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# FROST INVESTIGATION 1946 - 1947

REPORT ON

NEW ENGLAND DIVISION

INVESTIGATIONS



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APPENDIX I  
TO COMPREHENSIVE REPORT  
1946 - 1947

173  
234

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BOSTON, MASSACHUSETTS

APPENDIX 1

REPORT ON NEW ENGLAND DIVISION INVESTIGATIONS

PART 1

REPORT ON DOW FIELD, BANGOR, MAINE

PART 2

REPORT ON TEST SECTION, DOW FIELD, BANGOR, MAINE

PART 3

REPORT ON BEDFORD AIRFIELD, BEDFORD, MASS.

FROST INVESTIGATION

1946 - 1947

NEW ENGLAND DIVISION  
CORPS OF ENGINEERS  
DEPARTMENT OF THE ARMY  
BOSTON, MASSACHUSETTS

APPENDIX 1

PART 1

REPORT ON  
DOW FIELD, BANGOR, MAINE

FROST INVESTIGATION

1946 - 1947

TABLE OF CONTENTS

<u>PARAGRAPH</u>	<u>TITLE</u>	<u>PAGE</u>
	List of Tables. . . . .	iii
	List of Plates. . . . .	iv
I. INTRODUCTION		
1-01	Authorization . . . . .	1
1-02	Purpose . . . . .	1
1-03	Scope . . . . .	1
1-04	Definitions . . . . .	2
1-05	General Conditions. . . . .	2
1-06	Presentation of Data. . . . .	5
II. TEST AREA D		
2-01	Type of Pavement, Base and Subgrade . . . . .	5
2-02	Explorations. . . . .	5
2-03	Installations . . . . .	6
2-04	Observations and Measurements . . . . .	8
2-05	Field Tests . . . . .	9
2-06	Laboratory Tests. . . . .	11
2-07	Summary of Results. . . . .	12
III. TEST AREA E.		
3-01	Type of Pavement, Base and Subgrade . . . . .	15
3-02	Explorations. . . . .	15
3-03	Installations . . . . .	15
3-04	Observations and Measurements . . . . .	17
3-05	Field Tests . . . . .	19

<u>PARAGRAPH</u>	<u>TITLE</u>	<u>PAGE</u>
3-06	Laboratory Tests . . . . .	20
3-07	Summary of Results . . . . .	20
IV. TEST AREA F		
4-01	Type of Pavement, Base and Subgrade. . . . .	23
4-02	Explorations . . . . .	24
4-03	Installations. . . . .	24
4-04	Observations and Measurements. . . . .	25
4-05	Field Tests . . . . .	26
4-06	Laboratory Tests . . . . .	29
4-07	Summary of Results . . . . .	29
V. TURFED AREA		
5-01	Location and Description . . . . .	32
5-02	Explorations . . . . .	32
5-03	Installations. . . . .	32
5-04	Observations and Measurements. . . . .	33
5-05	Field Tests . . . . .	34
5-06	Laboratory Tests . . . . .	34
5-07	Summary of Results . . . . .	34
VI. CONCLUSIONS		
6-01	Conclusions. . . . .	36
	Glossary . . . . .	38

LIST OF TABLES

<u>TABLE</u>	<u>TITLE</u>
1	Chronological Summary of Explorations and Observations - (2 sheets)
2	Summary of Soil Test Data - (4 sheets)
3	Ground Water Table Observations - Test Area D
4	Ground Water Table Observations - Test Areas E and Turf Area
5	Thermometer Record of Subsurface Temperatures-Installation TW-3
6	Thermocouple Record of Subsurface Temperatures-Installation T886p
7	Thermometer Record of Subsurface Temperatures-Installation TW-2
8	Thermocouple Record of Subsurface Temperatures-Installation T697p
9	Thermometer Record of Subsurface Temperatures-Installation TW-1
10	Thermocouple Record of Subsurface Temperatures-Installation T693p
11	Thermocouple Record of Subsurface Temperatures-Installation T694p
12	Thermometer Record of Subsurface Temperatures-Installation TW-4
13	Summary of Plate Bearing Tests - Test Area D and E
14	Summary of Plate Bearing Tests - Test Area F

LIST OF PLATES

<u>PLATE</u>	<u>TITLE</u>
1	Geographical Location Map
2	Weather and Frost Penetration Data
3	Plans and Sections Test Areas D, E, F and Turf Area
4	Observation Well Details
5	Thermometer Well Details
6	Thermocouple Installation and Switch Box Details
7	Contour of Pavement and Base Thickness - Test Areas D, E and F
8	Frost Heave Contours-Test Areas D, E and F
9	Typical Subsurface Temperatures from Thermometer Wells
10	Typical Subsurface Temperatures from Thermocouples
11	Crack Survey-Test Areas D and E
12	Crack Survey-Test Area F
13	Plate Bearing Tests-Average Deflections-Test Areas D and E
14	Plate Bearing Tests-Rupture-Test Area F
15	Plate Bearing Tests-Subgrade Modulus-Test Area F
16	Water Content-Density Soil Profiles, Test Areas D, E and F
17	Soil Data Summary-Test Areas D, E and F
18	Frost Penetration vs. Thickness of Pavement and Base
19	Pavement Heave Related to Thickness of Frozen Subgrade
20	Subsurface Temperatures and Frost Penetration

# FROST INVESTIGATION

1946 - 1947

## REPORT ON DOW FIELD, BANGOR, MAINE

### I. INTRODUCTION

1-01. Authorization. The frost investigation program was continued in 1946-1947 by authorization contained in two letters from the Chief of Engineers to the Division Engineer, New England Division, dated 25 July 1946 and 12 August 1946, Subject: "Funds for Investigational Program for Fiscal Year 1947." The Frost Effects Laboratory, established at the New England Division by direction of the Chief of Engineers, as stated in Circular Letter No. 3221, dated 11 August 1944, was continued in its function.

1-02. Purpose. The purpose of this investigation has been the determination of development of frost action in the soils underlying airfield pavements as affected by various conditions of weather, soils, and ground water, and to augment the tests made and data obtained from the frost investigations conducted at Dow Field, Bangor, Maine during the fiscal years 1943-1944, 1944-1945, and 1945-1946.

1-03. Scope. This report contains, in detail, a description of tests and methods, the data collected, and the results of the frost investigation conducted at Dow Field, Bangor, Maine during the period from 1 July 1946 through 2 July 1947. The investigation at Dow Field included four test areas in which observations were made of ground water table, subsurface temperatures, frost penetration, ice segregation, water content, and density. Plate bearing tests were conducted in three of the test areas.

The climatic and other general conditions related to the frost investigation at Dow Field are also included in this report.

1-04. Definitions. The description of tests and analysis of results involve a specialized use of certain words and terms. These words and terms are defined in the glossary at the end of this part.

1-05. General Conditions.

a. Location, Terrain, and Drainage. Dow Field is located approximately two miles west of the city of Bangor in Penobscot County, Maine. Plate 1 shows the geographical location of the airfield in the New England Division. The field is located in an area of rolling terrain with hills composed of a thin mantle of slightly gravelly silt (glacial till) overlying bed rock. In the low areas between the hills a deposit of firm, brown to grey silty clay overlying the glacial till or bed-rock is found. There are a few bed-rock outcrops in the airfield area. The drainage system consists of paved gutters, ditches, culverts, pipe drains, and catch basins. Surface water from the landing strips is generally collected by longitudinal open ditches placed parallel to the outer edges of the landing strips. The ground water normally varies from approximately two feet to more than six feet below the surface.

b. Types of Pavement. All the airfield pavements are of the flexible type with the exception of approximately 276,000 square yards of portland cement concrete aprons, warm-up aprons, turnarounds and hardstands. The turnarounds and warm-up aprons at the ends of the runways are paved with seven inches of portland cement concrete with the outside lanes and lanes adjacent to longitudinal expansion joints uniformly thickened to 10 inches. The portland cement concrete pavement was placed on approximately 20 inches of well graded sand and gravel (GW). The runways are

paved with 3.5 inches of bituminous concrete for a width of 150 feet, placed on a well graded sand and gravel base (GW) of variable thickness (32 to 50 inches). The shoulders, 75 feet on each side of the runway, are bituminous surface treated gravel.

c. Previous Frost Investigations. An investigation consisting of field and laboratory tests during the freezing period, and traffic tests and field and laboratory tests during the frost melting period was made during the winter and spring of 1944. This investigation is presented in report "Frost Investigations and Pavement Behavior Tests, Dow Field, Bangor, Maine January 1946." The investigation of 1944 was augmented by a more comprehensive investigation during the fiscal year 1944-1945, which is reported in "Report on Dow Field, Bangor, Maine" Appendix 1 to "Comprehensive Report" Frost Investigation 1944-1945 dated June 1945. This investigation consisted of installation and subsequent periodic observations of ground water wells and subsurface temperature recording devices. It also included measurements of pavement heave, excavation of test pits to determine the variation in water content and density of the base and subgrade soils affected by frost action, and observations to determine the conditions affecting frost. Plate bearing tests were conducted at periodic intervals of time, and traffic tests were conducted during the frost melting period. Further frost investigations were conducted at Dow Field in the fiscal year 1945-1946 and are presented in "Report on Dow Field, Bangor, Maine" Appendix 1 to "Comprehensive Report" Frost Investigation 1945-1946 dated June 1946. This investigational program included all observations, tests and measurements made in previous years with the exception of traffic tests.

The test areas utilized during the current investigation are either the same as, or adjacent to the test areas used during the previous investigations. They were selected for further study on the basis of (a) pavement, base, and subgrade conditions; (b) the proximity of existing installations, and (c) the desirability of correlating the results of previous tests with the 1946-1947 tests. The installations for measurement of ground water and subsurface temperatures placed in service during the previous investigations have been utilized in the present investigation.

d. Weather Data.

(1) Temperature Records. Continuous air temperature records for the duration of the investigation were obtained from the recording thermograph used during previous investigations, and located 325 feet south of station 14,50 on the E-W runway until 22 November 1946 when it was removed to the Test Section (See Site Plan, Part 2, Plate 1). Daily maximum and minimum temperatures are plotted on Fig. 1, Plate 2.

(2) Freezing Index. The winter during the investigation was much milder than usual for Bangor, Maine. This is indicated by the 1946-1947 freezing index which was 965, or 24 per cent below the 13-year normal of 1275. The freezing index curve computed from the thermograph data for the period 1 November 1946 to 1 May 1947 is plotted on Fig. 4, Plate 2, together with the normal and 1945-1946 curves.

(3) Precipitation. During the three months prior to freezing, September to November inclusive, the accumulated rainfall at Dow Field was 9.3 inches or 17 per cent below the 21-year normal rainfall of 11.2 inches for the same period. Total precipitation during the period September 1946 to April 1947 inclusive was 23.9 inches, including the season's total snowfall (unmelted) of 61.2 inches. Accumulated rainfall

for September to December and accumulated snowfall for November to April are shown on Fig. 3, Plate 2. Daily precipitation records are plotted on Fig. 2, Plate 2.

