored such as digital publishing and desk top publishing.

There are some tools being developed the states can use now. Changes to the DMF processes are letting us use white lines for roads and other boundaries. Also, the soil lines have extended about 300 meters outside the boundary for ease in creating and using the maps.

Also, the technology for putting Soil Survey on CD-ROM is getting better. At NCGC we are looking at some quick but high quality processes for preparing and delivering soil survey. There should be an increase in Soil View availability this year also.

New processes have been developed to create general soil maps. These processes are written so that any state office should be able to make their own general soil maps. This should expedite the completion to publication ready maps. Also, this process will give the states the ability to create a standard base map for use in variety of applications.

The Resource Data Gateway is a valuable tool that will probably play a more important role in the future of soil survey along with the Geospatial Data warehouse. This application currently can provide a wealth of spatial information that is useful in soil survey.

NCGC also produces imagery for soil survey mapping and compiling. In the future, we will be supplying imagery (possibly served thru the Geospatial Data Warehouse) for field mapping and compiling for publication.

Publication Status

text_status

SS To	Area_Symb	Area_Name	Date Blue	Date PreBind	Date Distribu	SS Complet
12/18/200	NV766	ElkoSoutheast Part	1/25/2002	3/29/2002	4/3/2002	5/3/2002
1/10/2002	TX161	Freestone	2/25/2002	7/24/2002		
1/24/2002	LA011	Beauregard	3/25/2002	5/9/2002	5/22/2002	6/22/2002
1/24/2002	CA694	Mendocino Western Part		7/3/2002	7/24/2002	8/24/2002
2/7/2002	TN089	JEFFERSON	4/16/2002	8/5/2002	8/13/2002	
2/7/2002	WV003	BERKELEY	4/29/2002	8/12/2002	8/28/2002	
2/14/2002	TX615	LOVING/WINKLER	4/15/2002	7/11/2002	7/23/2002	
2/28/2002	ND073	RANSOM	5/22/2002	9/10/2002	9/27/2002	
2/28/2002	ND039	GRIGGS	5/28/2002	7/2/2002	7/23/2002	
2/28/2002	NV777	HUMBOLDT-EAST PART	4/29/2002	7/16/2002	7/19/2002	
2/28/2002	MO151	OSAGE	6/13/2002	9/12/2002	9/19/2002	9/23/2002
3/20/2002	MT101	TOOLE	6/19/2002	7/31/2002	9/27/2002	10/31/200
3/28/2002	KY641	MAGOFFIN/MORGAN	5/2/2002	6/20/2002	7/24/2002	
3/29/2002	MD021	FREDERICK	4/30/2002	6/4/2002	6/13/2002	
4/5/2002	ND051	MCINTOSH	5/20/2002	6/17/2002	7/16/2002	
4/11/2002	AK642	NORTH STAR	6/4/2002	7/16/2002		
4/12/2002	TN013	CAMPBELL	6/11/2002	9/10/2002	9/26/2002	
5/3/2002	ID608	ST. JOE AREA	9/20/2002			
5/7/2002	NY027	DUTCHESS	8/5/2002	11/4/2002		
5/7/2002	NV783	NYE-NE PART	8/29/2002	10/17/200	10/25/200	
5/23/2002	TX321	MATAGORDA	7/25/2002	8/26/2002	9/23/2002	
5/23/2002	IL045	EDGAR	7/15/2002	10/3/2002	10/28/200	
5/23/2002	PA133	YORK	7/8/2002	8/26/2002	9/23/2002	
5/30/2002	ND105	WILLIAMS	5/29/2002			
5/30/2002	IL027	CLINTON	7/25/2002	10/16/200	10/25/200	
5/30/2002	AK615	GERSTLE RIVER	7/26/2002			
5/30/2002	MI069	IOSCO	8/6/2002			
6/5/2002	NJ039	UNION	8/6/2002	10/2/2002	10/2/2002	
6/5/2002	TX147	FANNIN	7/31/2002	11/4/2002		
6/13/2002	AK600	MATANUSKA/SUSITNA VALLEY	10/11/2002			

SS To	Area_Symb	Area_Name	Date Blue	Date PreBind	Date Distribu	SS Complet
6/18/2002	TX225	HOUSTON	8/5/2002			
6/18/2002	TN021	CHEATHAM	7/30/2002	9/16/2002	9/23/2002	
7/3/2002	LA013	BIENVILLE	9/24/2002			
7/23/2002	WI019	CLARK	10/16/2002			
7/23/2002	IL111	MCHENRY	10/11/2002			
8/2/2002	TN043	DICKSON	9/19/2002	11/5/2002		
8/5/2002	MO057	DADE	10/23/2002			
8/26/2002	NV781	NYE - NW PART	10/16/2002			
8/30/2002	WV624	CALHOUN/ROANE	10/17/2002			
9/6/2002	WA648	Colville Indian Reservation	10/31/2002			
9/6/2002	OH031	COSHOCTON	10/31/2002			
9/9/2002	AK639	LOWER KENI PENN.	10/23/2002			
9/10/2002	MT622	GALLATIN CO AREA				
9/18/2002	TN057	GRAINGER				
10/21/200	IL035	CUMBERLAND				
10/21/200	WI091	PEPIN				
10/21/200	AL107	PICKENS				
10/22/200	TN139	POLK				

MLRA Project Management – the vision and progress--*Earl Lockridge, NSSC, Tom Calhoun, NHQ, Dennis Potter, SSS, MO*

Training for soil scientists who are managing soil survey projects has been largely relegated to that provided by the Project Leader who trained them. The quality of that training has been entirely dependent on the experience and expertise of their supervisor. Soil Scientists, for years, have identified a need to have a course that, at least in part, presents information about how to effectively manage a soil survey and provides the tools needed to accomplish that task. With the move to the MLRA concept of conducting soil surveys a request for the training was formally made by MO–11. The course was submitted to and approved by the National Employee Development Committee in 1998 and we met with a design team in June 1999. As they say, the rest is history.

Correlation and Management of MLRA Soil Surveys—*Earl Lockridge, NSSC, Lincoln, NE*

Course Update and Overview-- History and Development

Design Team - April 1999
Development Team - June 1999
Pilot - Ft. Worth - September 1999
Presented 8 sessions since Piloted

Objectives

- Analyze and evaluate existing soil surveys
- Develop an MLRA or other region project plan
- Describe the roles and responsibilities of the MLRA Project Leader, MLRA Office personnel, State Soil Scientist, and Sub-set Leader
- Apply MLRA Standard and Procedures to:
    - Gather and evaluate reference data
    - Establish methods for consistent data gathering
    - Conduct progressive correlation
    - Maintain and update OSEDs
    - Develop SSURGO products
    - Utilize NASIS for correlation activities
    - Prepare soil data for delivery in various formats
    - Utilize new technology for MLRA and other region project development and delivery

Location of Training Sessions

- Indianapolis, IN October 25-29, 1999
- Reno, NV February 7-11, 2000
- Alexandria, LA July 30-Aug. 3, 2001
- Rapid City, SD Sept. 10-14, 2001

• Raleigh, NC	Nov. 5-9, 2001
• Albuquerque, NM	Feb. 4-8, 2002
• Amherst, MA	June 10-14, 2002
• Columbia, MO	Aug. 26-30, 2002

