United States Department of Agriculture
Soil Conservation Service

Northeast NTC
Chester, PA 19013

Subject: Ground-Penetrating Radar Assistance and Training; Plymouth, Franklin, and Barnstable Counties, Massachusetts; 27-30 April 1992

Date: 7 May 1992

To: Richard J. Scanu
State Soil Scientist
Soil Conservation Service
Amherst, MA

Purpose:
To provide ground-penetrating radar (GPR) soil and archaeological field assistance and training.

Participants:
Al Averil, Project Leader, SCS, Greenfield, MA
James Doolittle, Soil Specialist, SCS, Chester, PA
Peter Fletcher, Project Leader, SCS, Middleboro, MA
Donald Liptack, District Conservationist, SCS, Barnstable, MA
Stephen Mrozowski, Assistant Professor, U. of Mass., Boston, MA
Joan Provost, Volunteer, SCS, Middleboro, MA
Stephen Spear, Soil Conservationist, SCS, Barnstable, MA
James Turenne, Soil Scientist (GPR), SCS, Middleboro, MA

Activities:
I travelled to Middleboro, Massachusetts on 26 April 1992. Field studies were conducted in accordance with the schedule outline in Jim Turenne letter of 8 April 1992. I returned to Chester, Pennsylvania, on 30 April 1992.

Equipment:
The ground-penetrating radar unit used in this study is the Subsurface Interface Radar (SIR) System-8 manufactured by Geophysical Survey Systems, Inc. [1]. Components of the SIR System-8 used in this study were the model 4800 control unit, ADTEK SR 8004H graphic recorder, ADTEK DT 6000 tape recorder, power distribution unit, transmission cable (30 m), and the models 3205 (120 MHz), 3105 (300 MHz), and 3102 (500 MHz) antennas. The system was powered by a 12-volt vehicular or deep-cycle, marine batteries.

Results:
1. I am most pleased with the technical competence of Jim Turenne. His interpretations are unpretentious and correct. He has done an

---

1. Use of trade names in this report is for identification purposes only and does not constitute endorsement by the authors or their institutions.

excellent job of integrating the use GPR and computer graphic techniques into SCS's programs in Massachusetts.

2. Field studies revealed that the model 3205 (120 MHz) remains the most versatile antenna for soil, engineering, and geologic investigations in Massachusetts. The models 3105 (300 MHz) and 3102 (500 MHz) antennas provide superior resolution of subsurface features, but are more restricted in their probing depths. **The success of the archaeological investigation at Yarmouth could not have been achieved without the use of a 500 MHz antenna.** The investigations of shallow or small features in soils require the use of the 500 MHz antenna. To provide full service to clients and projects, I encourage and recommend the purchase of a 500 MHz by SCS in Massachusetts.

3. I am interested in using GPR and RADAN software to "terrain correct" radar profiles. By this process radar profiles assume the natural topography of the transected area. This innovative process will help soil scientist improve their understanding of soil/landscape relations. A beginning to this project was made during this technical assistance visit. Unfortunately, this was more of a learning process for me with, at this time, little to show for our efforts. I will continue to process and analyze the radar data.

4. All radar profiles have been returned to Jim Turenne under a separate cover letter. Jim Turenne is processing the data collected at the Yarmouth archaeological site.

It was my pleasure to work with members of your fine staff.

With kind regards.

Jim Doolittle

James A. Doolittle
Soil Specialist

cc:
J. R. Culver, National Leader, Soil Survey Quality Assurance, NSSC, SCS, Lincoln, NE
A. J. Dornbusch, Jr., Director, Midwest NTC, SCS, Lincoln, NE
R. A. Gallo, State Conservationist, SCS, Amherst, MA

Discussion:

Ortstein study - Plymouth County

An area of Saugatuck and Berryland soils was transected with the 500 MHz antenna. A scanning time of 50 nanoseconds (ns) provided a probing depth of about 1.2 meters. Saugatuck is a member of the sandy, mixed, mesic, ortstein Aeric Haplaquods family, Berryland is a member of the sandy, siliceous, mesic, Typic Haplaquods family. The ortstein layer was not continuous at this site. Based on radar interpretations (verified at 5 observation sites) weakly cemented to cemented layer occurred at 64 % of the observation sites. When examined, soil profiles were moist throughout with a water table at depths of 15 to 20 inches. As the degree of cementation can vary with moisture content, the ortstein layer may be better expressed and more continuous during a drier time of the year. A poor reproduction of a portion of the transected area is included as Figure 1.

Soil/Bedrock study - Franklin County:

In glaciated upland areas of Franklin County, both the 300 and 500 MHz antennas provided adequate depth of penetration (about 3.5 meters). Probing depths were more restricted in soils formed from Triassic "redbed" materials. In most soils, the 500 MHz antenna discerned more subsurface features than the 300 MHz antenna. These features were caused by coarse fragments and tree roots. Images from these reflectors were undesired, complicated radar profiles, and masked the soil/bedrock interface. It was often difficult to chart the soil/bedrock interface with these antennas.

Multiple transects were conducted in areas of map unit 142C Cardigan-Nassau Association, 8 to 15 % slopes. Cardigan is a member of the coarse-loamy, mixed, mesic, Typic Dystrochrepts family; Nassaua is a member of the loamy-skeletal, mixed, mesic, Lithic Dystrochrepts family. Table 1 summarizes the results of this study.