1-06. Presentation of Data. Investigations were conducted at four test areas. Test Area "D" and Test Area "E" bituminous concrete pavement, Test Area "F", portland cement concrete pavement, and a turfed area designated "Turfed Area". The description of the areas, explorations conducted, installations, observations, and measurements made, field and laboratory tests conducted, and summary of results for each test area are presented in the following paragraphs.

## II. Test Area D.

2-01. Type of Pavement, Base and Subgrade. Test Area D, 75 feet by 100 feet, is located between stations 8/00 and 9/00 on the East-West Runway, between the centerline and the north edge of the pavement. The test area is the same as Test Area D used in the 1945-1946 Frost Investigation and is within the limits of Test Area C, 1944-45 Frost Investigation. The pavement consists of 4.8 inches of bituminous concrete placed on a well graded sand and gravel base (GW) with an average thickness of 44 inches, ranging from 36 to 52 inches. The subgrade consists of silty clay (CL). Plan and sections of the test area are shown on Plate 3. Contours of pavement and base thickness are shown on Plate 7.

2-02. Explorations. Six test pits T970pa, T985p, T990p, T993pa, T999pa, and T1005pa, were excavated to determine: (a) the depth of frost penetration and ice lens and crystal formations during the freezing period, and (b) soil conditions prior to freezing, during, and after the frost melting period. Five auger borings, T976a to T980a inclusive, were excavated for general soil classification of the plate bearing test area

located between stations 8/15 and 8/10. Locations of the explorations are shown on Plate 3. A chronological summary of the explorations is presented in Table 1, and the data obtained from the explorations are summarized in Table 2.

### 2-03. Installations.

a. Ground Water Observation Wells. Adjacent to or within the area are nine existing base observation wells and nine existing subgrade observation wells which were maintained and read periodically during the current investigation. Designations and locations of the individual wells are shown on Plate 3. Observation wells in the gravel base, T678a, and T683a consisted of a two-inch galvanized iron pipe with the upper end fitted with a standard galvanized iron coupling and plug and the lower end open on the top of the subgrade. The lower six inches of the pipe was perforated with ten one-quarter inch holes. The hole in which the pipe was set was back-filled with screened gravel and sealed with cold patch and hot asphalt topping. Observation wells in the gravel base, T910a to T916a, inclusive, consisted of 3/4-inch galvanized iron pipe capped with a standard galvanized iron coupling and plug. A small steel rod was welded across the outside of the coupling to prevent turning of the coupling when the plug is being removed. The 3/4-inch pipe contained a square wooden plug in the bottom. The lower portion of the pipe was perforated with 1/8-inch holes at every 90 degrees of circumference. The perforations, spaced two inches apart vertically, extended up from the bottom of the pipe a distance of one to three feet dependent on the depth of the well. Two similar holes were drilled into the pipe six inches from the top. The wells were installed so that the bottom six inches were firmly imbedded in the subgrade. The hole in which the

pipe was set was backfilled with sand and gravel and sealed at the top with cement grout. Observation wells in the subgrade, T651a, T652a, T663a and T664a consisted of a 1-1/2 inch standard galvanized pipe about six feet long with 1/4-inch perforations near the bottom placed inside of a casing of 2-1/2 inch pipe which extended to a depth of five feet. The space between the 1-1/2 inch pipe and the inside of the 2-1/2 inch casing was filled with grease. Observation wells in the subgrade, T904a to T908a, inclusive, consisted of 3/4-inch galvanized iron pipe with a standard galvanized iron coupling and plug on the upper end and a standard pipe cap on the lower end. A small steel rod was welded across the outside of the coupling to prevent turning of the coupling when the plug was being removed. The lower eight feet of the pipe was perforated with 1/8-inch holes spaced at 90 degrees around the pipe and four inches apart vertically. The hole in which the pipe was set was backfilled with coarse clean sand up to within 12 to 15 inches of the top on the subgrade. The hole was then backfilled with sand and gravel. The top of the hole was sealed with cement grout. Observation well details are shown on Plate 4.

b. Thermometers Wells. The area contained one existing thermometer well installation, TW3, which was maintained and read periodically during the current investigation. The installation is located as shown on Plate 3. The thermometer well installation consisted of eight separate wells, installed at predetermined depths which vary by approximately one foot intervals from 0.6 foot to eight feet. Each well consisted of one-inch diameter plastic pipe (Saran) plugged at each end with a rubber stopper. The lower end contained not less than three inches of anti-freeze in which was suspended a mercury thermometer. The thermometer was insulated from the tip of the bulb to the immersion line with paraffin and

plastic tubing to allow sufficient time for withdrawing the thermometer without appreciable change in readings. The thermometers were withdrawn as rapidly as possible for readings. The top of the well consisted of a standard galvanized iron pipe nipple, three inches in diameter which was capped with a standard coupling and plug. The nipple was attached to the one-inch plastic tubing by means of a rubber bushing which fitted tightly inside the pipe nipple. Typical thermometer well details are shown on Plate 5.

2-04. Observations and Measurements.

a. Ground Water Table. The depth to ground water was measured from the surface of the pavement periodically between 12 June 1946 and 24 June 1947 in all observation wells. Seasonal variations in the ground water elevations as observed in the subgrade wells are plotted as profiles on the section (at station 8+50) shown on Plate 3. Table 3 is a tabulation of all the ground water table measurements.

b. Frost Heave. Pavement elevations, on a 10-foot grid system, were obtained in a survey on 22 October 1946 prior to the freezing period and in three surveys on 5 February, 19 March, and 1 April 1947, during the freezing and frost melting periods. Plotted in the form of the frost heave contours shown on Plate 8 is the difference in elevation between normal pavement conditions and conditions on 5 February 1947, date of maximum observed heave. A plot of heave as related to thickness of frozen subgrade is shown on Plate 19.

c. Frost Penetration. The following four test pits, excavated periodically during the freezing and frost melting periods were utilized to determine the observed rate and depth of frost penetration:

<u>Test Pit No.</u>	<u>Date</u>	<u>Period</u>
T985p	3 Feb. 1947	Freezing
T990p	28 Feb. 1947	Freezing
T993pa	10 Mar. 1947	Frost Melting
T999pa	25 Mar. 1947	Frost Melting

Table 2 contains a record of the frost penetration information obtained from these test pits. A plot of frost penetration versus time is shown on Figure 5, Plate 2, and a plot of frost penetration versus thickness of pavement and base is shown on Plate 18.

d. Subsurface Temperatures. A record of subsurface temperatures was obtained by periodic reading of the eight thermometers in the thermometer well installation TW-3. Plots of typical subsurface temperatures versus depth for this installation are presented on Plate 9. The subsurface temperature observations are summarized in Table 5. Plots of the 28 and 32 degree lines are compared with the measured depth of frost on Plate 20.

e. Ice Lens Survey. Observations of ice lens and crystal formations were conducted while excavating the four test pits tabulated in Paragraph 2-04c. Table 2 contains a record of the ice lens and crystal information obtained from the test pits.

f. Crack Survey. A crack survey was made over the entire bituminous concrete pavement in Test Area D on 1 November 1946 and a second survey on 22 April 1947. A comparison of the number and length of the cracks for both surveys is shown by light and heavy lines on Plate 11.

#### 2-05. Field Tests.

a. Test Procedures. The tests were conducted as outlined in "Highway Materials" AASHO, Part II, 1942 Edition except as noted below.

(1) Determination of Density of Soil in Place. The

density of the soil in place was determined by use of the sand volume method.

(2) Plate Bearing Tests. Plate bearing tests were performed on the bituminous concrete pavement using a 30-inch diameter bearing plate placed on a thin leveling course of Ottawa sand placed directly on the pavement. The plate was loaded with a single application of 20,000 pounds and the load maintained for fifteen minutes or until deflection of the pavement had practically ceased, whichever occurred first. The maximum deflection under this load was recorded.

b. Tests.

(1) Water Content. Continuous water content samples of base and subgrade materials were obtained in four test pits, T970pa, T993pa, T999pa, and T1005pa excavated 30 October 1946 (normal period), 10 and 25 March 1947 (frost melting period) and 17 June 1947 (after frost melting period), respectively. Water contents plotted against depth are shown on Figure 1, Plate 16. Water content samples were obtained with each density sample, the degree of saturation computed, and the results presented in Table 2.

(2) Density. The density of the base and of the subgrade was obtained in the three test pits (T970pa, T999pa, and T1005pa) during the normal, frost melting and after frost melting periods, respectively. The densities were obtained to determine density changes due to frost action. The results of these tests are plotted in Figure 1 on Plate 16 in relation to the soil profile and are summarized in Table 2. Plots of water content versus density are shown in Figures 1 and 2, Plate 17.

(3) Plate Bearing Tests. Three series of plate bearing tests were made on a 25 by 25-foot section of bituminous concrete pavement. The first series, consisting of twelve tests, was conducted during the normal period on 29 October 1946. The second series, with a total of fifteen tests, was conducted in weekly groups of three tests each during the frost melting period between 24 March and 22 April 1947. A third series, with a total of 16 tests, was conducted in weekly groups of three tests each during the period after frost melting between 6 June and 2 July 1947.

Subdivision of the 25 by 25-foot test section into five-foot squares facilitated arrangement of the plate bearing tests so that tests conducted in any one period could be dispersed over the entire section. Locations of the individual tests within their respective squares are shown on Plate 3. Average deflection curves of the plate bearing tests are plotted on Plate 13. Test data are summarized in Table 13.

2-06. Laboratory Tests.

a. Soil Classification. No laboratory tests for classification of materials were conducted on samples of the base and subgrade materials. Since Test Area D is located within the limits of Test Area C of the 1944-1945 Frost Investigation Program the results of classification tests on representative samples made during the earlier investigation are considered applicable to Test Area D. The gradation of base and subgrade materials are shown in Figure 3, Plate 17. The physical properties of the representative samples of the base and subgrade materials are shown in tabular form in Figure 4, Plate 17.

