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Cooperative Geologic Project

Geologic Interpretation of Seismic Data

Relocation of Route 2

Cut, Stations 138 to 155

in Lancaster, Mass.



by

James E. Maynard, Geologist, U. S. Geological Survey

and

Rev. Daniel Linehan, S. J., Seismologist, Weston College

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3 plates ✓

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Seismic Series # \_\_\_\_\_

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General Statement

The proposed relocation of the Concord-Westminster Highway, Route 2, in Lancaster, Mass., requires a long, deep cut between stations 138 and 155. A preliminary seismic survey was made of the site in October 1949. At that time five seismic traverses were made along the base-line, and three transverse to it. This work showed an anomalous situation in the vicinity of shot point E. In order to obtain the required additional data to resolve these anomalies, four more seismic traverses were made in November 1949. Two of these were run along the base-line between station 138+52 and station 145+12 in such a way as to yield, in conjunction with the preliminary survey, depth data of a 660-foot traverse. One of the primary functions of this long line was to obtain a reliable bedrock velocity. The other two traverses were transverse to the long traverse. This report comprises all of the seismic and geologic work performed at this site.

The work was done as a part of a cooperative program of the Massachusetts Department of Public Works and the United States Geological Survey.

## Surface Geology

At this site the proposed road crosses a segment of the top and front of a sand and gravel kame terrace. The terrace between stations 140+65 and 146+70, encloses a low knob of till that rises to an altitude of approximately 15 feet above the general level of the terrace.

No bedrock is exposed at the site or in its immediate vicinity. The geology of the region, however, suggests that the bedrock underlying the site is phyllite, (a fine-grained, thinly foliated slaty rock). The attitude and trend of this phyllite could not be interpreted from the general structure of the region.

Shallow test pits showed that the terrace consists principally of sand of various grades, and sand with fine to medium gravel layers. Sand-size grades seem to predominate. Over much of the site, the sand and gravel appears to be a relatively thin veneer on till or bedrock.

Where examined in shallow test pits or under uprooted trees, the till is moderately compact with a relatively high clay and rock flour content, and about the average number of cobbles and small boulders. Relatively few large boulders were noted on or protruding from the till.

## Seismic Traverses

The plan of the seismic traverses is shown on sheet 1.

Five 330-foot consecutive traverses A-B<sub>1</sub>, B-C, C-D, D-E and E-F coincided with the base-line between stations 138+50 and 155+00. Two consecutive 220-foot cross traverses M-N, N-O intersected the base-line at station 141+40. One 330-foot cross traverse G-H intersected the base-line at station 143+00. Two 220-foot cross traverses I-J and K-L intersected the base-line at stations 142+00 and 149+00 respectively. In addition, F-E and E-D were run again so

as to yield velocity data for a 660-foot line, D-F.

The shot points for the traverses were located as follows:

A,	station	155+00			
B,	"	151+70			
C,	"	148+40			
D,	"	145+10			
E,	"	141+80			
F,	"	138+50			
G,	165 feet to the left (north) of station	143+00			
H,	165 " " " right(south) " "	143+00			
I,	110 " " " left (north) " "	142+00			
J,	110 " " " right(south) " "	142+00			
K,	110 " " " left (north) " "	149+00			
L,	110 " " " right(south) " "	149+00			
M,	215 " " " right(north) " "	140+80			
N,	station	141+25			
O,	220 feet to the right(south) " "	141+60			

#### Depths to Bedrock

A,	bedrock not detected, at least 90 feet
B,	" " " " " " " "
C,	" " " " " " " "
D,	" " " " " " 80 "
E,	43 feet
F,	12 "
G,	70 "
H,	46 "
I,	58 "
J,	58 "
K,	bedrock not detected, at least 80 feet
L,	" " " " " " " "
M,	60 feet
* N,	18 "
O,	20 "

\* These values were calculated from velocity data that was less reliable than that used for the other depth values.