Cadre Members:

Earl Lockridge, NSSC, Lincoln, NE
Tom Calhoun, NHQ, Washington, DC
Jeff Olson, Project Leader, Glenwood, AR
Dave Kingsbury, SDQS, Morgantown, WV
Mike Hanson, Asst. SSS, Bozeman, MT
Dennis Potter, SSS. Columbia, MO
Former Cadre Members
John Kelley, SDQS, Raleigh, NC
Charles Love, MO Leader, Auburn, AL
Steve Elmer, MLRA-PL, Rock Falls, IL

Two sessions scheduled for FY2003:

- **March 3-7, 2003 Columbia, MO**
- **July 14-18, 2003 Lincoln, NE**

Future Geospatial Tools for Soil Survey--*Christine Clarke, Resource Inventory Division, USDA- NRCS, Beltsville , MD*

Data Management-- Direction and Drivers

Examples:

- Field Service Center Agency business needs
  - Limited financial and human capital
  - Need for reliable consistent data
- Advancement in technology - facilities sharing resources
- OMB Circulars A-130, A-16 etc……
- Presidents Management Initiatives (E-government)
- Capital Resource Planning (data)
- System Architecture
  - Shared applications using industry standards
- Homeland Security
- OMB Circular A-16

SUBJECT: Coordination of Geographic Information and Related Spatial Data Activities, August 19, 2002

http://www.whitehouse.gov/omb/circulars/a016/a016_rev.html#2

- NRCS General Manual Title 170 Part 400

Cartography, Remote Sensing, Global Positioning Systems and Geospatial Data

http://policy.nrcs.usda.gov/scripts/lpsiis.dll/Main/home.htm

- USDA E-government policy

http://www.egov.gov/egovreport-3.cfm

E-Government Geospatial One-Stop

Office of Management and Budget E-Government initiative to improve the effectiveness, efficiency, and customer service throughout the Federal Government.

- Adopted by the President's Management Council (PMC) in October 2001 implements the "Expanding Electronic Government" reform outlined in the President's Management Agenda.
- The implementation of the Geospatial One-Stop will:

- Provide standards and models for the geospatial framework data content;
- Provide an interactive index to geospatial data holdings at the Federal and non-Federal levels;
- Initiate interaction between Federal, state, and local agencies about existing and planned spatial data collections; and
- Provide an online access point to geospatial data.

Guidelines for Ensuring and Maximizing the Quality, Objectivity, Utility, and Integrity of Information Disseminated by Federal Agencies (commonly referred to as the Data Quality Act)

OMB's guidelines require Federal agencies subject to the Paperwork Reduction Act (44 U.S.C. Chapter 35) to:

(1) issue information quality guidelines for the information the agencies disseminate;

(2) establish administrative mechanisms allowing affected persons to seek and obtain correction of information disseminated by the agencies on or after October 1, 2002 that does not comply with OMB or agency guidelines; and

(3) annually report to OMB the number and nature of complaints received by the agencies regarding agency compliance with OMB and agency guidelines and how such complaints were resolved.

http://www.ocio.usda.gov/irm/qi_guide/index.html

Sample Actions

- Develop Geodata Naming Conventions
- Develop and conduct geodata migration to central servers
- Identify Service Center Agency Geodata Administrators
- Procure data and application servers
- Increase telecommunications
- Integrate GPS and PDA tools into daily business practices
- Identify needed Service Center Agency geospatial related training needs.
- Integrate geospatial data requirements into system architecture

SCA Supporting Documents

GIS Data and Data Management

- Common Land Unit Standard (12/98)
- Geospatial Change Control Policy for Geospatial Data Directory Structure and File Naming Conventions (4/99)
- Standard for Service Center Data Naming (8/99)
- Geospatial Data Theme Inventory (8/99)
- Geospatial Data Acquisition, Integration, and Delivery National Implementation Strategy Plan (9/99)
- Geospatial Data Stewards (9/99)
- Standard for Geospatial Data (01/00)
- Geospatial Data Management Requirements ((05/00)
- Standard for Geospatial Data Set Metadata (8/00)
- Standard for Geospatial Data Set File Naming (8/00)

GIS Data and Data Management

- Geospatial Data Requirement Document (04/00)
- Improving Federal Geospatial Data Coordination (05/00)
- Security Analysis of Network Design Architecture Alternatives for Delivery of Data from USDA Data Centers (10/00)
- Implementation of Geospatial Data Warehouses (12/00)
- USDA Geodata Business Plan (01/01)

GIS Training

- USDA GIS National Training Strategy (6/99)
- Introduction to ArcView for USDA Service Center Agencies (6/99)

Strategy

Service Center GIS Strategy 2001, documents short and long term goals for critical infrastructure items required to support GIS in the SCAs. Budget requirements to meet each milestone is included. http://www.ftw.nrcs.usda.gov/remote.html

NCGC provides ESRI designed and customized GIS/GPS training to fit user needs. SCA staff are revisiting training needs and will update to reflect present environment and user needs. www.ftw.nrcs.usda.gov/gistraining/index.htm

Geodata provisioning--Developed to expedite the migration of existing geodata to centralized servers and support data sharing by SCA staff. Products include standard naming conventions and migration tools.

Geodata Provisioning -Training Objective

- Provide a framework and methodology for *consolidating, migrating, and managing shared geodata* for Service Center Implementation.
- All states participated, including Guam and Puerto Rico.
- 98% participation was from NRCS, 77% FSA and 71% RD
- Training completed October, 2002 by K. Green, ITC

Establishing Shared Geospatial Data at Service Centers

- Standardizing geodata directory structure
- Standardizing file names for geospatial data
- Migrating geospatial data at the Service Centers to the servers
  - Manual for Managing Geospatial Data Sets in Service Centers
  - Data Migration Tools

Data Migration Tools include: Geodata Conversion Utility with new Alias Tool and the SCDL

Vision of Geodata Management

To provide turnkey access to trusted geospatial data for Service Center and state staff; thereby enabling them to focus on their work rather than on obtaining, validating, and managing geospatial data at the local level.

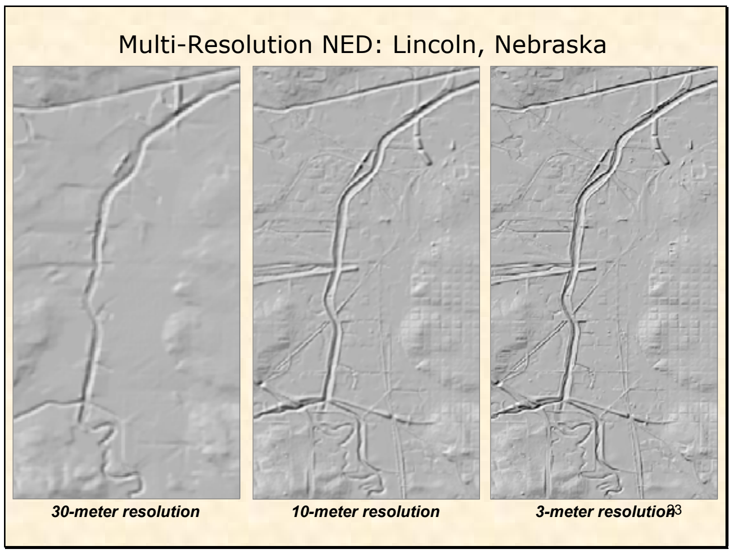
- Need for an enterprise geospatial system
- Need for new procedures due to technical nature, volume of data, security, and expense
- Need to ensure data currency, accuracy, completeness, authority, and objectivity
- Eliminate data redundancy

Currency, accuracy, completeness, authority and quality are research standards for material accepted in papers—applies to all types of data.