2-07. Summary of Results. Results of tests and observations for Test Area D are summarized as follows:

a. Soils. The frost susceptibility of the subgrade soil and the presence of frost susceptible soil in scattered pockets in the gravel base was established during the 1944-1945 investigation. Therefore, subgrade and base materials of Test Area D are considered to be frost susceptible.

b. Ground Water. During the 1946-1947 investigation, the ground water table in Test Area D maintained a relatively constant level at or above the top of the subgrade (approximately three feet from surface of pavement). Considering the average measurements of the five subgrade wells under the bituminous pavement at station 8+50 and the five base wells under the bituminous pavement at station 9+25 as a basis of comparison, the following ground water table fluctuations are indicated:

<u>Water Table Depth Below Pavement Surface (feet)</u>			
<u>Subgrade Wells</u>	<u>Base Wells</u>	<u>Date</u>	<u>Period</u>
2.8	3.2	12 June 1946	Normal
4.4	3.5	16 September	Normal
3.0	3.1	13 December	Freezing
4.4	4.6	22 January 1947	Freezing
2.4	2.4	26 March	Frost Melting
3.3	3.0	31 March	Frost Melting
2.8	3.1	9 April	After Frost Melting
3.3	3.1	23 April	After Frost Melting
2.4	2.6	5 May	After Frost Melting
3.0	3.1	21 May	After Frost Melting
2.8	3.2	17 June	After Frost Melting

It will be noted from the above table that measurements from the base wells closely parallel those from the subgrade wells and that the presence of a secondary water table is not indicated.

c. Pavement Heave. The maximum measured frost heave in Test Area D was 0.11 foot. No detrimental effects occurred as a result of this slight heave.

d. Depth of Frost Penetration. Measurements of frost penetration obtained in Test Area D with the freezing index at time of measurement are summarized in the following table:

<u>Depth of Frost Penetration (feet)</u>	<u>Date</u>	<u>Method of Measurement</u>	<u>Freezing Index (°F days)</u>
3.65	3 February 1947	Test Pit	753
3.60	22 February	Test Pit	950
4.05 (max.)	10 March	Test Pit	(8 days after max. F.I. of 965)
3.9 (max.)	28 February	Thermometer	950

e. Ice Segregation. Ice lens and crystal formations observed in Test Area D are summarized as follows:

<u>Formation, Size and Locale</u>		
<u>Date</u>	<u>Lens</u>	<u>Crystal</u>
3 February 1947	None	minute, in base
28 February	None	small, in base
10 March	0-1/16" thick, subgrade, thickest at bottom	None

f. Water Content and Density. Seasonal variations in the water content and density of gravel base and subgrade materials are shown by the following summary of tests made during excavation of four test pits in Test Area D:

<u>Date</u>	<u>Water Content</u> (per cent)		<u>Density</u> (lbs / cu. ft.)	
	<u>Base</u>	<u>Subgrade</u>	<u>Base</u>	<u>Subgrade</u>
30 October 1946	6.9	31.5	120	100
10 March 1947	14.4	25.9	-	-
25 March	8.0	24.0	132	104
17 June	8.0	20.0*	116	105*

g. Cracks in Pavement. The number of cracks in the pavement increased approximately 11 per cent during this investigation.

h. Effect of Frost Action on Subgrade Strength. Plate bearing tests indicate that there is a definite loss of pavement strength during the frost melting period as shown on Plate 13 by the plot of deflections versus time. From this plot it is observed that the average deflections for each group of tests in the frost melting period (March, April) range from 1.0 to 1.9 times greater than during the normal period in October. The average deflections for tests during the period after frost melting (June, July) are only from 0.8 to 1.2 times as great as the October deflections. These relationships are summarized as follows:

<u>Date of Test</u>	<u>Ratio of Average Deflections</u> <u>to Normal Period Average Deflection</u>
29 October 1946 (Normal Period)	1.0
24 March 1947)	1.9
1 April )	1.2
8 April ) Frost	1.2
15 April ) Melting	1.0
22 April ) Period	1.4
6 June)	1.2
13 June) After	1.0
20 June) Frost	0.9
27 June) Melting	0.8
2 July) Period	1.0

\*Discounting 1.3 ft. of organic soil

### III. Test Area E.

3-01. Type of Pavement, Base and Subgrade. Test Area E, 75 feet by 110 feet, is located between Stations 2/50 to 3/60 on the East-West runway between the centerline and the north edge of the pavement. The area is the same as Test Area E used in the 1945-1946 Frost Investigation and within the limits of Test Area C, 1944-1945 Frost Investigation. The pavement consists of 4.8 inches of bituminous concrete placed on a well graded sand and gravel base (GW) with an average thickness of 36 inches ranging from 30 to 43 inches. The subgrade consists of silty clay (CL). Plan and sections of the test area are shown on Plate 3. Contours of pavement and base thickness are shown on Plate 7.

3-02. Explorations. Seven test pits, T968pa, T982p, T986p, T991p, T995pa, T998pa, and T1001pa, were excavated to determine, (a) the depth of frost penetration and ice lens and crystal formations during the freezing period, and (b) soil conditions prior to freezing, during and after the frost melting period. Five auger borings, T971a to T975a inclusive, were excavated for general soil classification of the plate bearing test square located between stations 2/45 and 2/70. Locations of the explorations are shown on Plate 3. A chronological summary of the explorations is presented in Table 1, and the data obtained from the explorations are summarized in Table 2.

#### 3-03. Installations.

a. Ground Water Observation Wells. Adjacent to or within the area are nine existing base observation wells and seven existing sub-grade observation wells which were maintained and read periodically during the current investigation. Location of the individual wells are shown on

Plate 3. Observation well details are shown on Plate 4. Detailed descriptions of these types of installations are shown in paragraph 2-03a.

b. Thermocouple. The area contained one existing thermocouple installation, T886pa, which was maintained and read periodically during the current investigation. The installation consisted of 11 thermocouples imbedded at various distances beneath the surface of the pavement. Temperature observations were made by a potentiometer which indicated directly the temperature in degrees Fahrenheit at a selected thermocouple. Each thermocouple was prepared by stripping the lead sheathing and braid of the copper and constantan wires so that approximately one inch length of the copper and constantan wire could be twisted together and fused using an acetylene torch and silver solder flux. A five-inch length of Saran tubing, sealed at one end, was filled with 120-150 penetration, asphalt and white liquid, forced over the thermocouple. The 11 thermocouples were placed and the leads brought into a switch box which consisted of a 12-inch diameter steel pipe,  $1\frac{1}{2}$  feet long which contained a terminal board and rotary selector switch. Considerable slack was allowed in the leads to prevent breakage of the leads during settlement and frost action. The slack was encased in very heavy grease as a further precaution against rupture. A lead wire from the rotary switch to the potentiometer was kept in the switch box when not in use and the terminal board was protected from temperature differentials during readings by a plywood insulating cover and several layers of one inch thick felt. The installation is located as shown on Plate 3. Typical thermocouple installation details are shown on Plate 6.

c. Thermometer Wells. The area contained one existing thermometer well installation, TW-2, which was maintained and read periodically during the current investigation. Location of the installation is shown on Plate 3. Typical thermometer well details are shown on Plate 5. A detailed description of this type of installation is shown in paragraph 2-03,b.

3-04: Observations and Measurements.

a. Ground Water. The depth to ground water was measured periodically between 12 June 1946 and 24 June 1947 in all observation wells. Seasonal variations in the ground water elevations as observed in the subgrade wells are plotted as profiles on the section (at station 3/75) shown on Plate 3. Table 4 contains a summary of all the ground water table measurements.

b. Frost Heave. Pavement elevations, at intervals of 10 feet, were obtained in a survey on 22 October 1946 prior to the freezing period and in three surveys on 5 February, 19 March, and 1 April 1947, during the freezing and frost melting periods. Plotted in the form of the frost heave contours shown on Plate 8 is the difference in elevation between normal pavement conditions and conditions on 5 February, date of maximum observed heave. A plot of heave as related to thickness of frozen subgrade is shown on Plate 19.

c. Frost Penetration. The following five test pits, excavated during the freezing and frost melting periods were utilized to determine the observed rate and depth of frost penetration:

<u>Test Pit No.</u>	<u>Date</u>	<u>Period</u>
T982p	17 Jan. 1947	Freezing

T986p	14 Feb 1947	Freezing
T991p	5 March	Frost Melting
T995pa	12 March	Frost Melting
T998pa	21 March	Frost Melting

Table 2 contains a record of the frost penetration information obtained from these test pits. A plot of frost penetration versus time is shown on Figure 5, Plate 2, and a plot of frost penetration versus thickness of pavement and base is shown on Plate 18.

d. Subsurface Temperatures. A record of subsurface temperatures was obtained by periodic reading of the thermocouple installation T886pa and the eight thermometers at thermometer well installation TW-2. Plots of typical subsurface temperatures versus depth are shown on Plates 9 and 10, for the thermometer well and thermocouple installations, respectively. The subsurface temperature observations are summarized in Tables 6 and 7 for the thermocouple and thermometer well installations, respectively. Plots of the 28 and 32 degree lines for these installations are compared with the measured depth of frost on Plate 20.

e. Ice Lens Survey. Observations of ice lens and crystal formations were conducted while excavating the five test pits tabulated in paragraph 3-04,c. Table 2 contains a record of the ice lens and crystal information obtained from the test pits.

f. Crack Survey. A crack survey was made over the entire bituminous concrete pavement on 1 November 1946 and a second survey on 22 April 1947. A comparison of the number and length of the cracks for both surveys is shown by light and heavy lines on Plate 11.

3-05. Field Tests.

a. Test Procedures. Test procedures are described in paragraph 2-05 a.

b. Tests.

(1) Plate Bearing Tests. Three series of plate bearing tests were made on a 25 by 25 foot section of bituminous concrete pavement. The first series, consisting of twelve tests, was conducted during the normal period on 28 and 29 October 1946. The second series, with a total of eighteen tests, was conducted in weekly groups of three tests each, during the frost melting period between 21 March and 25 April 1947. A third series, with a total of fifteen tests, was conducted in weekly groups of three tests each during the period after frost melting between 6 June and 2 July 1947. Locations of the individual tests within their respective squares are shown on Plate 3. Average deflection curves of plate bearing tests are plotted on Plate 13. Test data are summarized in Table 13.

(2) Water Content. Continuous water content samples of base and subgrade materials were obtained in four test pits, T968pa, T995pa, T998pa, and T1004pa excavated 9 October 1946 (normal period), 12 and 21 March 1947 (frost melting period), and 16 June 1947 (after frost melting period), respectively. Water contents plotted against depth are shown in Figure 2, Plate 16. Water content samples were obtained with each density sample, the degree of saturation computed and the results presented in Table 2.

(3) Density. To determine the changes in density of the base and subgrade due to frost action, density samples were obtained

from three test pits, T968pa, T998pa, and T1004pa, during the normal, frost melting, and after frost melting periods, respectively. The results of these tests are plotted on Figure 2, Plate 16 in relation to the soil profile and are summarized in Table 2. Plots of water content versus density are shown in Figures 1 and 2, Plate 17.

### 3-06. Laboratory Tests.

a. Soil Classification. No laboratory tests were conducted on samples of the base and subgrade materials. Since Test Area E is located within the limits of Test Area C of the 1944-1945 Frost Investigation program the results of classification tests on representative samples made during the earlier investigation are considered applicable to Test Area E. The gradation of base and subgrade materials is shown in Figure 3, Plate 17. The physical properties of the representative samples of the base and subgrade materials are shown in tabular form in Figure 4, Plate 17.

