United States Department of Agriculture

Soil Conservation Service

Northeast NTC
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Subject: SOI - Ground-penetrating radar training and technical assistance; June 12-15 & July 17-21, 1989

Date: July 28, 1989

To: Rex O. Tracy
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Amherst, MA 01002

File code:330-20

Purpose:

To train soil scientists in the operation and use of the ground-penetrating radar (GPR). Field work was orientated towards developing interpretative skills and exploring new areas of GPR applications.

Principal Participants:

Al Averill,Jr.,Soil Scientist, SCS, Greenfield, MA
Joe Bagdon, Soil Conservationist, SCS, Greenfield, MA
Rudy Chlanda, Geologist, SCS, Amherst, MA
Jim Doolittle, Soil Specialist, SCS, Chester, PA
Peter Fletcher, Soil Scientist, SCS, Taunton, MA
Ricky Pershken, Geology Trainee, SCS, Amherst. MA
Dick Scanu, Asst. State Soil Scientist, SCS, Amherst, MA
Bill Taylor, Soil Scientist, SCS, Holden, MA
Chuck Truax, District Conservationist, SCS, Greenfield, MA
Jim Turenne, Soil Scientist, SCS, Acton, MA

Activities:

The week of June 12-15, 1989 was spent in Franklin County and the week of July 17-21, 1989 in Plymouth County. Training was provided to Al Averill and Jim Turenne in the operation of the GPR and the interpretation of the radar profiles during both weeks. Principal areas of application included determining the depth to bedrock, variations in the depth to the water table, the thickness of sand and gravel deposits, the depth and volume of peat reserves in cranberry bogs, and zones of salt water intrusion.

Discussion:

The training of Al Averill and Jim Turenne in the operation and use of the GPR progressed well. I found these two soil scientists to be bright and exceptionally receptive to training and enthusiastic

about using GPR techniques in their soil survey work. Their progress with the radar was most remarkable and exceptional. I have full confidence in their understanding of the uses and limitation of the GPR, their operation of the equipment, and their developing interpretive skills.

The use of the GPR is highly site specific. While most of Massachusetts is highly suited to ground-penetrating radar techniques, results from some areas are hindered by a lack of clearly definable interfaces. This is especially true in bedrock investigations. In some areas, the image of the soil/bedrock contact is partially hidden or obscured by a highly fractured bedrock surface or large amounts of stones and boulders in the overlying soil materials. Soil scientist were advised as to making the more correct interpretation, conducting multiple transects at differing ranges, and with different control and recorder settings.

Two areas of promising GPR application were explored in Plymouth County: investigations of cranberry bogs and coastal zones where salt water intrusion and ground water contamination are concerns.

In organic soils, GPR has been used to: determine the thickness of organic soil materials, estimate the degrees(s) of humification, classify Histosols, and profile the topography at the base of the organic materials.

Conventional surveying tools and aerial photographs have provided accurate information concerning the classification and areal extent of organic soil materials. They do not, however, provide accurate data for estimating peat volume. Soil scientist, conservationists, engineers, and geologists working for SCS, often must rely on other agencies or sources to provide data on the depth and distribution of organic soil materials in cranberry bogs. With the GPR, SCS has a fast and accurate tool for determining the depth, distribution, and volume of peat within bogs

To estimate the volume of organic materials within cranberry bogs a larger number of measurements to depths beyond the current limits of soil survey investigations would be required. Volumetric determinations of peat reserves are time-consuming and costly. The speed and continuous subsurface profiling by GPR reduce the cost of data collection and permit sampling of a greater area. With GPR it is possible to quickly inventory peatlands, assess the volume of peat reserves, estimate the thickness of layers of varying degrees of humification, and profile the topography at the base of the organic materials.

To test this concept, a small cranberry bog near Vallersville in Plymouth County was systematically sampled with the GPR. Figure 1 is a representative profile from the cranberry bog. In this figure all measurements are in meters. The interface separating the organic from mineral soil materials is apparent and ranges from 0 to 4.2 meters (13.7 feet) in this figure.

The GPR data was processed through the SURFER software program to produce a two dimensional contour plot of the cranberry bog (Figure

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2) and to compute the volume of organics within the bog. The cranberry bog has an area of 329,952 square feet, and an estimated volume 2,328,700 cubic feet of peat. Thicknesses of organic materials range from 0 to 27.1 feet. Massachusetts has excellent tools to inventory peatlands!