- Multi-resolution (nested layers)
  - 1-arc-second (30 meters)
  - 1/3-arc-second (10 meters)

- 1/9-arc-second (3 meters)

- High resolution, "non-standard" source data
  - LIDAR - light detection and ranging
  - IFSAR - interferometric synthetic aperture radar
  - Photogrammetric
  - Cartographic



The Elevation Derivatives for National Applications (EDNA) *(previously known as NED-H)*

- An interagency effort with its goal the development of a hydrologically correct version of the National Elevation Dataset (NED) and systematic derivation of standard hydrologic derivatives.
- The quality and wall-to-wall coverage of the high resolution digital elevation data, the development of the National Hydrography Dataset (NHD) and advances in GIS application of terrain modeling have made possible the development of these derivative data layers.

Mobile Data Computing Device Team

- Service Center Agency effort
- Goal: capture agency business needs for the use of field devices.
- Requirements used to support CCE procurement of hardware and software.
- Timeline:

  - procure devices October
  - capture business needs by January
  - develop contract avenue for agencies by spring
- Team lead: Frank Geter, ITC

MDCD Requirements collection sites

- Cultural Resource Compliance - Vermont
- Field Collection and Surveying - Survey Grade GPS and ArcView - Arkansas
- National Resources Inventory - Connecticut
- Soil Survey - South Dakota and Texas
- Conservation Planning - Michigan and Texas
- Wetland Reserve Program - Missouri

NRCS GIS Listserv

Open to all

To Subscribe: http://gis.itc.nrcs.usda.gov/discussion/subscribe_tool.html

To send message to all on list:

NRCS_GIS@lists.nrcs.usda.gov

TEUI Geospatial Toolkit Overview--*Eric Winthers, USDA- Forest Service*

Abstract
Terrestrial Ecological Unit Inventory (TEUI) endeavors to classify and map ecosystems based on environmental factors, including climate, landform, geology, vegetation, and soils. These inventories provide resource specialists with baseline information and serve as a core data layer in project planning, watershed analysis, and forest plan revision. The TEUI-Geospatial Toolkit accesses and combines the capabilities of remote sensing, geographic information system (GIS) technology, and raw computing power in an easy-to-use format, allowing TEUI specialists to formulate mapping concepts and digitize ecological units directly into GIS. This customized software application functions entirely within the Forest Service corporate hardware/software platform. Products generated by this toolkit utilize and are compatible with Arc/Info™, ArcView™, ERDAS Imagine™, Visual Basic™, Access™, Oracle™ databases, and the Forest Service's Natural Resource Information System Terrestrial Module (NRIS-Terra), as well as the National Soil Information System of the Natural Resource Conservation Service (NRCS). The TEUI-Geospatial Toolkit is helping modernize natural-resource inventory by providing specialists with tools to visualize, map, and interactively analyze terrestrial landscapes.

INTRODUCTION

Background

TEUI is one of the land-survey systems used by the Forest Service to classify and map ecosystems and provide baseline resource information so that local land planners can make informed and practical management decisions. TEUI stratifies landscapes into repeating ecological units based on abiotic factors of the physical environment and biotic variables like potential natural vegetation (PNV). According to Cleland et al. (1997), the purpose of a TEUI is to classify ecosystem types and map land areas that have similar management capabilities to a consistent standard throughout the national forest system lands (Winthers et al., 2001). TEUI products (maps, spatial and tabular databases, map-unit descriptions, ecological-type descriptions and interpretations) provide basic land-unit information that can be used in ecological and watershed assessments; burned area emergency rehabilitation (BAER), range-allotment plan updates, forest plan revisions, and project-level planning and analysis, as well as implementation and monitoring. Data collected through TEUI are stored and managed by the Natural Resource Information System Terrestrial Module (NRIS-Terra) and the National Soil Information System of the Natural Resource Conservation Service (NRCS), cooperators at ID team and public meetings.

The National Hierarchical Framework of Ecological Units is a land classification that provides a method for portraying terrestrial ecological units at multiple scales (Figure 1). It offers a way to stratify the Earth into progressively smaller and more homogeneous units and is deeply woven into the concept of TEUI. At the broadest level ecoregions are divided into subregions, landtype associations, and land units. Using these different scales, managers, scientists, and planners can address ecological concerns in an organized, strategic manner. For instance, landtype associations (landscape scale) are useful for forest or area wide planning and watershed analysis, whereas landtypes (land unit scale) are better suited for the project level to assist with resource analysis and on-the-ground planning. Traditional inventory mapping methods rely heavily on aerial photography (Soil Conservation Service, 1993). Unfortunately, this medium presents problems when large areas are being mapped. Photo-derived maps often reflect the bias of photo interpreters, adversely affecting the consistency of the TEUI product. In addition, spatial landscape analyses are usually conducted only after mapping has been completed, rather than being integrated into the process.

To fully utilize multiscale ecological information and share it within, as well as outside the agency, the Forest Service must collect consistent and continuous ecosystem baseline data, which is difficult to achieve using traditional methods. Remote sensing, GIS technologies, and raw computing power have dramatically improved over the last few years and promise to make the TEUI process much more efficient and consistent. Therefore, resource and geospatial experts are revising protocols in the *Terrestrial Ecological Unite Inventory Technical Guide* and developing state-of-the-art tools to assist specialists.

To address these tasks, a project team has been assembled, consisting of resource specialists from the Custer National Forest, TEUI coordinators, specialists from Washington Office and Regions 1 and 4, and personnel from the Remote Sensing Applications Center, was assembled and assigned the task. The team defined the project scope around TEUI mapping requirements and draft TEUI Technical Guide. The pilot application was developed in the context of an ongoing TEUI being conducted on the Custer National Forest. Some of the immediate utility of this application will be tested in conducting new TEUIs as well as updating existing land type level resource inventories.