3-07. Summary of Results. Results of tests and observations for Test Area E are summarized as follows:

a. Soils. The frost susceptibility of the subgrade soil and the presence of frost susceptible soil in scattered pockets in the gravel base of Test Area C was established during the 1944-1945 investigation. Therefore, the subgrade and base materials of Test Area E are considered to be frost susceptible.

b. Ground Water During the 1946-1947 investigation, the ground water table in Test Area E maintained a relatively constant level at or above the top of the subgrade (approximately 3.5 feet) except during January when the water table dropped as low as 6.7 feet below the surface. Considering the average measurements of the three subgrade wells under the bituminous pavement at station 3475 and the three base

wells under the bituminous pavement at station 3/50 as a basis of comparison, the following ground water table fluctuations are indicated:

Water Table Depth Below Pavement Surface (feet)		Date	Period
<u>Subgrade Wells</u>	<u>Base Wells</u>		
3.1	3.1	12 June 1946	Normal
3.9	3.4	16 September	Normal
3.0	3.4	12 November	Normal
4.1	3.6	18 November	Normal
3.4	3.5	13 December	Freezing
6.7	Dry	20 January 1947	Freezing
3.4	2.5	24 March	Frost Melting
4.0	2.9	28 March	Frost Melting
3.1	2.9	9 April	After Frost Melting
2.5	2.5	7 May	After Frost Melting
3.0	2.7	12 May	After Frost Melting
3.0	3.0	17 June	After Frost Melting

It will be noted from the above table that measurements from the base wells closely parallel those from the subgrade wells and that the presence of a secondary or perched water table is indicated whenever the subgrade well measurements drop below the base well measurements.

c. Pavement Heave. The maximum measured frost heave in Test Area E was 0.17 feet. No detrimental effects occurred as a result of this slight heave.

d. Depth of Frost Penetration. Measurements of frost penetration obtained in Test Area E with the freezing index at time of measurement are summarized in the following table:

<u>Depth of Frost Penetration (feet)</u>	<u>Date</u>	<u>Method of Measurement</u>	<u>Freezing Index (°F Days)</u>
3.2	17 January 1947	Test Pit	597
3.7	14 February	Test Pit	833

3.9 (max)	5 March	Test Pit (3 days after max. F.I. of 965)	
4.2 (max)	25 February	Thermometer	932
3.8 (max)	13 February	Thermocouple	826

e. Ice Segregation. Ice lens and crystal formations observed in Test Area E are summarized as follows:

<u>Formation, Size and Locale</u>		
<u>Date</u>	<u>Lens</u>	<u>Crystal</u>
17 January 1947	None	In base
14 February	0-1/8" thick, subgrade (3.3' to 3.7')	In base (0.4' to 3.3')
5 March	1/32" thick, 1/4" apart, subgrade	None
12 March	0-1/4" thick, 1" apart, thickest at bottom, last 3" subgrade	In base (0.5' to 3.0')
21 March	1/16"-1/8" thick, 1/4-3/8" apart, subgrade (3.2' to 3.4')	In base (2.5' to 2.9')

f. Water Content and Density. Seasonal variations in the water content and density of gravel base and subgrade materials are shown by the following summary of tests made during excavation of four test pits in Test Area E:

<u>Date</u>	<u>Water Content (per cent)</u>		<u>Density (lbs/cu.ft.)</u>	
	<u>Base</u>	<u>Subgrade</u>	<u>Base</u>	<u>Subgrade</u>
9 October 1946	6.9	23.3	115	101
12 March 1947	10.9	24.0	-	-
21 March	10.8	23.8	115	102
16 June	13.8	23.6	129	101

g. Cracks in Pavement. The number of cracks in the pavement increased approximately seven per cent during this investigation.

h. Effect of Frost Action on Subgrade Strength. Plate bearing tests indicate that there is a definite loss of pavement strength during the frost melting period as shown on Plate 13 by the plot

of pavement deflection versus time. From this plot it is observed that the average deflections for each group of tests in the frost melting period (March, April) range from 1.3 to 1.7 times greater than during the October normal period. While the average deflections for tests during the period after frost melting (June, July) are only from 0.8 to 1.3 times as great as the October deflection. These relationships are summarized as follows:

<u>Date of Test</u>		<u>Ratio of Average Deflections to Normal Period Average Deflection</u>
28 October 1946	Normal Period	1.0
21 March 1947	Frost Melting Period	1.7
28 March		1.3
4 April		1.6
11 April		1.6
18 April		1.3
25 April		1.3
6 June	After Frost Melting Period	1.3
13 June		1.2
20 June		0.8
27 June		1.2
2 July		1.0

#### IV. Test Area F.

4-01. Type of Pavement, Base and Subgrade. Test Area F is located on the portland cement concrete pavement turn-around constructed in a cut area at the west end of Taxiway A (Sta. 1/59 to Sta. 2/50). The area is the same as Test Area F used in the 1945-1946 Frost Investigation and adjacent to Test Area A used during the 1944-1945 Frost Investigation. The pavement consists of a uniform seven inch slab except that the outside lanes and lanes adjacent to the longitudinal expansion joints, are uniformly thickened at the edges to 10 inches. The pavement was placed on a well-graded sand and gravel base (G1) with an average thickness of 18

inches ranging from 12 to 22 inches. The subgrade consists of silty clay (CL). A plan and a cross section of the test area are shown on Plate 3. Contours of pavement and base thickness are shown on Plate 7.

4-02. Explorations. Nine test pits, T969pa, T981p, T989p, T994pa, T997pa, T1001p, T1002pa, T1003pa, and T1006pa, were excavated to determine: (a) the depth of frost penetration and ice lens and crystal formations during the freezing period, and (b) soil conditions prior to freezing, during and after the frost melting period. Locations of the explorations are shown on Plate 3. A chronological summary of the explorations is presented in Table 1, and the data obtained from the explorations are summarized in Table 2.

4-03. Installations.

a. Ground Water Observation Wells. Within the area are three existing base observation wells and four existing subgrade observation wells which were maintained and read periodically during the current investigation. Locations of the individual wells are shown on Plate 3. Observation well details are shown on Plate 4. Detailed descriptions of these types of installations are presented in paragraph 2-03, a.

b. Thermocouple. Adjacent to the area, in Test Area A, 1944-1945 Frost Investigation, on the E-W Runway, is one existing thermocouple installation, T697p, which was maintained and read periodically during the current investigation. The installation is located as shown on Plate 3. Typical thermocouple installation details are shown on Plate 6. This type of installation is described in paragraph 3-03, b.

c. Thermometer Wells. Adjacent to the area, in Test Area A, 1944-1945 Frost Investigation, on the E-W Runway, is one existing

thermometer well installation, TW-1, which was maintained and read periodically during the current investigation. Location of the installation is shown on Plate 3. Typical thermometer well details are shown on Plate 5. A detailed description of this type of installation is presented in paragraph 2-03,b.

4-04. Observations and Measurements.

a. Ground Water. The depth to ground water was measured periodically between 12 June 1946 and 24 June 1947 in all observation wells. Table 4 contains a summary of all the ground water table measurements.

b. Frost Heave. Elevations at the southeast corners of the concrete slabs in the test area were obtained in a survey on 22 October 1946 prior to the freezing period, and in three surveys on 5 February, 19 March, and 1 April 1947, during the freezing and frost melting periods. Plotted in the form of heave contours on Plate 8 is the difference in elevation between normal pavement conditions and conditions on 5 February, date of maximum observed heave. A plot of heave as related to thickness of frozen subgrade is shown on Plate 19.

c. Frost Penetration. The following five test pits, excavated during the freezing and frost melting periods, were utilized to determine the observed rate and depth of frost penetration:

<u>Test Pit No.</u>	<u>Date</u>	<u>Period</u>
T981p	16 January 1947	Freezing
T989p	25 February	Freezing
T994pa	11 March	Frost Melting
T997pa	20 March	Frost Melting
T1001p	31 March	Frost Melting

Table 2 contains a record of the frost penetration information obtained

from these test pits. A plot of frost penetration versus time is shown in Figure 5, Plate 2, and a plot of frost penetration versus thickness of pavement and base is shown on Plate 18.

d. Subsurface Temperatures. Records of subsurface temperatures were obtained by periodic reading of the thermocouple installation T697p, and the thermometer well installation TW-1. The subsurface temperature observations are summarized in Table 8, and Table 9, for the thermocouple and thermometer well installations, respectively. Plots of typical subsurface temperatures versus depth for the thermometer well and thermocouple readings are shown on Plate 9 and 10 respectively. Plots of the 28 and 32 degree lines for these installations are compared with the measured depth of frost on Plate 20.

e. Ice Lens Survey. Observations of ice lens and crystal formations were conducted while excavating the five test pits tabulated in Paragraph 4-04,c. Table 2 contains a record of the ice lens and crystal information from the test pits.

f. Crack Survey. A crack survey was made over the entire cement concrete pavement in Test Area F on 1 November 1946 and again on 22 April 1947. A comparison of the number and length of the cracks for both surveys is shown by light and heavy lines on Plate 12.

#### 4-05. Field Tests.

##### a. Test Procedures.

(1) Plate Bearing Tests (Rupture). The standard procedure as described in the Engineering Manual was used to determine the load required to fracture corners of the cement concrete pavement slabs, with the exception that a plate 24 inches in diameter was used. The

plate was seated on a thin layer of sand at the corner of the slab. The edge of the plate was three inches from the slab edges. Two extensometers were placed in a line bisecting the right angle formed by the pavement joints. The load was applied in increments of 20, 10, then 5 thousand pounds up to a maximum of 60 thousand pounds. If the available load was not sufficient to cause failure, the loading was released in one decrement and reloaded by increments to the maximum total load. This procedure was repeated until rupture occurred or for a total of five repetitions.

(2) Plate Bearing Tests (Subgrade Modulus). Tests were performed on top of the gravel base directly beneath the rigid pavement using a 30-inch diameter plate. The load was applied in increments of 5,000 pounds up to a maximum of 20,000 pounds. The load for each increment was maintained constant and deflection readings were taken at time intervals of  $\frac{1}{4}$ , 1, 3, 5, 7, 9, 10, 12, 14, 15, 17, 19, 20, 22, 24, 25, 27, 29, and 30 minutes or until the deformation change in a five minute period was less than three per cent of the total change for the load increment. The load was then released in 5,000 pound decrements and rebound readings were taken at the same time intervals used during loading as described above.

(3) Water Content Determination. See description in Paragraph 2-05,a, (1).

(4) Density of Soil In Place Determination. See description in Paragraph 2-05,a, (2).

b. Tests.

(1) Plate Bearing Tests (Rupture). Six rupture tests were made on top of the pavement using a 24-inch diameter plate applied at the corner of pavement joints. The locations of the tests are shown

on Plate 3. Table 14 presents a summary of the tests, and Plate 14 contains plots of the test results.