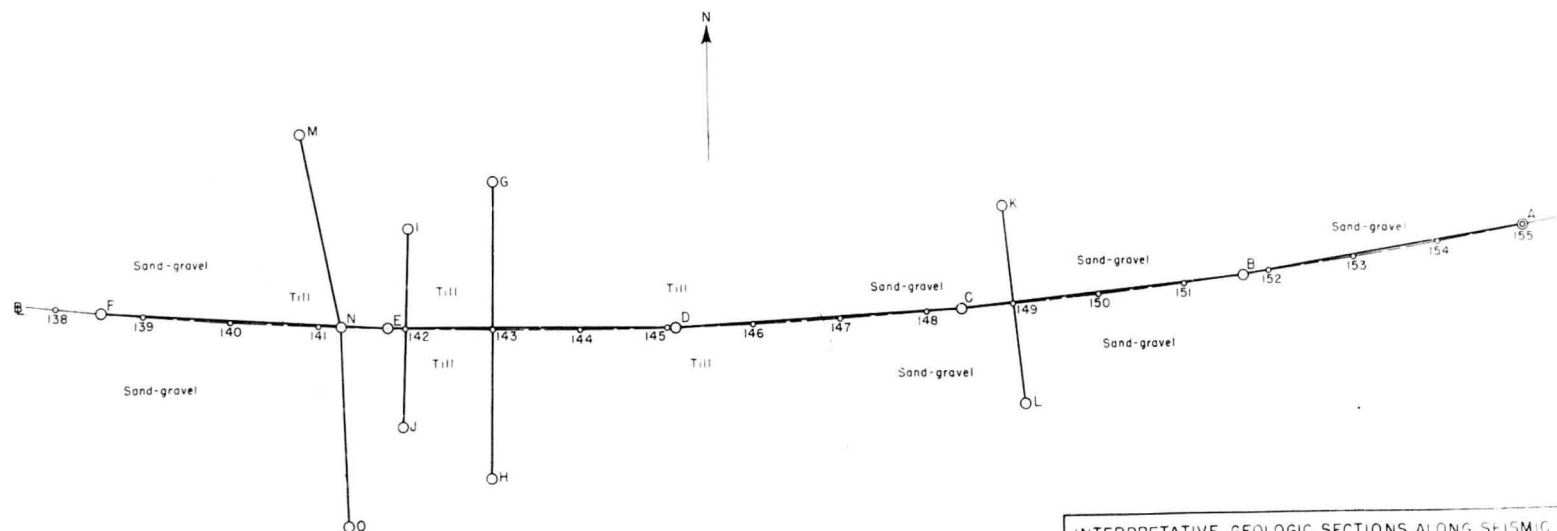
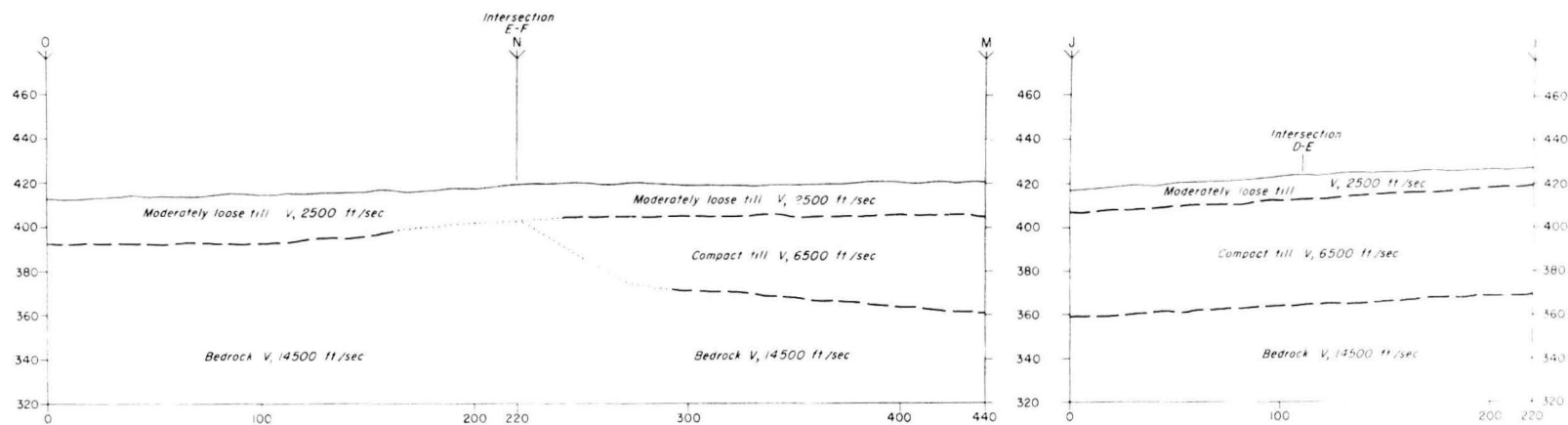
#### Geologic Interpretation of Seismic Data