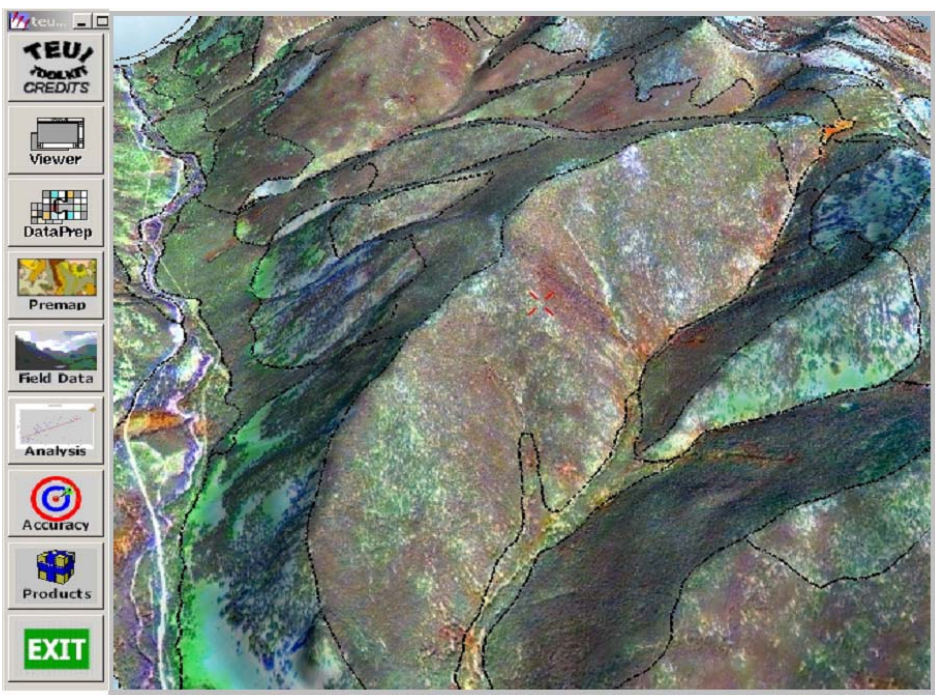
This project proposes developing a prototype software application called the TEUI-Geospatial Toolkit (Figure 2). It is designed to facilitate TEUI mapping and support major aspects of natural resource inventory. Specifically, the TEUI toolkit makes use of advanced, machine-aided methods to process geospatial data, enabling resource specialists to formulate mapping concepts and efficiently delineate ecological strata directly into GIS. Products generated from this toolkit will function entirely within the corporate hardware platform, including Arc/Info™, ArcView™, Access™, Oracle™, and NRIS-Terra databases. The proposed toolkit will formulate more standardized, efficient, and cost-effective methods to complete TEUI surveys, specifically at the land type association and land type scales. It also has the capability of quickly generating 3-D perspective views and other visualization enhancements promoting better communication among internal and external cooperators.

Figure 1. The National Hierarchical Framework of Ecological Units defines appropriate scales for applying TEUI in ecosystem management.

The National Hierarchical Framework of Ecological Units

Planning and Analysis Scale	Ecological Unit	Purpose, Objectives, and General Use	General Size Range
Ecoregion Global Continental Regional	Domain Division Province	Broad applicability for modeling and sampling; Large area planning and assessment; International planning	Millions to ten thousands of square miles.
Subregion	Section Subsection	Strategic, multi-forest, statewide, and multi-agency analysis and assessment	Thousands to tens of square miles.
Landscape	Landtype Association	Forest or areawide planning and watershed analysis	Thousands to tens of acres.
Land Unit	Landtype Landtype Phase	Project and management area planning and analysis	Hundreds to less than ten acres.

Figure 2. The TEUI-Geospatial Toolkit is a customized software application designed for landscape mapping.



GROUP DISCUSSIONS

Group 1 Discussion -- Define a minimum set of National Soil Interpretations - *Chad McGrath, SSS-OR Moderator / Steve Carpenter, SSS-WV Recorder*

We have never lost a court case using national interps since they have been validated. Would the state or local interps be validated to the point that they would stand up in a court case.

We should have a natl set of interps that are broad enough to cover all the variety of local situations?

Everyone agrees we want a national set. They should be similar to what we have now!

Do we need to add some natl interps that are not currently in NASIS?
Yes!

Verifying criteria to go into the interpretation:
Should it be in the scientific literature?
Local interps may not be as well documented for court; Downside of sharing local interps.
How do we add to the list? Why worry about a minimum set? Perhaps whole list should be national.
Who develops local criteria and are the criteria valid?
Be able to adjust the National Interp.

Review of Part 620 NSSH, 1993

Urban interps for the East Coast.

Landslide interp.
Should not get into geology, but could look at surface information.
Surficial mass movement.

Building Site Development: Are they conceptually OK?
B OK
C OK
D OK
E OK
F OK
G Lawns-degree of disturbance, pesticide and nutrient leaching.

WIN-PEST does this cover?
Soil prone to leaching or soil prone to runoff.

Building Site Development N&P Leaching and Runoff.
Interps based on solid soil chemical and physical properties.
Extensive peer review of the interp.

Stormwater management interps
How to set National criteria among state regulation?

Construction Material
Sand and Gravel criteria needs to be revised, cannot get a good, needs to consider bulk density.
Topsoil needs to be revised for irreversible shrinkage.

Recreational development
Keep, but need review.
How do you consider visual aesthetics for camping and picnic areas?
What criteria are used by the park people?
Need to review with the partners.

Waste Management
Need a carcass disposal interp.
Similar to sanitary landfill area.
Needed for catastrophic situations for APHIS.
Land application of sludge needs an odor component.

Sanitary facilities
Can there be a national interp for septic systems?
Should this be a weathervane interp?

Water Management
Want to add some irrigation interps
- Sprinkler
- Drip
- Border

Water Quality
Nitrogen fate-leaching and volatilization

Forestry interps
Some local tweaking needed.

Wildlife Habitat Suitability
We need some interps here, even though national leadership does not support.

Agronomic Practices
Nitrogen Fate
Tillage-fragility of structure
Phosphorous buffering capacity
Organic matter enhancement potential

RECOMMENDATIONS:

- The feeling of the group was unanimous that a national set of interpretations is needed.
- The current set of interpretations should be kept and perhaps added to.
- The national set needs to be thoroughly reviewed and updated where necessary.
- Need the complete list of rating criteria for all of the interpretation just as we used to have in NSSH.
- The national set of interpretations will provide a framework for the development of local interpretations.
- There needs to be a process of peer review for locally developed interpretations.
- The national set of interpretations possibly should provide a template for the development of local interpretations.
- There are a number of additional interpretations that are needed such as those for types of irrigation. Calif. Interpretations could be adopted as a starting point. These will need to be modified for different parts of the country.

Group 2 Discussion -- How will we build the Corporate Soil database? Local Flexibility (eFOTG) vs Official data? *Terry Aho, ITC; Moderator / Jon Gerkin, SSS-OH Recorder*

The soil data warehouse and soil data mart is expected to be deployed sometime next year (summer 2003). This will be the first time we have a single source of official soil data. This provides a corporate soil database available for public access, as well as providing agency program support (FOTG), a single source to support congressional inquires, providing soil data for various models (FSA-CRP, RUSLE, WinPst, etc.) and providing soil resource assessments and analysis capabilities over broad geographic areas.

Discussion Summary:

- Is there a target date that should be set to fully populate the warehouse/data mart with official data?
  - If a short timeframe is set, clear picture of workload needed, alternative approaches to validating/populating the data.
- What are the workload issues to populate data from NASIS transactional to the corporate soil data warehouse and soil data mart?
  - Some areas the workload to validate the data is 2 to 6 years.
  - If this is a division or agency priority may need adjustments in mapping goals.
- What constrains and opportunities are there with our current local partnerships for delivering data? Local web sites and partnerships with edu's, state government, etc, for delivering soil data.
- How do we migrate from a dispersed delivery of vintages of soil survey data, to a single source?
- What recommendations does the group want to make?
  - This is one of the highest priority
  - Clarify Official Soil Survey Data Issue? New Policy? Electronic Data Policy issues.