(2) Plate Bearing Tests (Subgrade Modulus). Six subgrade modulus tests were performed directly on the sand and gravel base after the pavement had been removed. Locations of the tests are shown on Plate 3. Results of tests are plotted on Plate 15 and the test results are summarized on Table 14.

(3) Water Content. Continuous water content samples of the base and subgrade materials were obtained at vertical intervals of 0.2 feet from the following six test pits:

<u>Test Pit No.</u>	<u>Date</u>	<u>Period</u>
T969pa	28 October 1946	Normal
T994pa	11 March 1947	Frost Melting
T997pa	20 March	Frost Melting
T1002pa	14 April	After Frost Melting
T1003pa	10 June	After Frost Melting
T1006pa	26 June	After Frost Melting

Water contents plotted against depth are shown in Figure 3, Plate 16.

Water content samples were obtained with each density sample, the degree of saturation computed and the results presented in Table 2.

(4) Density. To determine the changes in density of the base and subgrade due to frost action, density samples were obtained from the four testpits, T969pa, T1002pa, T1003pa, and T1006pa. The results of these tests are plotted in relation to the soil profile on Figure 3, Plate 16, and are summarized in Table 2. Plots of water content versus density are shown in Figures 1 and 2, Plate 17.

4-06. Laboratory Tests.

a. Soil Classification. No laboratory tests were conducted on samples of base and subgrade materials. Since the Test Area F is located adjacent to Test Area A of the 1944-1945 Frost Investigation Program, the results of classification tests on representative samples made during this investigation are considered applicable to Test Area F. The gradation of base and subgrade materials is shown in Figure 3, Plate 17. The physical properties of the representative samples of the base and subgrade materials are shown in tabular form in Figure 4, Plate 17.

4-07. Summary of Results. Results of tests and observations for Test Area F are summarized as follows:

a. Soils. The frost susceptibility of the base and subgrade materials of Test Area A was established during the 1944-1945 investigation. The subgrade and base materials of Test Area F are therefore considered to be frost susceptible.

b. Ground Water. During the 1946-1947 investigation, the ground water table in Test Area F remained in the subgrade about one foot below the gravel base during the period prior to freezing, and dropped as low as five feet below the base during the freezing period. During the frost melting and after frost melting periods, the water table remained at or slightly above the top of the subgrade (approximately 2.4 feet). Considering the average measurements of the four subgrade wells and the three base wells in the area as a basis of comparison, the following ground water table fluctuations are noted:

<u>Water Table Depth Below Pavement Surface (feet)</u>		<u>Date</u>	<u>Period</u>
<u>Subgrade Wells</u>	<u>Base Wells</u>		
2.3	1.4	12 Juno 1946	Normal
3.0	1.6	17 July 1946	Normal
1.6	0.8	12 November 1946	Normal
2.8	2.0	3 December 1946	Freezing
1.5	0.6	13 December 1946	Freezing
6.4	-	20 January 1947	Freezing
6.7	1.4	20 March 1947	Frost Melting
1.6	0.6	7 April 1947	Frost Melting
2.0	1.1	28 April 1947	After Frost Melting
1.1	0.6	5 May 1947	After Frost Melting
1.7	1.2	12 May 1947	After Frost Melting
1.1	0.8	4 June 1947	After Frost Melting (Normal)
1.8	1.3	24 June 1947	After Frost Melting (Normal)

It will be noted from the above table that observations of the base wells indicate the presence of a secondary or perched water table in the gravel base throughout the course of investigation.

c. Pavement Heave. The maximum frost heave measured in Test Area F was 0.26 feet. No detrimental effects were caused by the heave.

d. Depth of Frost Penetration. Measurements of frost penetration obtained in Test Area F with the freezing index at time of measurement are summarized in the following table:

<u>Depth of Frost Penetration (feet)</u>	<u>Date</u>	<u>Method of Measurement</u>	<u>Freezing Index (°F days)</u>
3.5	16 January 1947	Test Pit	593
3.7 (max.)	25 February	Test Pit	932
3.6 (max.)	18 February	Thermometer	833
4.3 (max.)	13 January	Thermocouple	567

e. Ice Segregation. The ice lens and crystals formations observed in Test Area F are summarized as follows:

<u>Date</u>	<u>Formation, Size and Locale</u>	
	<u>Lens</u>	<u>Crystal</u>
16 January 1947	None	In subgrade (2.0' - 3.5')
25 February	Hairline, subgrade (2.2'-3.0')	In base (0.6'-2.2')
11 March	None	Very fine in subgrade (2.4'-3.5')
20 March	None	Few, small in base (1.6'-2.0')

f. Water Content and Density. Seasonal variations in the water content and density of gravel base and subgrade materials are shown by the following summary of tests which were made during excavation of six test pits in Test Area F:

<u>Date</u>	<u>Water Content (per cent)</u>		<u>Density (lbs/cu.ft.)</u>	
	<u>Base</u>	<u>Subgrade</u>	<u>Base</u>	<u>Subgrade</u>
28 October 1946	9.6	20.6	144	109
11 March 1947	7.6	24.9	-	-
20 March	12.6	20.6	-	-
14 April	12.3	29.0	145	102
10 June	14.8	18.0	135	108
26 June	11.1	20.6	138	107

g. Cracks in Pavement. The number of cracks in the pavement increased approximately five per cent during this investigation.

h. Effect of Frost Action on Subgrade Strength. Plate bearing tests on the portland cement concrete pavement indicate a loss

of foundation strength during the frost melting period. Before the freezing period the supporting capacity of a 24-inch diameter plate was 2.1 times greater than that measured during the frost melting period. Plate bearing tests performed directly on top of the base also indicated a loss of strength. Prior to the freezing period supporting capacity of a 30-inch diameter plate was 1.5 times greater than that measured during the frost melting period.

#### V. Turfed Area.

5-01. Location and Description. The Turfed Area is located adjacent to the South Edge of the E-W Runway between Sta. 13<sup>+</sup>/<sub>50</sub> and 14<sup>+</sup>/<sub>50</sub>. This Turfed Area was investigated during both the 1944-1945 and 1945-1946 investigations. The Turfed Area consists of seeded top soil from 0.2 to 0.5 foot in depth overlying approximately three feet of silty clay (CL). Below the silty clay stratum is a silty glacial till (GC). A plan of the area is shown on Plate 3.

5-02. Explorations. Seven test pits T983p, T984p, T987p, T988p, T992pa, T996p, and T1000p were excavated in the Turfed Area during the freezing and frost melting periods to determine; (a) the depth of frost penetration, (b) ice lens and crystal formations, and (c) soil conditions. Locations of explorations are shown on Plate 3. A chronological summary of the explorations is contained in Table 1 and the data obtained are presented in Table 2.

#### 5-03. Installations.

a. Ground Water Observation Well. The area contains one subgrade observation well, T695a, which was utilized during the current investigations. Location of the well is shown on Plate 3. Observation

well details are shown on Plate 4 and detailed descriptions are shown in paragraph 2-03, a.

b. Thermocouple. The area contains two thermocouple installations T693p and T694p, which were maintained and read periodically during the investigation. The installations are located as shown on Plate. Details are shown on Plate 6, and a detailed description is presented in paragraph 3-03, b.

c. Thermometer Wells. The area contains one thermometer well installation, TW-4, which was utilized during the present investigation. It is located as shown on Plate 3. Details are shown on Plate 5, and detailed description is given in paragraph 2-03, b.

5-04. Observations and Measurements.

a. Ground Water. The depth to ground water was measured in the observation well periodically between 12 June 1946 and 24 June 1947. Table 4 contains a record of the measurements.

b. Frost Heave. No frost heave measurements were made in the Turf Area. However, indications were that heave of the surface did occur.

c. Frost Penetration. Table 2 contains a record of frost penetration data obtained from the test pits excavated in the Turf Area. A plot of frost penetration versus time is shown in Figure 5, Plate 2.

d. Subsurface Temperatures. A record of the subsurface temperatures at the thermocouple installations, T693p and T694p, and the thermometer well installation TW-4, was obtained by periodic readings. Tables 10, 11 and 12 are summaries of the temperatures obtained from the thermocouple installations T693p and T694p, and the thermometer well installation TW-4, respectively. Plots of typical subsurface temperatures versus depth for the thermometer well and thermocouple readings are shown

on Plates 9 and 10, respectively. Plots of the 28 and 32 degree lines for these installations are compared with the measured depth of frost on Plate 20.

e. Ice Lens Survey. Ice lens and crystal formations were observed while excavating the test pits. Table 2 contains a record of these observations.

5-05. Field Tests.

a. Test Procedures. Test procedures are described in paragraph 2-05.

b. Water Content. Continuous water content samples were taken in the test pit T992pa excavated 6 March 1946. Summary of results are presented in Table 2.

5-06. Laboratory Tests.

a. Soil Classification. No laboratory tests were conducted on samples of the subgrade materials. The results of classification tests on representative samples made during 1944-1945 Frost Investigation Program are considered applicable. The gradation of the subgrade materials are shown in Figure 3, Plate 17. The physical properties of the representative samples of the subgrade materials are shown in tabular form in Figure 4, Plate 17.

5-07. Summary of Results.

a. Soils. The frost susceptibility of the soil in the Turf Area was established during the 1944-1945 investigation.

b. Ground Water. Measurements from the observation well indicate the following fluctuations in the ground water table level:

Water Table  
Depth Below  
Ground Surface  
(feet)

<u>Depth Below Ground Surface (feet)</u>	<u>Date</u>	<u>Period</u>
6.2	17 July 1946	Normal
4.5	31 October	Normal
0.0	12 November	Normal
1.6	3 December	Freezing
0.1	13 December	Freezing
4.6	4 January 1947	Freezing
2.5	20 March	Frost Melting
0.5	24 March	Frost Melting
4.4	26 March	Frost Melting
0.0	7 April	Frost Melting
1.4	28 April	After Frost Melting
0.2	5 May	After Frost Melting
1.5	28 May	After Frost Melting
0.0	4 June	After Frost Melting
3.4	24 June	After Frost Melting

c. Depth of Frost Penetration. Measurements of frost penetration obtained with the freezing index at time of measurement are summarized in the following table:

<u>Depth of Frost Penetration (feet)</u>		<u>Date</u>	<u>Method of Measurement</u>	<u>Freezing Index (°F days)</u>
<u>Sta. 13/50</u>	<u>Sta. 14/50</u>			
-	1.1	17 Jan. 1947	Test Pit	597
2.2	-	30 Jan.	Test Pit	721
2.2	1.7	20 Feb.	Test Pit	869
2.3(max.)	-	6 March	Test Pit	(4 days after max.F.I. of 965)
-	1.8(max.)	13 March	Test Pit	(11 days after max.F.I. of 965)
-	3.0(max.)	23 Jan.	Thermocouple	693
2.4(max.)	-	14 Feb.	Thermometer	833
2.7(max.)	-	17 Mar.	Thermocouple	(15 days after max. F.I. of 965)

d. Ice Segregation. The ice lens and crystal formations observed are summarized as follows:

<u>Formation, Size and Locale</u>		
<u>Date</u>	<u>Lens</u>	<u>Crystal</u>
30 Jan. 1947 (Station 13/50)	0-3/8" thick, largest at 14"	0.3' to 2.3'
20 Feb. 1947 (Station 14/50)	None	0.0' to 1.7'
20 Feb. 1947 (Station 13/50)	0-3/8" thick, to frost line	None
6 Mar. 1947 (Station 13/50)	Fine, close, at 0.5' 1/8" thick, 3/8-1/2" apart, at 2.0-2.25' 1/2" thick, at 2.3' (frostline)	None
13 Mar. 1947 (Station 13/50)	0-1/8" thick, at 1.5-1.8'	None

e. Soil Conditions. No data are available for density studies. The average water content was 28.2 per cent on 6 March 1947 during the frost melting period.