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To evaluate the feasibility of using GPR techniques to chart areas of salt water intrusion and ground water contamination in coastal zones, a study site was selected along Saquish Neck (a tombolo which separates Plymouth Bay from a brackish back bay area) near Duxbury. Figure 3 is the GPR profile of the transect conducted across the tombolo. In Figure 3, all measurements are in feet. Plymouth Bay is on the left, the back bay area is on the right.

Zones of higher soil conductivity rapidly dissipate the radar signal and result in "white-out" areas or zones of no signal return. Salts increase the conductivity of soils. Zones of higher soil conductivity, i.e. brackish or salt water, are believed to be responsible for the lateral and vertical dissipation of the radar signal along this profile. In Figure 3, intrusions of salt water occur between depths of 0 to 15 feet and depths greater than 17 feet along the Plymouth Bay shore. The water table has been highlighted with a dark line in this figure. Also, stratifications within the tombolo are evident.

In Figure 4, the radar imagery from Saquish Neck has been topographical corrected and present in graphic form. The deeper measurements in both figures (3 & 4) are only approximations as the velocity of the radar signal through the saturated strata below the water table was not confirmed by ground truth measurements.

This survey at Saquish has produced evidence supporting the concept that GPR techniques can be used to map zones of brackish or salt water.

I would like to express my gratitude for the opportunity to work in Massachusetts and with members of your fine staff. With kind regards.

James A. Doolittle
Soil Specialist (GPR)