Discussion Notes:

Moderator: Terry Aho
Recorder: Jon Gerken

The above questions were used as seed questions for beginning discussion. The following is a recorder of the tread of discussion.

The discussion started with a brief description of the mechanism how the warehouse and dart mart will work.

- State Soil Scientist selects the attribute data from NASIS and exports to staging server.

- In the staging server the tabular data is matched up with spatial data (if exists) from the Digitizing Unit. State Soil Scientist has the opportunity to review the data and where necessary other business units such as MO and NCGC can review the data for exact joins with existing data and survey boundary matching existing boundary map.
- Once approved by State Soil Scientist the data set moves to the warehouse were it's versioned and processed to the Soil Data Mart for public distribution.
- The Soil Data Mart will provide the source of FOTG and SSURGO datasets. Hopefully the first release of the Soil Data Mart will provide eFOTG reporting capability that will reduce the workload of managing eFOTG section II data (pdf, mdb, doc, etc.).

Some states have made decisions that they can not control the data by using a local customized template. Will they still be able to do that in the Soil Data Mart? The first iteration of the data mart will provide this capability. When a customer selects data for a survey area we will know were the data is coming from and the data mart will look if a local state template exists and offer that template for the default choice.

What happens to accessory information in the soil survey report? The first phase of the data mart is focusing only on the spatial and tabular data for FOTG and SSURGO. The Total Requirements Statement for Soil Data Delivery and Distribution has identified the requirement of providing the delivery of manuscript data, pre-written material, quest authored material, images, survey's on CD's, etc.

Should a target date be set for full population of available data in the warehouse? Discussion turned to looking first at the issue of workload to prepare the data in NASIS before it can be exported to the warehouse. Some states may need 4 to 6 years to have complete coverage delivered to the data mart.

How will refreshing of the data be done? Will it be easier than the current SSURGO refresh process? States would submit updated data which would have linkages built with existing spatial data and once approved in the staging server would be versioned and delivered to the warehouse. Also, the Soil Data Mart will have an optional customer registration capability. The customer internal or external can register to be notified when data for a survey of interest has been updated. The system will provide for downloading only that portion spatial or tabular that has been updated. They do not have to download the complete package if they do not want to.

Discussion again focused on that we need to know the workload first before a target date for populating the warehouse can be set. There is concern that eFOTG looks different in different states. Data in eFOTG should come from the data mart if it's there. Some things in FOTG section II are not in the NASIS database and will still need to be posted on eFOTG.

If eFOTG and data mart are different products the workload would be much greater. We need to have a good, detailed definition of the product before we know the workload.

Recommend NRCS make delivery of data to warehouse our top priority and slow down or shut down other operations so we can populate the warehouse. Need to define a minimum data set needed. Things like soil moisture status must be accurate so that hydric soils report works correctly.

Should pdf files of published report be put in the data mart so it is accessible? Some thought not, that all in the data mart should have same format.

Some states are planning to clean up data to send to warehouse with no interpretations. Interpretations will be cleaned up later and create a new download when interpretations are clean.

Redirect resources in states to work only on database editing would be a problem where partnerships commitments tie us to delivering other products. If we redirect staff to NASIS editing, how long would it take.

Not all of the work needs to be done by soil scientists. Some parts of the job can be accomplished by training non-soil personnel. This possible where validating and updating the data in NASIS to a published soil survey report suggested complete redirection of staff would not be recommended on a national scale.

Question whether any state had done significant validation. Some had and their data was in good shape. It was good coming in from SSSD.

Is there a potential for developing new tools to make the editing job more efficient?

Having complete coverage in a common format will be a big advantage over what we have now. Our current state is that we have many different formats that are being distributed as official data. In many cases the data in these products differ.

A policy statement would be needed to designate the warehouse as the official data source agency-wide. **The group recommends this as top priority.** But let's not shut down all other soils operations.

The group suggests that until the warehouse is up, that states protect legends that were used for downloads so they cannot be accidentally edited before being published to the warehouse.

A question about whether data can be restored to transactional database from warehouse. Not currently possible, but might be a good consideration.

Group 3 Discussion -- Last Acre to Publication in one year—How do we get there? *Ken Lubich, Moderator/Bill Taylor, Ass't SS, MA Recorder*

One year is good target, but if we can get surveys published in 2 years - still good
Should be top priority
Should shift resources.

Last acre to Publication in one year Recommendations:

Backlog

Shift resources to work on backlog

Develop budget initiative and attempt to get more funds

States review their status and develop plan to get their part done - develop into national plan

Management/Make resource decision within states - keep on top of what needs to be done

Look at publishing less in the survey, but don't give up quality
Project surveys

Assure current process are followed - progressive correlation, compilation, NASIS, Manuscript development - expand to progressive digitizing and DMF.
Look at publishing less in the survey, but don't give up quality

HISTORY OF US SOIL SURVEY-C.E. KELLOGG

Notes on C.E. Kellogg--*R.B. Grossman, NSSC, Lincoln, NE*

This is to record notes for a brief talk on Dr. Kellogg at the Interpretations Meeting, St. Joseph, Missouri, October 28-31, 2002. This is done hurriedly to meet a request by Doug Helms. It is written at a McDonalds on November 3, 2002, without access to notes. I do not have the time in the next month or so to do anything more. I will weave a bit here and there into my talk at the upcoming ASA Meeting.

Background – Setting

1. 1960-1970 period; speaker, 30-40 years old, hired as were Flach, Holzhey, Franzmeier, Lynn, etc., to work in Investigations and provide a source of leadership in the future.

2. Period eight years after 1952 consolidation which gave Bureau of Plant Industry (BPI) under Kellogg control of larger SCS soil survey. Intellectual, naturalistic approach gained control of larger utilitarian enterprise. Money for SCS soil survey came from FDR policy to fund agencies working directly on plight of U.S. agriculture. Kellogg gained control in waning days of HST administration and Secretary Brannon.

3. Veterans of World War II, if 25 when demobilized in 1945, were 40-50 years old – prime of professional career during 1960-1970. Brokaw's Finest Generation. As a 30-year old, I would participate in sampling trips with party leaders wearing pilot fleece-lined jackets – some 25 mission people. Healthy balance between independence and altruism which lack today.

Kellogg Personally

4. In his 60s, seemed old and Victorian; I feared him. Back stiffened by a device and some limitations to turning neck – I think. Would sit in front row, turned 45 degrees to front where he could be in contact with speaker and participants.

5. Very strong self control. All reference materials given a consecutive number – numerous filing cabinets in his office – he showed me them.

6. He would laugh at his own stories and his mouth would work.

7. He was a mild socialist. The Depression had a strong influence. I think he, in part, modeled himself on FDR. They had a certain similarity – physical limitations, large heads, and Kellogg also may have had a stroke.

8. He permitted by his demeanor, etc., no public off-color jokes; sexism, etc.

9. A serious man. We would meet Monday through Friday commonly in Chicago (Midland Hotel). Consult 1960-1970 National Technical Work Planning reports. We worked hard to do hard technical stuff. No comparison to meetings today.

Subjects Kellogg Repeated

10. Placed emphasis on working on the commonplace.

11. No Frigid Vertisols. Kellogg had strong opinions on certain narrow technical matters of the time. I suppose the argument would be that PE deficit not strong enough to produce the water deficiency needed to use the potential extensibility to produce cracks – see paragraph 31 of my talk, "Linking Records to Soil Interpretations".