## VI. Conclusions

6-01. Conclusions. Based on a study of the data, the following conclusions are presented:

a. Soils. The base and subgrade soils are frost susceptible.

b. Weather. The weather conditions were milder than normal.

The freezing index was 24 per cent below the normal, and the precipitation in the three months, September to November 1946, inclusive, was 17 per cent below normal. The cumulative snowfall during the winter was 61 inches, which is greater than the snowfall in the previous winter. The paved test areas were kept free from ice and snow consistent with normal runway plowing schedules.

c. Pavement Heave and Ground Water. The maximum pavement heave (0.26 foot) was measured in the portland cement concrete pavement of Test Area F. The maximum heave measured in Test Area D was 0.11 foot and in

Test Area E it was 0.17 foot. Ground water measurements indicate gradual lowering in Test Area F from about 1.5 feet below the surface in the fall to 6.5 feet during the freezing period and a subsequent rise to 1.5 feet below the surface during the frost melting period. In Test Area E the ground water table dropped from about 3.0 feet below the surface in the fall to 7.0 feet during the freezing period. In the frost melting period the water rose to about 3.5 feet below the surface. In Test Area D the ground water table fluctuated in relatively small increments from 3.0 feet to 4.5 feet to 2.5 feet below the pavement surface.

d. Frost Penetration. The depth of maximum frost penetration was approximately the same (3.7 to 4.0 feet) in Test Areas D, E and F although there is a considerable variation in the thickness of pavement and gravel base of the areas. There was slightly greater penetration under the portland cement concrete. In the Turfed Test Area the depth of maximum frost penetration was approximately 60 per cent of that under the paved areas. Plate 18 presents a plot of the frost penetration versus thickness of pavement and base which summarizes the data for Test Areas D, E and F. A plot of the measured thickness of the frozen subgrade versus pavement heave is shown on Plate 19.

e. Reduced Subgrade Strength. During the frost melting period the deflection of the pavements in the test areas, as measured by pavement bearing tests using a 30-inch diameter bearing plate, was 1.0 to 1.9 times greater than during the normal period.

## GLOSSARY

The following words and terms are defined with respect to their specialized use in this report:

- Base**                                    The term "base" applies to the course of specially selected soils, mineral aggregates or treated soils, placed and compacted on the natural or compacted subgrade.
- Degree Day**                            A degree day for one day is the algebraic difference between 32°F and the daily mean temperature. The degree day is plus when the daily mean temperature is below 32° F and minus when above. A cumulative degree-day-time curve is obtained by plotting cumulative degree days against time.
- Density**                                Density is the unit dry weight in pounds per cubic foot.
- Depth of Freezing  
Temperature Penetration**            The depth of freezing temperature penetration is the maximum depth below the surface, of the freezing temperature (32° F).
- Freezing Index**                        The freezing index is a measure of the combined duration and magnitude of below freezing air temperatures occurring during any given winter.
- Freezing Period**                        The freezing period is the time during which the frost is in the ground and there is no reduction in strength of foundation materials due to frost action.
- Frost Action**                            Frost action is the accumulation of water in the form of ice lenses in the soil under natural freezing conditions.

Frost Heave	Frost heave is the raising of the pavement surface due to the accumulation of ice lenses. The amount of heave in most soils is approximately equal to the cumulative thickness of the ice lenses.
Frost Melting Period	The frost melting period is the time of the year during which the frost in the foundation materials is returning to a liquid state.
Frost Susceptible Soil	Frost susceptible soil is a soil in which frost action is possible. Any soil which contains three per cent or more, by weight, of grains smaller than 0.02 mm. diameter, shall be considered susceptible to frost action.
Frost Penetration	The maximum depth from the surface to the bottom of the frozen soil.
Frozen Soil	Frozen soil as referred to in this report is as follows: <ul style="list-style-type: none"> <li>(a) Homogeneously Frozen Soil - A homogeneously frozen soil is a soil in which all the water in the soil is frozen within the natural voids existing in the soil, without observable-accumulation of ice lenses or frost forms exceeding in volume such natural void spaces.</li> <li>(b) Stratified Frozen Soil - A stratified frozen soil is a soil in which a part of the water in the soil is frozen in the form of observable ice lenses, occupying space in excess of the original soil voids.</li> </ul>
Frozen Zone	The limits of depth within which the soil is frozen is referred to as the frozen zone.
Ground Water Table	The ground water table is the free water surface nearest the ground surface.
Homogeneously Frozen Soil	See "Frozen Soil".

Ice Crystals	The formation of ice particles found in the pores of homogeneous frozen soil is referred to as ice crystals.
Ice Lenses	Ice lenses are the ice formations in stratified frozen soil occurring in repeated layers, in general, parallel to each other and normal to the direction of heat loss.
Non-frost Susceptible Materials	Non-frost susceptible materials are crushed rock, sand and gravel, gravel, slag, cinders, or any other cohesionless material in which frost action is not possible.
Normal Freezing Index	Normal freezing index is the index computed for normal air temperatures, based upon a long period of record, usually ten years or more.
Normal Period	The normal period is the time of the year, summer and fall, when there is no reduction in strength of foundation materials due to frost action.
Pavement	The term "pavement" is defined as a covering of a prepared or manufactured product superimposed upon a subgrade or base to serve as an abrasive and weather resisting structural medium.
Stratified Frozen Soil	See "Frozen Soil".
Subgrade	The term "subgrade" applies to the natural soil in place upon which a pavement is placed, or to fill material upon which a base is constructed.
Test Area	The test area is the portion of the airfield selected for observations and investigations.
Test Element	A test element consists of a unit of the test embankment which is a model of a runway where the materials of construction were placed at a predetermined condition with temperature measuring equipment and observation wells placed during construction.

### Test Embankment

The test embankment consists of fourteen test elements. The elements placed in two rows of seven each were constructed for the purpose of observing the rate and depth of frost penetration, the effect of type of pavement on rate and depth of frost penetration and the effect of density, water content, degree of saturation, and water table on frost action.

### Water Content

Water content is the ratio, expressed as a percentage, of the weight of water in a given soil mass to the weight of solid particles.

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
1946-1947  
CHRONOLOGICAL SUMMARY  
OF  
EXPLORATIONS AND OBSERVATIONS

<u>DATE</u>	<u>OPERATION</u>
1-8 October 1946	Existing installations checked and prepared for future observations.
9-22 October	One test pit excavated to determine subsurface conditions prior to freezing. Initial level surveys made for heave measurements.
25-31 October	Twenty seven plate bearing tests performed. Two test pits excavated to determine subsurface conditions prior to freezing.
1-15 November	Ten auger holes excavated to determine soil profiles. <b>Initial crack surveys made.</b>
22 November	Thermograph moved from Turf Area to Test Section.
16-31 January 1947	Five test pits excavated to determine depth of frost penetration.
1-28 February	Six test pits excavated to determine depth of frost penetration. Heave surveys made.
1-13 March	Five test pits excavated to determine depth of frost penetration, water contents and ice formations.
13-17 March	Heave surveys made. One test pit excavated to determine depth of frost penetration and observe ice formations.

DATEOPERATION

20-25 March	Three test pits excavated to determine depth of frost penetration, water contents, densities and ice formations. Six plate bearing tests performed.
26-31 March	Two test pits excavated to determine depth of frost penetration and to observe ice formations. Three plate bearing tests performed.
1-15 April	Heave surveys made. One test pit excavated to determine water contents and densities. Nineteen plate bearing tests performed.
15-30 April	Crack surveys made. Nine plate bearing tests performed.
1-15 June	Sixteen plate bearing tests performed. One test pit excavated to determine water contents and densities.
15-30 June	Three test pits excavated to determine water contents and densities. Fourteen plate bearing tests performed.
1-2 July	Six plate bearing tests performed.

EXPLORATION NO.	DATE	TEST AREA	LOCATION	TYPE OF MATERIAL	DEPTH (FT.)	FROST PENETRATION (FT.)	DEPTH TO WATER TABLE (FT.)	SOIL CLASS	% Finer than			
									GRA			
									0.005 mm	0.02 mm	0.05 mm	0.10 mm
T968pa	9 Oct. 1946	E	2440 28' N	Bituminous Concrete Base " " Subgrade " " "	0.0-0.3 0.3-3.1  3.1-11.2  6.1-6.3	0.0		GW " " CL " " "				
T969pa	26 Oct. 1946	F	2413 28' N	Cement Concrete Base " Subgrade " " "	0.0-0.7 0.7-2.5  2.5-15.0  5.7-6.0	0.0		GW " " CL " " "				
T970pa	30 Oct. 1946	D	5430 47' N	Bituminous Concrete Base " " Subgrade "	0.0-0.4 0.4-4.2  4.2-10.5  5.5-6.0	0.0	3.9	GW " " " CL "				
T971a	1 Nov. 1946	E	2446 .5' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.8 3.8-6.0	0.0		GW CL				
T972a	1 Nov. 1946	E	2446 24' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.2 3.2-6.0	0.0		GW CL				
T973a	1 Nov. 1946	E	2469 24' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.2 3.2-6.0	0.0		GW CL				
T974a	1 Nov. 1946	E	2457 12.5' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.0 4.0-6.0	0.0		GW CL				
T975a	1 Nov. 1946	E	2469 .5' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.0 4.0-6.0	0.0	4.5	GW CL				
T976a	4 Nov. 1946	D	8416 21' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.7 4.7-6.0	0.0	4.3	GW CL				
T977a	4 Nov. 1946	D	8416 4.5' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.5 4.5-6.0	0.0	4.2	GW CL				
T978a	4 Nov. 1946	D	8439 4.5' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.6 4.6-6.0	0.0	4.2	GW CL				
T979a	4 Nov. 1946	D	8439 21' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.4 4.4-6.0	0.0	4.3	GW CL				
T980a	4 Nov. 1946	D	8428 32.5' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-4.0 4.0-6.0	0.0	4.0	GW CL				

FROST INVESTIGATION  
SUMMARY OF SOIL TEST DATA  
DOW FIELD, BANGOR, ME.