Table 1

Results of GPR Interpretation of Soil Depth Distribution within Map Unit 142C Cardigan-Nassau Association, 8 to 15 % slopes

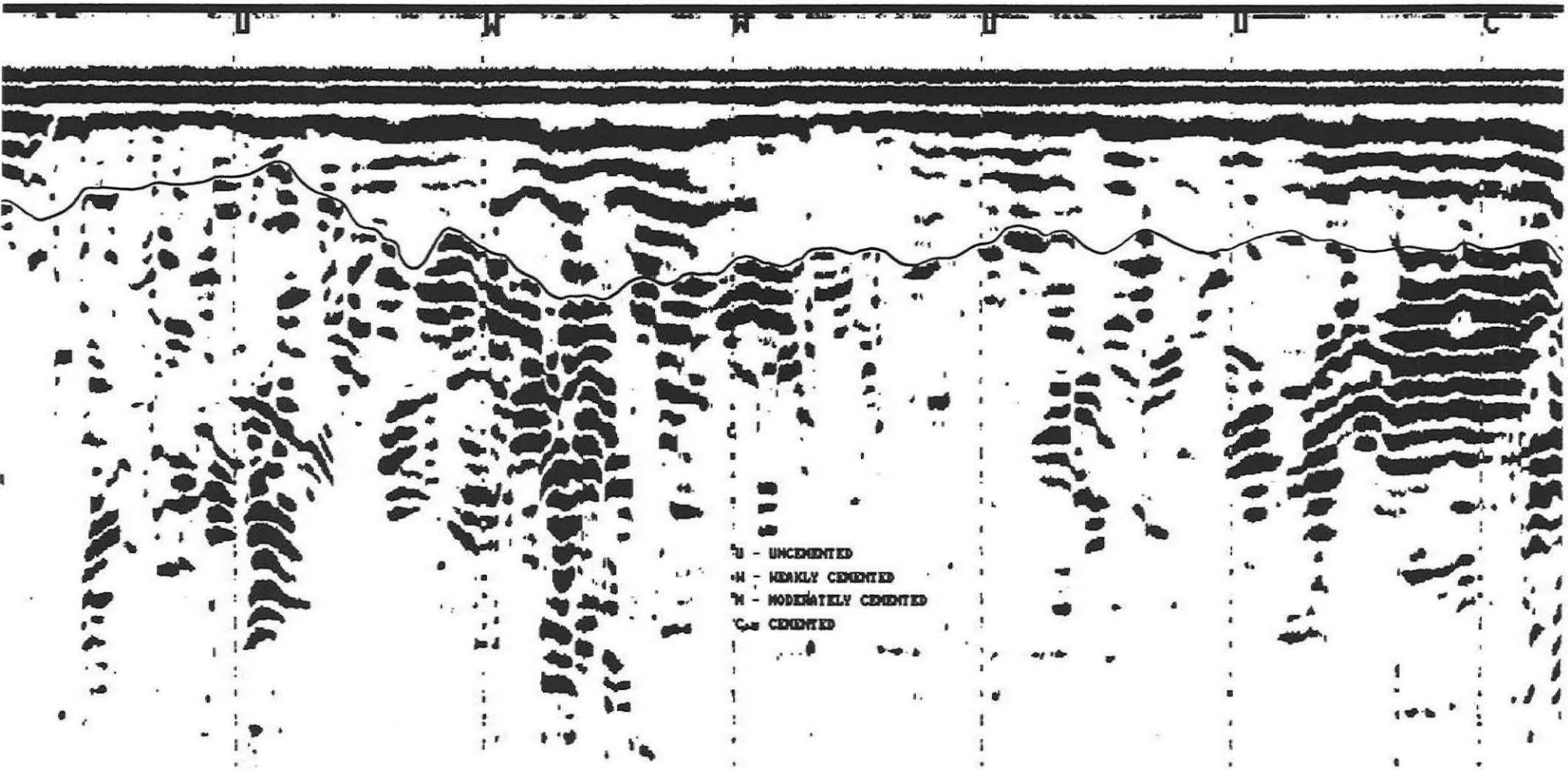
Transect No.	Shallow	Moderately Deep	Deep	Very Deep
1	42%	58%		
2	33%	42%		25%
3	67%	33%		
4	25%	75%		
5	33%	42%	25%	
6	42%	42%	8%	8%
AVG:	**40%**	**49%**	**5.5%**	**5.5%**

An area of Bernardston silt loam, 8 to 15 % slopes was traversed with the 300 MHZ antenna. Bernardston is a member of the coarse-loamy, mixed, mesic Typic Dystrochrept family. Radar profiles revealed that the drumloid landform was underlain by several strata of contrasting glacial materials. These strata were interpreted as being nearly horizontal and truncated by the slope. Some of these strata may represent the layer of "firm" till described in the lower part of the Bernardston soil profile. A detailed soil-landscape study of this and similar sites with the GPR is encouraged. This study will require computer processing and analysis of the radar data.

Archaeological Site Assessment - Barnstable County

In response to Dr Stephen Mrozowski's letter (of 3 April 1992) to Donald Liptack, an archaeological; site assessment of a Late Prehistoric/Early Historic Native American cornfield was conducted on 30 April 1992. Using the 500 MHz antenna, the extent of the cornfield was determined and individual planting mounds were identified. Radar interpretations were confirmed by observations made in small pits and through auger borings.

Preliminary results from this study are most promising and were enthusiastically received by all participants.


U - UNCEMENTED
W - WEAKLY CEMENTED
M - MODERATELY CEMENTED
C - CEMENTED