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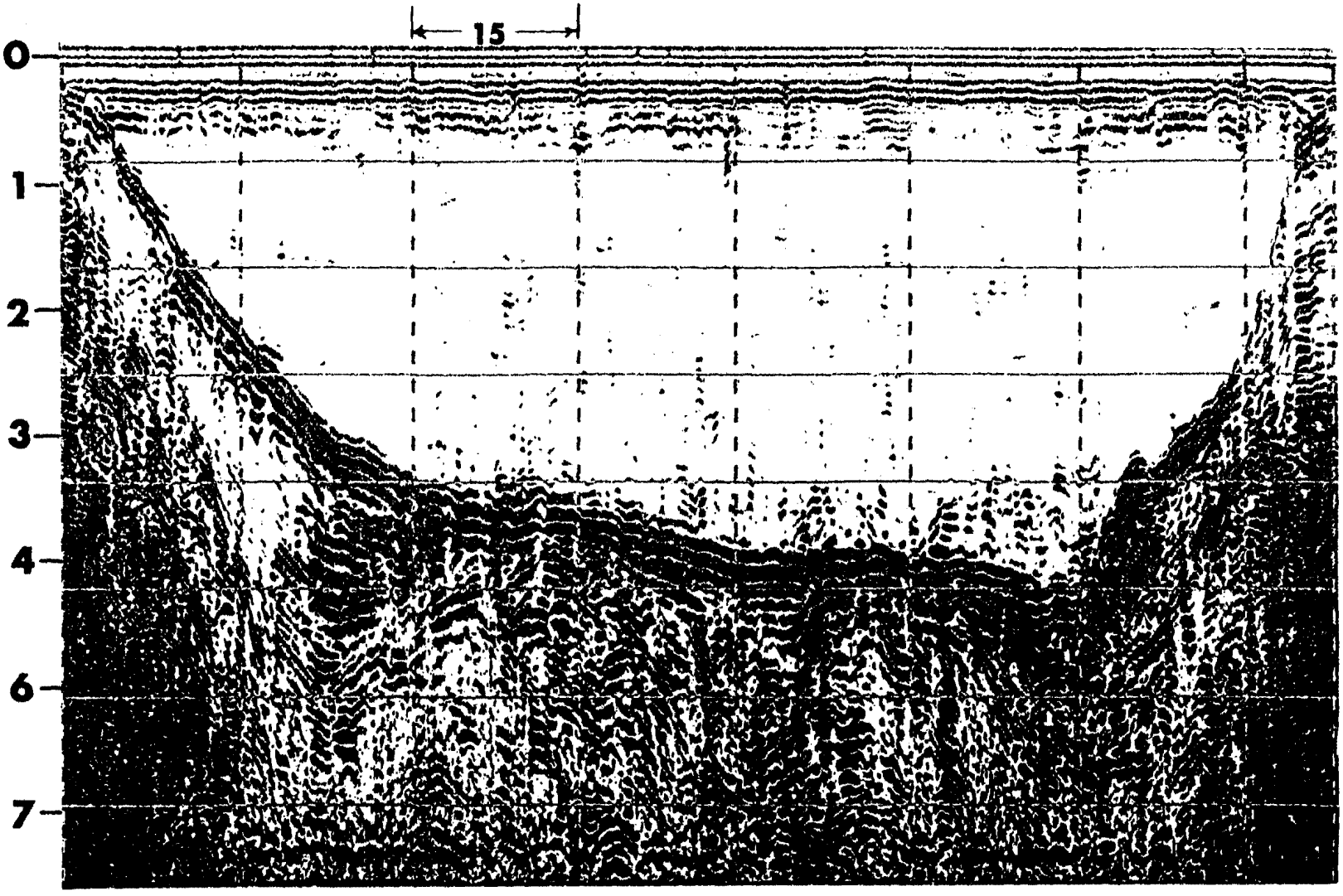
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