SOIL DATA							FIELD IN-PLACE TESTS				REMARKS			
GRAIN SIZE % finer than indicated grain size							ATTERBERG LIMITS		SPECIFIC GRAVITY			DENSITY LBS./CU.FT.	WATER CONTENT	PER- CENT SATUR- ATION
0.02 mm	0.05 mm	0.10 mm	0.297 mm	2.0 mm	4.7 mm	19.1 mm	L.L.	P.L.	< 4	> 4				
											115	5.2	56	Auger hole from 6.0' to refusal at 11.2'.
											150	6.0	100	
											150	9.5	100	
											114	21.0	100	
											95	21.0	82	
											100	21.0	93	
											97	21.3	87	Auger hole from 6.0' to 15.0'. Pit left open over night at 6.0' depth. No collection of water.
											141	9.3	100	
											147	9.8	100	
											118	17.0	98	
											111	19.6	100	
											100	21.0	81	
											106	21.8	100	Auger hole from 6.0' to refusal at 10.5'.
											127	5.2	43	
											124	6.6	50	
											115	7.1	42	
											113	8.8	38	
											97	40.1	100	
											105	22.9	96	

WAR DEPARTMENT

FROST IN  
SUMMARY OF  
DOW FIELD

EXPLORATION NO.	DATE	TEST AREA	LOCATION	TYPE OF MATERIAL	DEPTH (FT.)	FROST PENETRATION (FT.)	DEPTH TO WATER TABLE (FT.)	SOIL CLASS.	% Finer than			
									0.075 mm	0.075 mm	0.075 mm	0.075 mm
T981p	16 Jan. 1947	F	1466 58' N	Cement Concrete Base Subgrade	0.0-0.6 0.6-2.0 2.0-3.6	3.5		GW CL				
T982p	17 Jan. 1947	E	3400 18' N	Bituminous Concrete Base	0.0-0.4 0.4-3.2	3.2		GW				
T983p	17 Jan. 1947	Turf	1468 290'S	Subgrade	0.0-1.5	1.1		CL				
T984p	30 Jan. 1947	Turf	1580 215'S	Topsoil Subgrade	0.0-0.3 0.3-2.5	2.2		CL				
T985p	3 Feb. 1947	D	9400 27' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.4 3.4-3.9	3.65		GW CL				
T986p	14 Feb. 1947	E	3400 27' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.3 3.3-4.2	3.7		GW CL				
T987p	20 Feb. 1947	Turf	1480 292'S	Subgrade	0.0-1.7	1.7		CL				
T988p	20 Feb. 1947	Turf	1400 220'S	Topsoil Subgrade	0.0-0.2 0.2-2.6	2.2		CL				
T989p	25 Feb. 1947	F	1472 42' N	Cement Concrete Base Subgrade	0.0-0.6 0.6-2.2 2.2-4.1	3.7		GW CL				
T990p	28 Feb. 1947	D	9408 27' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.6 3.6-4.0	3.6		GW CL				
T991p	5 Mar. 1947	E	2485 30' N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.2 3.2-4.2	3.9		GW CL				
T992pa	6 Mar. 1947	Turf	1450 215'S	Topsoil Subgrade	0.0-0.4 0.4-4.7	2.3		CL				
T993pa	10 Mar. 1947	D	9425 27' N	Bituminous Concrete Base Subgrade	0.0-0.5 0.5-3.5 3.5-8.0	4.05		GW CL				
T994pa	11 Mar. 1947	F	1471 22' N	Cement Concrete Base Subgrade	0.0-0.55 0.55-2.4 2.4-11.0	3.55		GW CL				
T995pa	12 Mar. 1947	E	2480 26' N	Bituminous Concrete Base Subgrade	0.0-0.5 0.5-3.0 3.0-13.0	3.75		GW CL				

INVESTIGATION  
 SOIL TEST DATA  
 D, BANGOR, ME.

SOIL DATA					FIELD IN-PLACE TESTS				REMARKS			
GRAIN SIZE					ATTERBERG LIMITS		SPECIFIC GRAVITY			DENSITY	WATER CONTENT	PER-CENT SATURATION
than indicated grain size					LL.	PL.	< 4	> 4		LBS./CU. FT.		
10 mm	0.297 mm	2.0 mm	4.7 mm	75 mm								
											Ice crystals from 2.0' to 3.5'.	
											Ice crystals found in base. No ice lenses found.	
											Small ice crystals found.	
											Ice crystals and lenses varying from hairline to 3/8" in thickness. Largest lenses at 1 1/2" in depth.	
											Ice crystals to depth of frost penetration.	
											Lenses hairline to 1/8" in thickness from 3.5' to 3.7'. Crystals from 0 1/4' to 3.3'.	
											No ice lenses found. Crystals from 0.0' to 1.7'.	
											Ice lenses to frost line varying from hair line to 3/8" in thickness.	
											Small crystals in base. Hairline lenses throughout subgrade.	
											Small crystals found in base.	
											Ice lenses throughout subgrade 1/32" thick and spaced 1/4" apart.	
									29.3 29.7 26.9 26.7		Ice lenses to frost line varying from hairline to 1/2" in thickness and spaced from 1/2" to 1" apart.	
									11.6 13.0 18.5		Auger hole from 6.0' to 8.0'. Augering discontinued at 8.0' because of water from melting snow entering pit. Organic material from 3.5' to 3.7'. Ice lenses in subgrade from hairline to 1/16" in thickness.	
									21.9 29.9			
									10.8 4.5		Auger hole from 4.0' to 11.0'. Organic material from 2.6' to 2.8' and from 4.0' to 4.6'. No lenses or crystals observed in base. Very fine crystals in subgrade.	
									23.0 25.0 23.8 27.7			
									9.2 12.5		Auger hole from 3.8' to 13.0'. Ice crystals found in base. Ice lenses throughout subgrade varying from hairline to 1/4" in thickness. Lenses at frost line 1" apart.	
									23.0 23.1 23.3 26.6			

FROST INVEST  
SUMMARY OF SOIL  
DOW FIELD, BA

EXPLORATION NO.	DATE	TEST AREA	LOCALITY	TYPE OF MATERIAL	DEPTH (FT.)	FROST PENETRATION (FT.)	DEPTH TO WATER TABLE (FT.)	SOIL CLASS.	GRAIN SIZE					
									% finer than indicated					
									0.075 mm	0.075 mm	0.075 mm	0.075 mm	0.075 mm	
T996p	13 Mar. 1947	Turf	11/70 500'S	Topsoil Subgrade	0.0-0.2 0.2-2.0	1.8		CL						
T997pa	20 Mar. 1947	F	14/0 71'S	Cement Concrete Base Subgrade	0.0-0.6 0.6-2.0 2.0-9.0	1.2 to 3.4	1.1	OW CL						
T998pa	21 Mar. 1947	E	2/55 35'N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.2 3.2-10.5	2.05 to 3.4		OW CL						
T999pa	25 Mar. 1947	D	8/25 47'N	Bituminous Concrete Base Subgrade	0.0-0.4 0.4-3.7 3.7-12.3	3.7 to 3.9 (see remarks)	3.6	OW CL						
T1000p	27 Mar. 1947	Turf	11/00 215'S	Topsoil Subgrade	0.0-0.2 0.2-2.5	0.0 to 0.3 0.55 to 2.2		CL						
T1001p	31 Mar. 1947	F	2/51 42'S	Cement Concrete Base Subgrade	0.0-0.6 0.6-1.6 1.6-3.0	0.9 to 2.6		OW CL						
T1002pa	11 Apr. 1947	F	2/13 49'N	Cement Concrete Base Subgrade	0.0-0.7 0.7-2.2 2.2-14.5	0.0	1.3	OW CL						
T1003pa	10 June 1947	F	2/09 12'S	Cement Concrete Base Subgrade	0.0-0.7 0.7-2.4 2.4-14.0	0.0	1.2	OW CL						

FROST INVESTIGATION  
SUMMARY OF SOIL TEST DATA  
LOW FIELD, BANGOR, ME.

SOIL DATA							FIELD IN-PLACE TESTS			REMARKS			
GRAIN SIZE % finer than indicated grain size						ATTERBERG LIMITS		SPECIFIC GRAVITY			DENSITY LBS./CU.FT.	WATER CONTENT	PER- CENT SATUR- ATION
0.075 mm	0.075 mm	0.10 mm	0.297 mm	2.0 mm	4.7 mm	19.1 mm	L.L.	P.L.	< 4		> 4		
													Ice lenses from 1.5' to 1.8' varying from hairline to 1/8" thickness.
													Few crystals in base.
												12.6	Ground water seeping in from under concrete and from top 6" of gravel at rate of 1/2 gallon / min.
												15.8	
												19.1	
												20.6	
												22.8	
													Auger hole from 6.0' to refusal at 10.5'.
													Few ice crystals in base. Ice lenses in subgrade from 3.2' to 3.4' varying from 1/16" to 1/8" in thickness and spaced from 1/4" to 3/8" apart.
												14.6	
												14.3	
												11.6	
												14.5	
												105	
												104	
												97	
												21.3	
												23.3	
												24.4	
												24.1	
												25.8	
													Auger hole from 6.0' to refusal at 12.3'.
													Probable frost from 3.7' to 3.9'. No ice lenses or crystals found.
												14.4	
												4.3	
												4.5	
												7.4	
												13.5	
													Auger hole from 6.0' to refusal at 14.5'.
													Ice lenses from 0.55' to 2.2' var. from 1/8" to 1/2" in thickness spaced 2" apart at frost line.
													Few crystals in base. Hairline lenses in subgrade.
													Auger hole from 6.0' to refusal at 14.5'.
													Water flowing into pit at rate of 2 gallons / min.
												15.8	
												13.2	
													Auger hole from 6.0' to 14.0'.
													Water from base flowing into pit at rate of 6 gallons / min. and from subgrade at rate of 15 gallons / min.
													Organic material from 2.6' to 3.0'.
												100	
												95	
												108	
												106	
												101	
												97	
												24.6	
												20.8	
												23.0	
												27.9	
												28.9	
												39.9	
												32.5	
												32.4	
												30.8	
												55.5	
													Auger hole from 6.0' to 14.0'.
													Water from base flowing into pit at rate of 6 gallons / min. and from subgrade at rate of 15 gallons / min.
													Organic material from 2.6' to 3.0'.
												133	
												138	
												95	
												112	
												116	
												108	

FROST INVESTIGATION  
SUMMARY OF SOIL  
DOW FIELD, BA

EXPLORATION NO.	DATE	TEST AREA	LOCATION	TYPE OF MATERIAL	DEPTH (FT.)	FROST PENETRATION (FT.)	DEPTH TO WATER TABLE (FT.)	SOIL CLASS.	GRAIN SIZE				
									% finer than and				
									0.005 mm	0.02 mm	0.05 mm	0.10 mm	0.25 mm
T1004pa	16 June 1947	E	27.0 27.8	Bituminous Concrete	0.0-0.4	0.0	3.1	GW					
				Base	0.4-1.1								
				"	1.1-1.9								
				"	1.9-2.9								
				"	2.9-3.1								
				Subgrade	3.1-11.4								
				"	3.1-3.4								
T1005pa	17 June 1947	D	27.0 48.8	Bituminous Concrete	0.0-0.4	0.0	3.6	GW					
				Base	0.4-4.1								
				"	4.1-0.9								
				"	1.4-1.9								
				"	2.4-2.9								
				Subgrade	4.1-10.2								
				"	4.2-4.5								
T1006pa	26 June 1947	F	27.12 62.3	Cement Concrete	0.0-0.7	0.0		GW					
				Base	0.7-2.0								
				"	2.0-1.0								
				"	1.6-2.0								
				Subgrade	2.0-12.0								
				"	2.0-2.3								
				"	3.0-3.4								

FROST INVESTIGATION  
 SUMMARY OF SOIL TEST DATA  
 DOW FIELD, BANGOR, ME.