12. He always mentioned that he had fought a good fight to get our title, "Soil Scientist". Obviously proud of the effort.

13. James Joyce, of course.

14. Spoke of strength of Extension Service – a reason for emphasis on Nonagricultural Interpretations to avoid clash on agronomic information. Hence, the S-5s included properties for engineering (engineering particle size, Unified, AASHTO placements, permeability = Ksat). Because largely texture driven morphological based horizon separations not needed, which not corrected until recently.

15. Michigan experience. J.O. Veatch and strip mapping for road right-of-way – see Michigan Highway Department manuals. Veatch was held in very high esteem. An audience member (Teachman?) corroborated that Veatch did quality mapping. We should investigate him in a historical sense.

16. McKenzie County, North Dakota. Where he and his students mapped in the summer. Young man. Rumors a tinge of the old fashioned male-female involvements as in the Music Man. The students, as old men, spoke of it highly. It was a touchstone of youth.

17. The AES support in the struggle for supremacy between BPI and SCS.

18. 1938 Yearbook of Agriculture. Met with Henry Wallace, Secretary of Agriculture, who insisted there be a classification system developed in the few months before publication. Note – There is a stop gap 1960(?) assemblage of papers in 1960 in Soil Science Notes – The writer thinks Smith's entry on the taxonomy scene was his paper on the name Bruniga (sp.) for non-Mollisols published in the early 1950s(?) in SSSAP.

Relation to Staff

19. At the National Office there was Smith (Investigations), Klingebiel (Interpretations), Simonson (Correlation), Hockensmith (Chief Administrative Office – previous Head SCS soil survey). The four principle correlators were Johnson (West), Aandahl (Midwest), Ligon (later Bartelli) (South), and Arnold Bauer (Northeast) – at least this was the cast early in the decade. Simonson, Aandahl were Kellogg's students and Johnson – a bit younger – came along just after Kellogg left North Dakota.

20. Tension between Simonson and the principle correlators in control over correlations (echos of MOs vs. NHQ today) and between Simonson and Smith on soil taxonomy. Kellogg public moderator. Have no knowledge of inner decision making. Simonson was the intellectual – closer to Kellogg in that sense. But I think Kellogg also was too clever to be trapped by a shared intellectualism.

21. Although Kellogg talked interpretations constantly, treatment of Klingebiel did not quite seem on the same plane as Simonson, Smith.

22. The fight for assumption of leadership between Bartelli and Johnson came later – I think. It holds much interest to me. But research is needed to get the particular correct. The decision has echos to this day. I don't think McDonalds is the place to explore it – although good breakfast burritos..

The Scene at Taxonomy Meetings

23. For all of us the early genesis of Soil Taxonomy should hold some interest. I was present at a meeting or two of the principle correlators and the National Office senior staff. Kellogg was present most of the time. He sat as described before. He would speak occasionally assuming the floor suddenly about this occasion or that and gave occasional admonitions - no "frigid Vertisols". He seemed to moderate among staff by spreading his positive comments among his staff. The danger to me was that the staff may have been playing to Kellogg's biases. There were no Action Registers, flip charts, paper on the walls (organized brainstorming). It was a blackboard which Smith used well and the intelligence and broad knowledge of the audience (again, remember everyone had experienced the Depression and World War II). There seemed no stress – no hurry- and I don't know how decisions were carried forward. Any of the people present could come to the blackboard. Most rose and spoke from the audience. It seemed that the views of the principle correlators were very important to Smith. However, he may have been also trying in part to win their support in the battle with Simonson.

Interpretive Downside

The thoughts to follow are very much my own and are only recorded, not to argue as much as to share a view of lost opportunity.

24. For reasons not apparent, the 1951 Manual in the area of water does not contain much of the world class hydrology program of the SCS. The SCS had a system then for estimating permeability from structure (O'Neil, etc.), before the 1951 Manual. The Hydrologic Group and the Curve Number were (I believe) at hand or nearly so. In 1956, the Mason paper did a statistical study of thousands of core measurements of what is essentially permeability. I will distribute a file on the matter later.

25. I don't think we exploited the potential of ARS and the AES to do interpretations for the soil survey – and we still don't really. Perhaps the ARS was too inchoate having only recently assumed responsibility for the SCS hydrology program. Guy Smith did use the AES for Histosol research and Joe Kubota did trace metal work at an ARS laboratory.

26. The broadness of layers discussed in paragraph 13 was a huge mistake. We continue today to use NASIS as a tool for partial reporting of our potential information. We can't change that for the whole. But we could for a very small subset and thereby take a step towards integration in NSSC.

Charles Edwin Kellogg--*J. Douglas Helms, Senior Historian, Natural Resources Conservation Service, Washington, D.C.*

Birth- August 2, 1902 at Ionia, Michigan
Formative Years-
Palo High School, Palo, Michigan
B.A. Michigan State College, 1925
Ph. D. Michigan State College 1929
Graduate work, University of Wisconsin, Michigan Department of Conservation, Soil Mapper, Summers 1923-1926
Michigan Land Economic Survey, Michigan State College and Michigan State Highway Department, Fellow in Soils, April 1926 - April 1928
Wisconsin Geological and Natural History Survey, University of Wisconsin, Soil research and, in charge, soil mapping parties, 1928-1930
North Dakota Agricultural College, January 1, 1930 – January 31, 1934

CAREER IN THE SOIL CONSERVATION SERVICE (SCS)
Soil Survey Division
Associate Soil Technologist, February 1, 1934
Senior Soil Scientist, October 1, 1934
Acting Chief, July 1934-June 935
Principal Soil Scientist and Chief of the Soil Survey Division, July 1, 1935
Retired May 31, 1971

QUOTES & PUBLICATIONS
"Soil type as a factor in highway construction in Michigan. Michigan Academy of Sc., Arts, and Letters. 10: 169-177. 1929.
"A method for the classification of rural lands for assessment in western North Dakota. Journal of Land and Public Util. Economics 9:10-15. 1933
"A method of rural land classification (With J. K. Ableiter). USDA Technical Bulletin 469. 29 pp. 1935.
Soil Blowing and Dust Storms. USDA Misc. Pub. 221. 1935 (very timely)
The Development and Significance of the Great Soils Groups of the United States. USDA Misc. Pub. 229. 1935.
Soil Survey Manual. USDA Misc. Pub. 274. 1937
Soils and Men. Yearbook of Agriculture

"the first soil scientist to persuade highway engineers to make substantial changes in design because of soil subgrade conditions revealed by accurate use of standard methods of soil classification. The importance of this concept is shown by the recently issued Bulletin 22 of the Highway Research Board, Public Roads Administration, "Engineering Use of Agricultural Soil Maps." Nomination for USDA Distinguished Service Award.

Kellogg, Charles Edwin. 1930. "Preliminary study of the profiles of the principal soil types of Wisconsin, Ph. D. diss., Michigan State College of Agriculture and Applied Science, Soils Department, East Lansing, Michigan.

"reworked and developed the classification of soils in Wisconsin." (From nomination for USDA Distinguished Service Award).

"In western North Dakota, he developed the first scientific system for rural land classification for equitable tax assessment based upon the potential productivity of the lands."