The geologic sections as interpreted from the surface geology and the seismic data are shown on sheets 1, 2, and 3. No bedrock was detected along the base-line between station 144 and 155. In general, over most of this segment bedrock is at least 90 feet below the surface, and at station 145 it

is at least 80 feet below the surface. Between stations 138+50 and 141+40, along the base-line, and to the south of it the average indicated depth to bedrock is approximately 16 feet; to the north of the base-line the bedrock surface appears to decline steeply with a depth of approximately 33 feet at a point 80 feet to the north of station 141+20. From the seismic data there is a definite bedrock escarpment in the vicinity of shot point E, but the exact location and relief of this escarpment are uncertain from the present data. The escarpment is shown by dotted lines on the sections.

Over most of this site from station 142 to station 155 a surface layer of gravel or moderately loose till from 8 to 20 feet thick overlies a zone of compact till with a minimum thickness of 40 feet and a maximum seismically explored thickness of approximately 80 feet. Between stations 138+50 and 141 sand and gravel or moderately loose till appears to directly overlie bedrock.

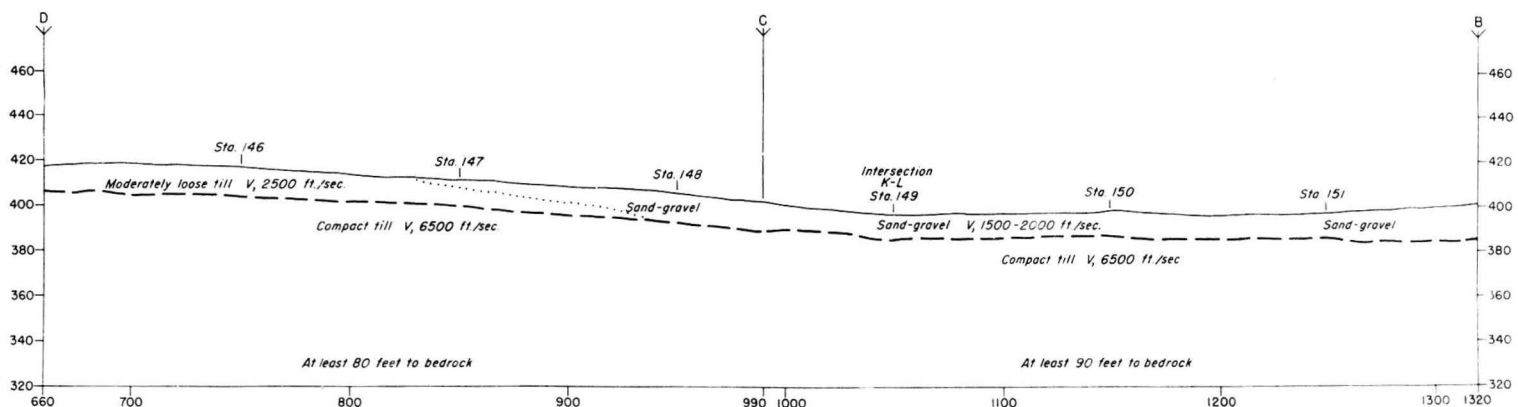
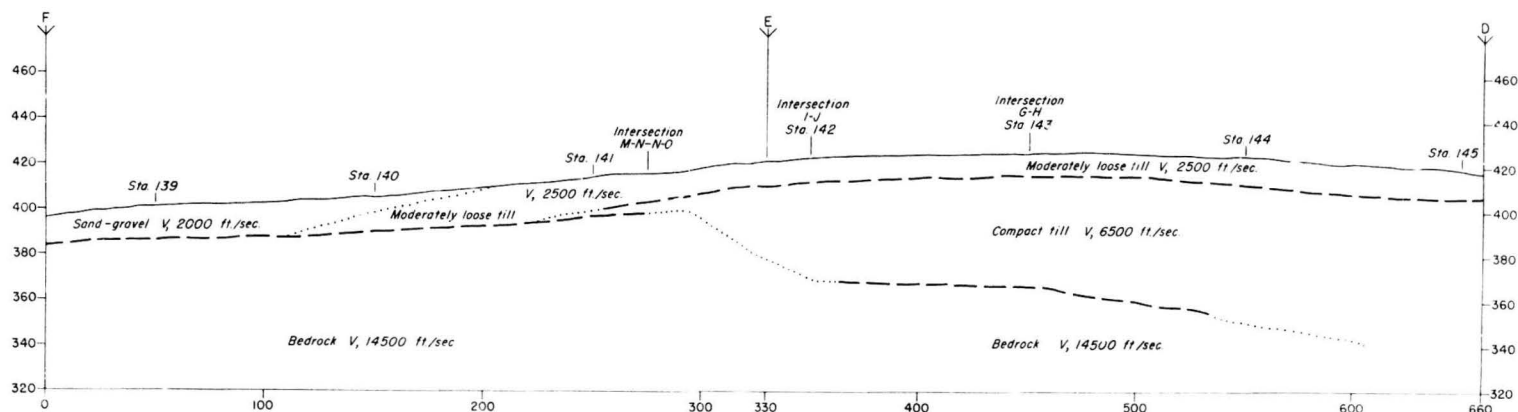
The bedrock profiles are shown by smooth curves, but the actual bedrock surface is undoubtedly much more irregular than these curves would indicate. Numerous knobs, ridges, pinnacles, and depressions may occur both above and below the bedrock profile as plotted.



PLAN OF TRAVERSES
SCALE 1 INCH = 100 FEET
Letter refers to unit points at ends of traverses Numbers refer to D.P.W. stations on baseline

NOTE:  
Dotted portion of section indicates  
inconclusive seismic data.