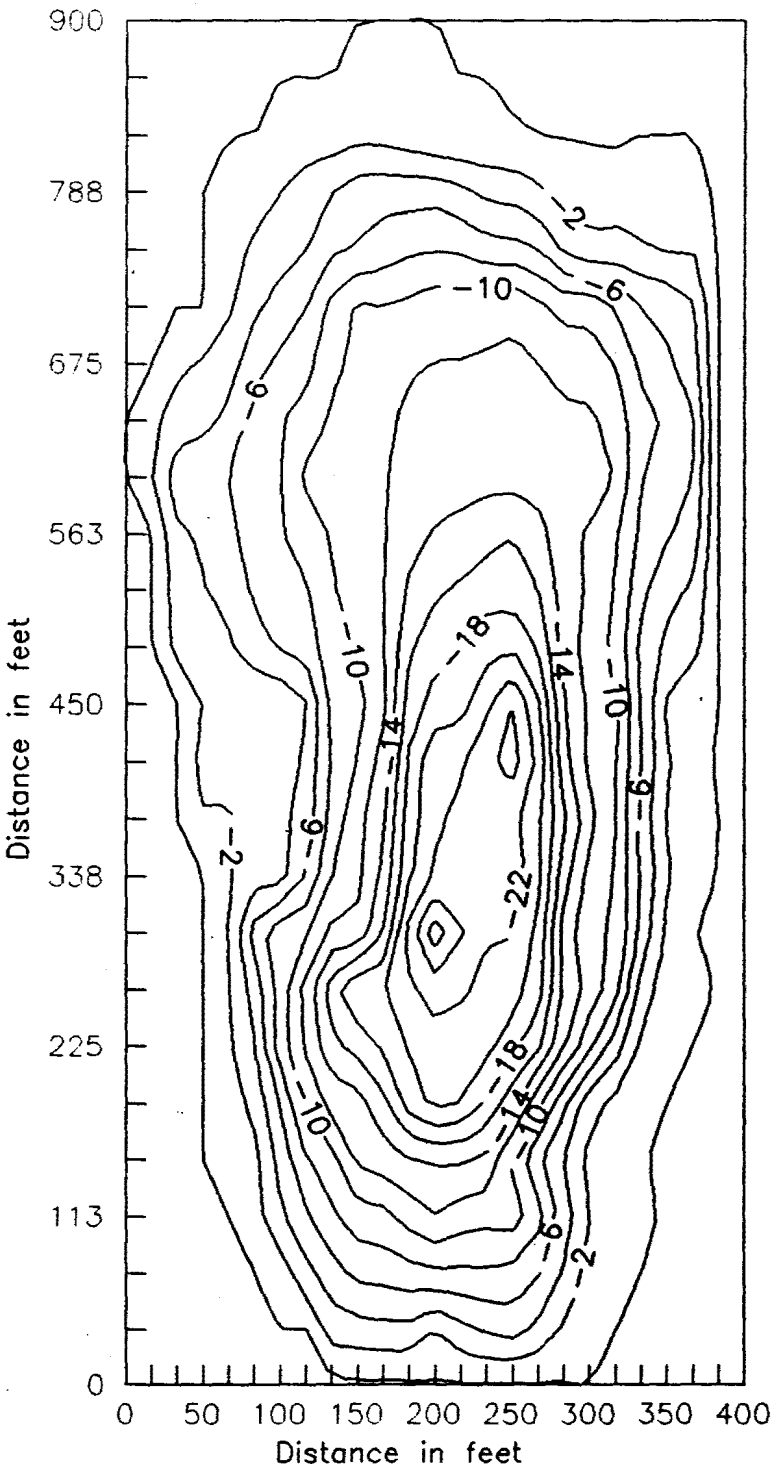
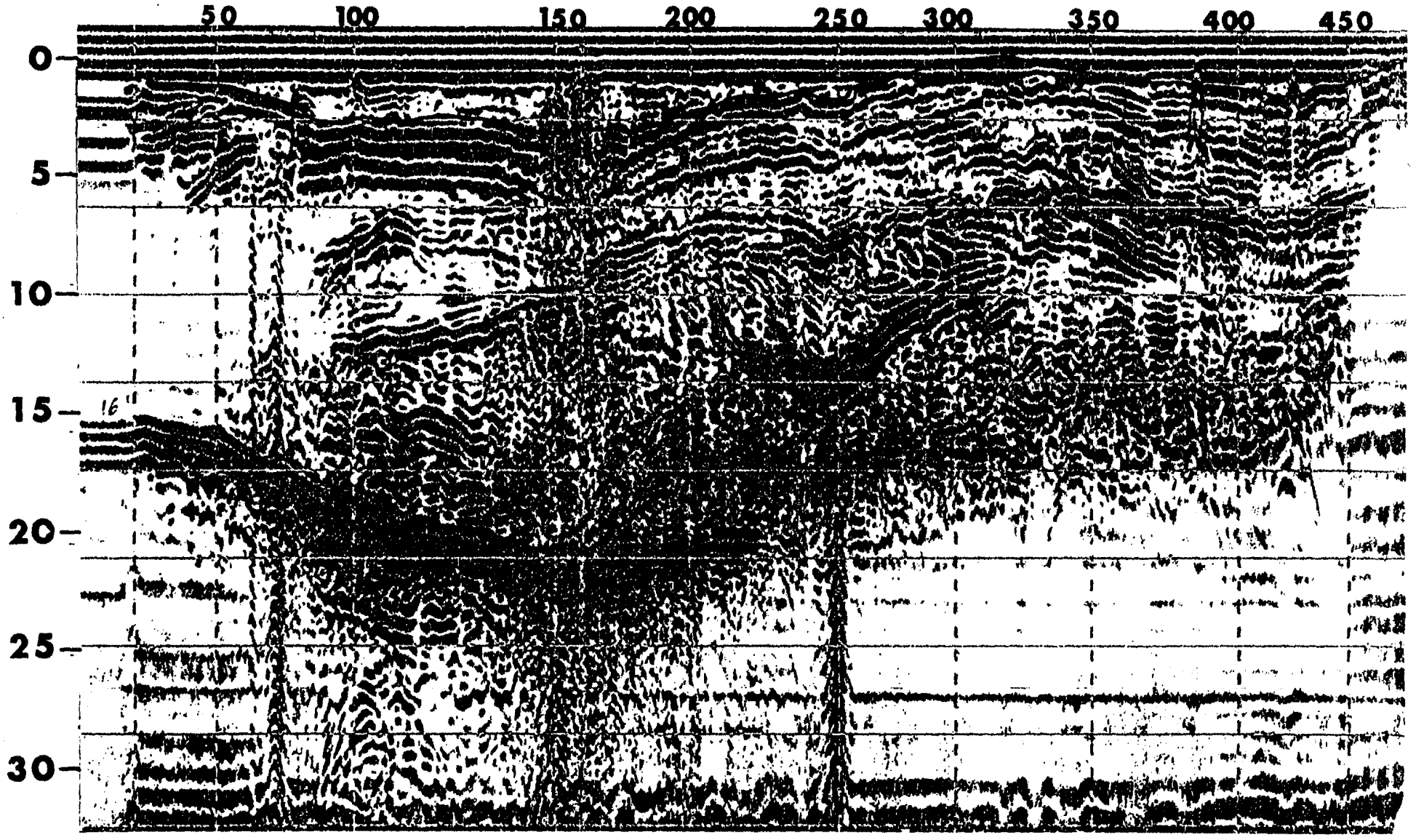
DEPTH OF PEAT IN A MASSACHUSETTS' BOG