"Since there are many, many soils those relationships are too complicated to be resolved by a few simple slogans or programs". P. 306. The Soils That Support Us.

Veiled comment about soil conservation. Discuss attitude toward ACP and lime.

"To a degree it is a science that deals with relationships. To be understood, one must also have some knowledge of literature, history, anthropology, geology, botany, chemistry, and other arts and sciences."
Page 342. The Soils That Support Us

STUDENTS
Roy W. Simonson
Marlin G. Cline
A. Clifford Orvedal
Andrew "Andy" Aandahl
William M. Johnson
(Others in the soil survey in SCS).

APPENDIX 1--Agenda

National State Soil Scientist's Meeting-Agenda
"Interpreting the Soil Survey for Conservation Planning"
October 28- November 1, 2002
St. Joseph, Missouri

Monday October 28, 2002

Afternoon Session Moderator Dennis Potter, SSS-MO
Hyde/Krugg Conference Room – Ramada Inn

1:00-1:20 PM Welcome—State Conservationist MO- Farm Bill Patricia Hufford, Assistant State Conservationist for Field Operations, St. Joseph MO

1:20 – 1:50 PM Introductions & Expectations –Maxine Levin, NHQ SSD

1:50 – 2:00 PM Development of Action Register—Assignment of Action Register Team to follow presentations and facilitate recording of Action items with flip charts and note-taking.(***Team Leader- Luis Hernandez, SSS-NE Team Members-David Smith, SSS-CA; Phil Camp, SSS-AZ; Jerry Schaar, SSS-SD; Ron L. Taylor, SSS-NJ)***

2:00-2:30 PM FY03 Soil Survey Division Priorities *–Berman Hudson, Director*

2:30-3:00 PM Break

3:00- 3:15 PM (By Teleconference) Chief Bruce Knight, NRCS—View of the National Cooperative Soil Survey—An Infrastructure for NRCS

3:15-3:45 PM National Cartography & Geospatial Center—Soils & Geospatial Initiatives (Relationships to Interpretations in Soil Survey)**—Tommie Parham, Director, NCGC**

3:45- 4:30 PM National Soil Interpretation Advisory Group Role and Vision - Making Soil Surveys and Interpretations Relevant for Users,
Dave Hammer, University of Missouri

4:30-5:00 PM Using the Soil Survey for Conservation Planning and Beyond, ***Maurice Mausbach, Deputy Chief, Soil Survey and Resource Assessment, NRCS***

5:00 -7:30 PM Soils Social Hour - Computer Technology Demo Forum- State Soil Scientists are encouraged to bring CD's or Demos of their products or demos to show on laptop systems to others informally (Hyde/Krugg Conference Rm)

Tuesday October 29, 2002

Morning Session Moderator Darwin Newton, SSS-TN
Hyde/Krugg Conference Room – Ramada Inn

7:30 –8:15AM Defining the National Soil Survey Center's and States' roles with regard to interpretations—*Karl Hipple /Russ Kelsea, NSSC*
Working with groups to set criteria, soil interpretations and potentials. How to work with state and local groups to provide the information they need - Data vs. information and setting up data use guidelines

8:15-8:45AM Linking Research to Soil Interpretations —*Bob Grossman, NSSC*

8:45-9:15AM History/Rationale and Tools for NASIS-Fuzzy Logic (Documentation) Bob Nielsen - NSSC

9:15-9:30AM Break

9:30-10:00AM NASIS and the Interpretations Modules: Strengths & Challenges— *Steve Lawrence, Assistant State Soil Scientist, Athens, GA*

10:00-11:00AM Panel of Soil Scientists from the Field: Case studies in using interpretations modules in the field office **(*Darrel Kautz, Palmer, AK; Ed Mersiovsky, Little Rock, AR, Lisa Krall, Vernon, CT)***

11:00AM-12 Noon Working with Criteria & NASIS to make Regional Soil Interpretations—How did we do it? Step by Step**---Sue Southard, Data Quality Specialist, Davis CA**

12:00 Noon Lunch

Afternoon Session Moderator *Jim Ford, SSS-OK*
Hyde/Krugg Conference Room - Ramada Inn

1–1:15 PM Prototypes for Documenting Soil Interpretations—*Bob Neilsen, NSSC*

1:15-2:00 PM Testing and Evaluating Soil Interpretation Criteria—Test case examples of Regional Criteria **Can we still have National Criteria? —*Joyce Scheyer, NSSC, Ronald Morton, Florence SC, Steve Wangemann, BIA, Toppenish, WA***

2:00-2:30 PM Soil Geo-Chemistry Investigations and Lead Impacts within Urban Soil Interpretations—Data base questions to do with trace and heavy metal toxicity; where does soil geochemistry fit into soil survey?**-- *Mike Wilson, Joyce Scheyer***

2:30-3:00PM Break

3:00-3:45 and 3:50-5:00 PM Mini Sessions (Each participant will attend 2 sessions)

Group 1--(Lotus) Beyond Thematic Maps-Spatial Interpretations Steve Peaslee

Group 2--(Corby Grove) RUSLE2 Demo Dave Lightle
Group 3—(Bartlett) EBI Criteria Russ Kelsea
Group 4—(Patee) Soil Conditioning Index Lee Norfleet

5:00 -7:30 PM Soils Social Hour – Poster Session and Marketing Demo Forum- State Soil Scientists are encouraged to bring Posters of ongoing research and/or CD's or Demos of their Marketing products to show informally (Hyde/Krugg Conference Rm)

6:00-7:00 PM (Concurrently) Open Discussion Group – Impacts to Technical Soil Services and Resource Soil Scientists by the Farm Bill (Moderator—Kip Kolsinkas, CT SSS) (Lotus Rm.)

Wednesday October 30, 2002

Morning Session Moderator *Neil Petersen, SSS-WA*
Hyde/Krugg Conference Room - Ramada Inn

7:30 –8:00AM NASIS/SBAAG---SBAAG Update; Ft. Collins activity -Ken Scheffe and Ken Harward

8:00-9:30AM Soils Data and Information—the Public Interface - Participants submit questions for the panel on Monday PM and Tues. AM - Moderator will ask questions to panel members
NASIS 5.1 Central Server; Soil Data Warehouse; Soil Data Viewer & Customer Service Tool Kit; Web access to soil survey data; issues related to "official" data; data requirements for program delivery; and data population workload and responsibility. (**Panel-Rick Bigler, Bob Nielsen, Jim Fortner, Terry Aho, Ken Harward, Gary Muckel)**

9:30-10:00 AM Break

10:00-10:45 and 10:50-12:00 AM Mini Sessions (Each participant will attend 2 sessions)

Group 1--(Lotus) Beyond Thematic Maps-Spatial Interpretations Steve Peaslee
Group 2--(Corby Grove) RUSLE2 Demo Dave Lightle
Group 3—(Bartlett) EBI Criteria Russ Kelsea
Group 4—(Patee) Soil Conditioning Index Lee Norfleet

12 Noon Lunch

Wednesday October 30, 2002

Afternoon Session Moderator *George Teachman, Aberdeen, MD*
Hyde/Krugg Conference Room - Ramada Inn

1:00-1:20 PM LESA/CALES—FPPA (Ray Sinclair, Cheryl Simmons)