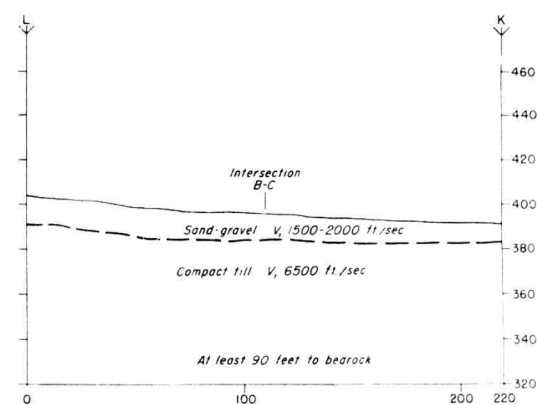
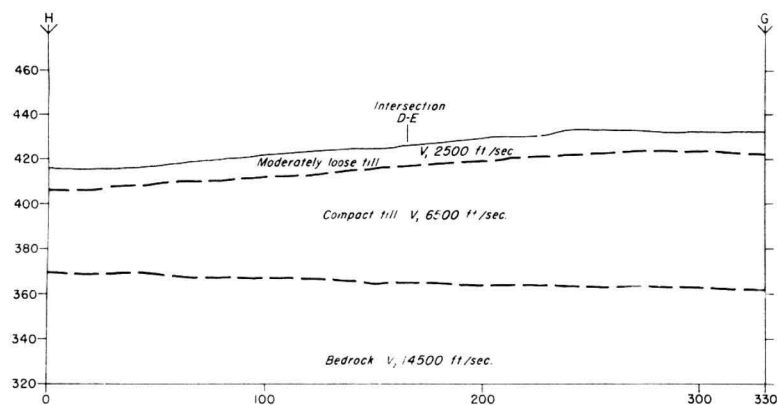
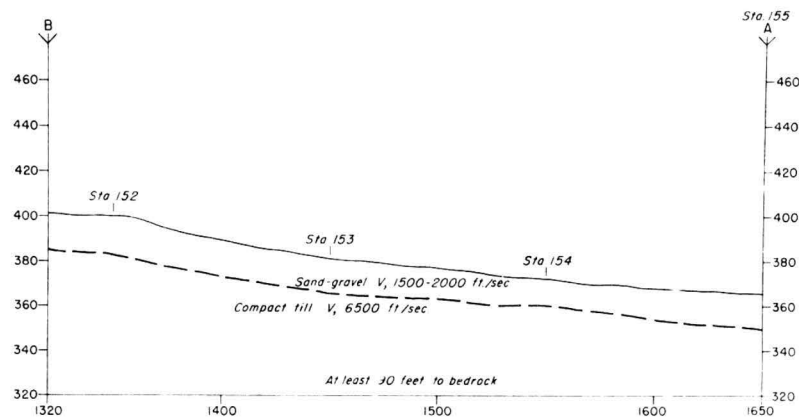
INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES	
LANCASTER	ROUTE NO 2
RELOCATION-ROUTE 2 INDUSTRIAL FARM SITE STAS 138-155	
SCALE 1 INCH = 40 FEET	GEODESIC BY JAMES E. MAYNARD
<div> </div> SIGHT POINT <div> </div> Apparent seismic velocity (ft/sec)	GEODESIC DATA BY DANIEL LINEHAN, S.E. ENGINEERING BY W.H. STEAD, B.S. & J. OWEN
DATE: OCT. 1949	SHEET 1 OF 3



PLAN OF TRAVERSES
SCALE 1 INCH = 40 FEET
Letters refer to shot points at ends of traverses

NOTE:  
Dotted portions of sections indicate  
inconclusive seismic data

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES	
LANCASTER	ROUTE NO 2
RELOCATION - ROUTE 2 INDUSTRIAL FARM SITE STAS. 138-155	
SCALE 1 INCH = 40 FEET	GEOLOGY BY JAMES E. MAYNARD
↓ Shot point	SEISMIC DATA BY DANIEL LINEHAN, S.J.
V <sub>s</sub> Apparent seismic velocity (feet in feet per second)	ENGINEERING BY W.H. STEAD & C. J. OWEN
DATE OCT. 1949	SHEET 2 OF 3



PLAN OF TRAVERSES	
SCALE 1 INCH	FEET
Letters refer to shot points along traverses	

INTERPRETATIVE GEOLOGIC SECTIONS ALONG SEISMIC TRAVERSES	
LANCASTER	ROUTE NO 2
RELOCATION—ROUTE 2 INDUSTRIAL FARM SITE STAS 138-155	
SCALE 1 INCH = 40 FEET	GEOLOGIST BY JAMES E. MAYNARD
Shot point	SEISMIC DATA BY DANIEL LINEHAN, S.J.
Apparent seismic velocity (ft/sec) in feet per second	ENGINEERING BY W.H. STEAD & C. J. OWEN
DATE OCT. 1949	SHEET 3 OF 3