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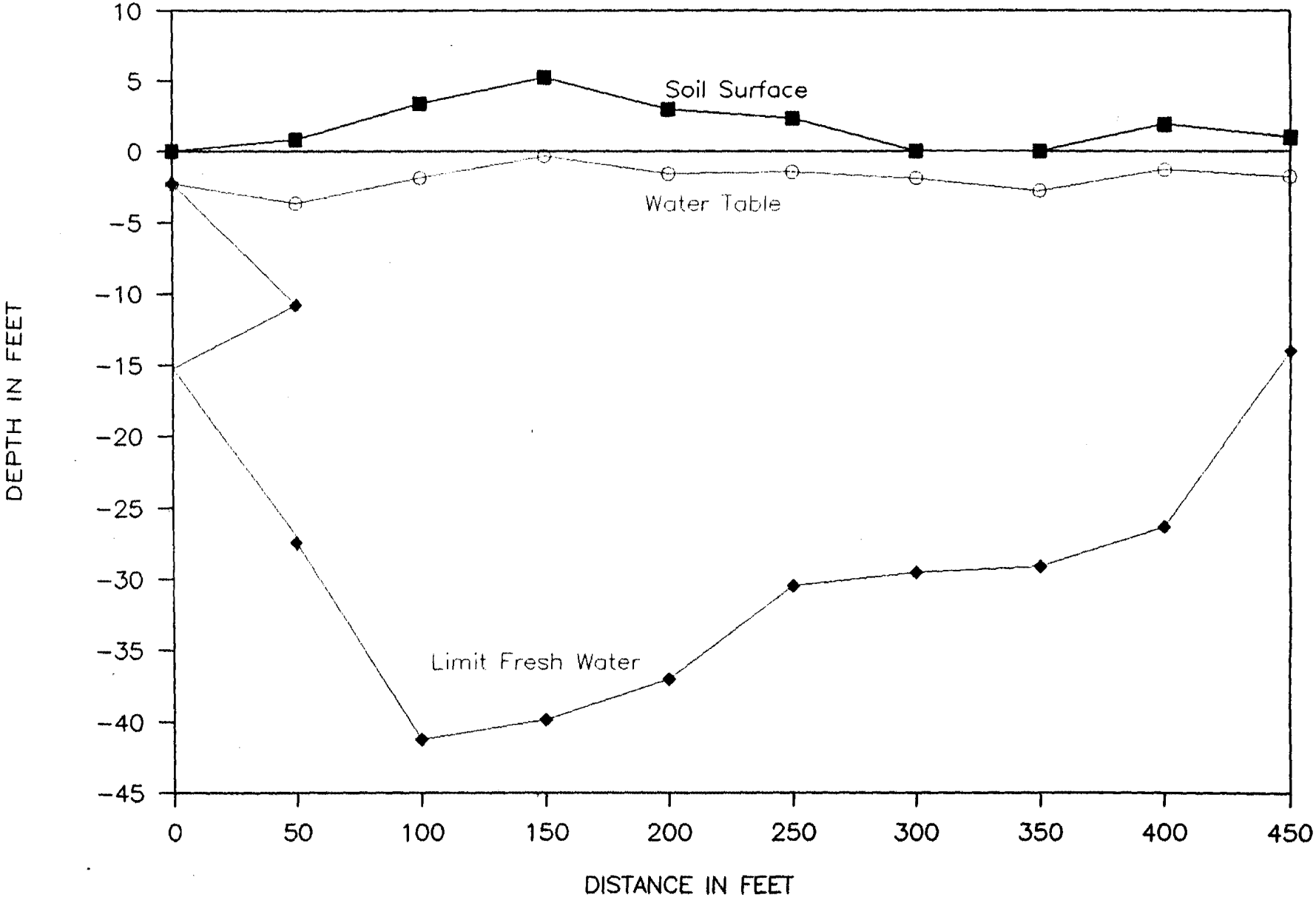
LIMITS OF FRESH WATER

SAQUISH NECK, PLYMOUTH, MA