1:20-1:40PM Regional Technology Coordination in Implementing the Farm Bill Craig Derickson, RTS, NP

1:40-2:10PM Use Dependent/Dynamic Soil Properties—Algorithms & New NASIS Calculations and Validations Cathy Seybold, NSSC

2:10-2:45 PM Geophysical Methods within NRCS: Applications for the Farm Bill—Ed Stein, NY and Wes Tuttle, NSSC, NC

2:45 – 3:15 PM Break

3:15-3:30 PM 3-D Mapper-Applications to Soil Survey ---Ken Lubich, WI

3:30-5:30 PM Panel—Landscape Analysis Applications for Field Soil Survey
(Sheryl Kunickus, Landscape Analyst, NHQ-Moderator)
Toby Rodgers, Okanogan, WA (remote mapping)
Suzann Kienast, North Logan, UT (remote mapping)
David Howell, Arcata, CA (properties/interpretations)
Duaine Simonson, Richland Center, WI (SoiLIM-landscape)
Anthony Khiel, TN/ Douglas Thomas, NC (SoiLIM-landscape/remote sensing)

Thursday October 31, 2003

Moderator Morning Session *David Kriz, SSS-VA*
Hyde/Krugg Conference Room -- Ramada Inn

7:30-8:00 AM Panel—Landscape Analysis Applications for Field Soil Survey Discussion

8:00-8:30 AM Soil Survey Schedule/PRMS/Soil Survey Reportable Codes--- progress and policy **(Jim Ware)**

8:30-9:00 AM Publications and Digital Map Finishing Backlog-State Management of Manuscript and publication process **(Ken Lubich, NSSC; Stan Anderson, NSSC; Mike Kortum, NCGC)**

9:00-9:30 AM NCGC Soil Support Branch –Resource Data Gateway, GIS and technology support for the field soil surveys**(Nathan McCaleb, NCGC)**

9:30 -10:00 AM Break

10:00-10:30 AM Recruitment---OPM Standards/Needs; Career Intern Program, Progress in recruitment; Soils Scholar program **(Jason Parman, OPM Kansas City)**

10:30- 11:15 AM MLRA Project Management---the vision and progress ***(*Earl Lockridge, NSSC, Tom Calhoun, NHQ, Dennis Potter, SSS MO)**

11:15-11:30 AM Soil Survey Standards (Craig Ditzler, National Leader)

11:30-12:30 AM Future Geospatial Tools for Soil Survey—Chris Clarke, RID, Eric Winthers, USFS, MT

12:30 AM Lunch

Thursday October 31, 2002

Break Out Rooms- Ramada Inn
1:30-4:00 PM National Soil Survey Interpretations Advisory Group Meeting (Corby Grove)
National Soil Survey Technical Services Advisory Group Meeting (Ashland)

Concurrently

1:30 - 2:30 PM Group 1 Discussion -- Define a minimum set of National Soil Interpretations - Chad McGrath, SSS-OR Moderator / Steve Carpenter, SSS-WV Recorder (Bartlett Rm.)

1:30 - 2:30 PM Group 2 Discussion -- How will we build the Corporate Soil database? Local Flexibility (eFOTG) vs Official data? Terry Aho, ITC; Moderator / Jon Gerkin, SSS-OH Recorder (Patee Rm.)

1:30-2:30 PM Group 3 Discussion -- Last Acre to Publication in one year—How do we get there? Ken Lubich, Moderator/Bill Taylor, Ass't SS, MA Recorder (Hyde/Krugg Conference Rm.)

(Reconvene in Hyde/Krugg Conference Room)
Afternoon Session Moderator Edward Ealy, SSS-GA

2:30-2:20 PM Discussion Group Summaries

2:20-2:50 PM Break

2:50-3:20 PM Kellogg's 100th Anniversary -- Bob Grossman/Douglas Helms

3:20-4:00 PM Review of Action Register Team

4:00-5:00 PM Director's Forum- Panel/Discussion of Further Issues & Questions**— Berman Hudson, Bob Ahrens, Craig Ditzler, Karl Hipple, Russ Kelsea, Carolyn Olson, Dewayne Mays, Bill Puckett, Tommie Parham, Maxine Levin**

5:00 PM Adjourn

APPENDIX 2—Action Register for State Soil Scientist's Meeting

STATE SOIL SCIENTISTS MEETING
October 2002
St. Joseph, MO

-- Action Register --

CHARGE: Capture major suggestions, recommendations, and items raised during the course of the meeting.

1. **Prepare to submit names for Soil Scientist of the Year and Soil Scientist Achievement Awards nominations in January 2003 (B. Hudson).**

2. **Develop technologies/techniques to meet update needs with an acceptable refresh rate while increasing mapping accuracy by 50 percent and double production rates (B. Hudson).**

3. **Develop standards for using new technologies in soil survey information delivery, i.e. WEB-based/CD ROM, etc. (B. Hudson).**

4. **Begin developing data and concepts for papers/posters for presentations at World Soil Congress in 2006, including papers on statistics and spatial variability in soil survey and properties (B. Hudson & M. Mausbach)**

5. **Strengthen interaction with Regional Technology Groups (C. Derickson).**

6. **Engage/develop partnerships with Universities (including 1890, HACU, and Tribal Institutions) and Congress to achieve higher profile within 5 years. (M. Levin)**

7. **Pay more attention to ensuring that all elements of soil survey process (i.e., compilation, database, tech and English edits, etc.) are addressed progressively with field mapping completion as a means to decrease publication backlog. (M. Mausbach)**

8. **Increase use of career intern program for soil scientists (Chief Knight)**

9. **Develop closer interface between field soil scientists and our clients (D. Hammer)**

10. **Explore ways to support the use of Technical Service Providers (TSP) when assisting conservation planning technical assistance the use soil survey information, i.e., training and follow-up strategies (Chief Knight, M. Mausbach).**

11. **Identify what urban soil interpretations customers are requesting. (Calhoun)**

12. **Need to market and educate customers on the use of soil survey information. (Kelsea)**

13. **Need for reasonable uniformity across the country on quality criteria in the FOTG. (Derickson)**

14. **Need consistency between MO's in guidance/procedures for populating key data elements. (Lawrence)**

15. **We need to have better communication between NRCS, universities, cooperators, and customers. (Lawrence)**

16. **Request that each state review the list of soil surveys on SOILS web site and provide any updates/revisions to Gary Muckel. (Muckel)**

17. **Request that each state to quality review the soil information that was (quickly) posted to Section II of eFOTG's. (Derickson)**

18. **Need for dialogue with ARS on carbon issues -- modeling erosion versus sequestration. (Grossman)**

19. **Where 50 million dollars worth of pedon data should be housed. (Grossman)**

20. **Prepare new soil monolith (possible replacement) for Smithsonian display. (J. Ware)**

21. **Consider including a tour featuring GIS applications in soil survey to the 2006 World Soils Congress (Grossman).**

22. **Consider needs for additional funding for leaf off NAPP because of potential NAPP funding priority changes due to NAIP (Ware)**

23. **Develop a publication backlog reduction strategy. Focus on process steps, possible resource shifts, and operations management efficiency. (Lubich)**

TEAM: Luis Hernandez, Phil Camp, Jerry Schaar, Ron Taylor, David Smith