SOIL DATA						FIELD IN-PLACE TESTS				REMARKS			
GRAIN SIZE						ATTERBERG LIMITS		SPECIFIC GRAVITY			DENSITY LBS./CU. FT.	WATER CONTENT	PER- CENT SATUR- ATION
% Finer than indicated grain size						L.L.	P.L.	< 4	> 4				
0.075 mm	0.15 mm	0.297 mm	2.0 mm	4.7 mm	19.1 mm								
										132	7.6	75	Auger hole from 6.0' to refusal at 11.4'.
										137	6.5	76	
										130	16.5	100	
										119	24.5	100	
										107	20.5	93	
										101	23.7	93	Auger hole from 6.0' to refusal at 10.2'. Organic muck from 4.1' to 5.5'.
										102	23.2	93	
										96	27.0	94	
										100	5.5	22	
										123	6.9	42	
										123	8.5	52	Auger hole from 2.0' to 12.0'.
										118	11.2	71	
										99	57.6		
										36	120.0		
										105	20.0	88	
										140	10.4	100	
										137	11.9	100	
										105	19.0	84	
										115	17.3	98	
										108	20.9	99	
										100	25.0	97	

1

2

DATE	BASE WELLS										7006 9420 170'S	7006 9420 170'S	7006 9420 170'S		
	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S	7016 9420 170'S					
12 June 46	1.8	1.0	3.1	3.4	3.7										
28 June 46	1.0	1.1	3.4	3.5	3.7	Dry									
17 July 46	2.2	1.8	3.4	3.7	3.7	2.8 Mud									
22 July 46	-	1.1	3.6	3.8	3.7	2.6 Mud									
5 Aug 46	-	1.0	3.0	3.1	3.7	Dry									
19 Aug 46	-	1.2	3.4	3.9	3.7	3.8									
4 Sept 46	-	1.5	3.6	3.7	3.7										
16 Sept 46	-	1.7	3.6	3.9	3.7	2.0									
10 Oct 46	-	1.8	-	3.6	3.9	Dry									
20 Oct 46	-	1.5	-	-	3.9	-									
11 Oct 46	-	1.5	3.2	3.9	3.8	3.1									
11 Nov 46	-	0.6	3.0	2.9	3.1	3.5									
18 Nov 46	-	1.3	3.4	2.9	3.1	3.4									
20 Nov 46	2.0	1.0	3.5	3.7	3.7	2.8									
3 Dec 46	2.0	2.0	3.4	3.5	3.7	3.4									
13 Dec 46	1.1	-	3.1	3.7	3.8	-									
26 Dec 46	2.2	2.8	3.2	3.7	3.8	1.0									
4 Jan 47	2.7 Ice	2.7	0.6 Ice	3.1	3.8	2.6									
20 Jan 47	2.6 Ice	0.3 Ice	Dry	Dry	3.6	Dry									
5 Feb 47	0.6 Ice	0.6 Ice	4.0	3.6	Dry	Dry									
20 Mar 47	3.1 Ice	3.1 Ice	3.3	3.5	3.3	2.8									
24 Mar 47	0.0	0.3 Ice	3.0	3.1	3.1	1.4									
28 Mar 47	- Ice	- Ice	2.8	2.1	3.0	1.1									
31 Mar 47	- Ice	- Ice	3.0	3.1	3.3	2.2									
1 Apr 47	2.0	1.1	3.2	3.9	3.6	1.3									
2 Apr 47	1.2	0.7	3.0	3.3	3.3	2.6									
4 Apr 47	- Ice	- Ice	2.9	3.0	3.5	2.1									
7 Apr 47	1.8	1.8	3.0	3.4	3.2	2.8									
9 Apr 47	1.6	0.8	3.2	3.1	3.7	2.5									
11 Apr 47	1.5	0.9	3.0	3.1	3.4	2.6									
14 Apr 47	1.6	1.0	3.0	3.1	3.5	2.8									
16 Apr 47	1.7	0.9	3.0	3.1	3.5	2.8									
18 Apr 47	1.8	0.5	3.1	3.1	3.5	2.7									
21 Apr 47	2.0	1.2	3.0	3.6	3.5	Dry									
23 Apr 47	2.0	1.0	3.2	3.3	3.3	Dry									
25 Apr 47	1.7	1.0	3.0	3.0	3.6	2.6									
28 Apr 47	1.7	0.8	3.1	3.0	3.5	2.9									
30 Apr 47	1.1	0.5	3.0	3.0	3.5	2.8									
2 May 47	1.0	0.3	3.0	2.9	3.3	2.1									
5 May 47	1.0	0.5	2.9	2.8	3.0	2.0									
7 May 47	1.4	0.8	3.0	2.6	3.0	2.0									
9 May 47	1.6	0.9	3.0	3.0	3.3	2.6									
12 May 47	1.5	1.0	3.0	3.1	3.4	2.6									
14 May 47	1.6	0.6	3.0	3.0	3.4	Dry									
16 May 47	2.0	1.0	3.0	3.0	3.6	2.4									
19 May 47	1.5	0.8	3.0	2.9	3.6	2.6									
21 May 47	1.7	0.9	3.1	3.0	3.3	2.4									
23 May 47	1.6	0.9	3.0	3.0	3.6	2.7									
26 May 47	1.4	0.5	3.0	3.0	3.3	2.6									
28 May 47	1.5	1.0	3.0	3.0	3.7	-									
1 June 47	1.5	0.6	3.5	2.9	3.3	2.3									
10 June 47	1.5	0.8	3.0	2.7	3.3	2.0									
17 June 47	1.4	1.0	3.1	2.7	3.3	-									
24 June 47	1.7	1.0	3.1	3.4	3.6	Dry									
DEPTH OF WELL	3.1	3.3	5.3	3.5	3.1	2.6	3.7	4.2	3.3	11.7	6.4	14.2			

A

SUBGRADE WELLS

797a 870 150" B	746a 870 70" B	7907a 870 65" B	7906a 870 L	7905a 870 65" B	7652a 870 70" B	7901a 870 150" B	7661a 870 70" B	7651a 870 70" B
1.4	3.5	2.0	3.4	2.7	2.6	2.7	3.2	2.9
2.7	3.4	3.4	4.0	2.9	3.0	3.2	3.3	3.0
3.4	3.4	4.0	5.0	3.0	3.0	4.0	3.5	3.0
3.5	4.0	4.0	5.0	3.0	3.0	3.5	3.5	2.5
3.9	4.0	4.0	5.0	3.4	3.0	3.0	3.4	3.0
4.2	3.6	4.0	5.0	3.8	3.5	4.0	3.6	2.5
4.6	4.0	4.3	5.3	4.6	4.1	3.7	3.6	4.4
4.8	4.2	4.5	5.4	4.5	3.5	3.7	3.8	3.4
5.2	4.2	4.6	5.1	4.0	3.4	3.7	3.6	3.5
5.1	3.6	4.0	5.0	4.1	3.4	3.6	3.5	2.0
5.0	4.0	4.5	4.4	3.8	3.8	3.5	3.7	3.4
5.2	4.5	4.1	4.0	4.7	3.2	2.6	3.4	3.3
2.3	4.7	4.4	4.1	3.7	3.5	3.3	3.5	3.2
2.0	3.6	3.3	3.2	3.1	3.3	2.5	3.1	3.0
2.3	4.5	3.1	3.7	3.5	3.0	2.6	-	-
1.2	4.0	2.5	3.1	2.7	3.0	2.5	3.1	2.2
1.2	3.3	3.2	3.2	3.3	3.4	0.6 Ice	3.0	2.4
1.6 Ice	3.8	3.0	4.5	4.0	4.1	-	-	-
1.7 Ice	3.7	3.6	4.2	4.7	4.5	0.6 Ice	4.1	-
3.0 Ice	3.8	0.7 Ice	0.8 Ice	0.5 Ice	5.0	0.7 Ice	2.5	2.4
2.3	3.7	3.3	4.0	2.7	2.3	3.0	3.4	3.8
2.3	3.2	3.0	3.6	2.0	2.4	2.2	3.2	3.2
1.0	3.6	2.0	2.2	2.1	2.1	1.5	2.0	2.0
2.7	3.5	3.5	3.5	2.7	2.7	2.6	2.7	2.7
1.8	3.1	3.3	3.0	2.3	3.5	2.6	3.1	3.2
1.2	3.5	3.0	3.3	2.5	2.8	1.0	3.1	3.0
1.2	3.1	3.3	3.4	2.3	2.8	1.1	3.0	3.0
1.0	3.2	3.0	3.2	2.3	2.3	0.1	3.0	2.9
1.5	3.4	3.0	3.3	2.3	2.4	1.1	3.0	3.0
1.3	3.3	3.0	3.0	2.5	2.5	1.1	3.2	2.9
1.0	3.3	3.1	3.2	2.6	2.6	1.0	3.0	2.5
1.4	3.1	3.1	3.1	2.7	2.7	1.8	3.0	3.0
1.0	3.2	3.0	3.1	2.7	2.4	1.5	3.0	2.9
1.9	3.1	3.2	3.2	2.9	2.9	2.1	3.0	3.0
1.4	4.0	3.0	3.4	3.0	3.0	2.0	3.0	2.6
1.0	4.0	3.0	3.1	2.6	2.6	1.9	3.0	2.6
1.0	3.5	3.2	3.5	2.7	2.7	1.7	3.2	2.9
1.0	3.5	3.0	3.0	2.6	2.6	1.0	3.0	2.6
1.1	3.3	3.0	3.0	2.0	2.2	0.9	2.3	2.0
1.0	3.0	2.1	2.7	2.0	2.0	1.0	2.9	2.6
1.0	3.1	2.4	2.6	2.1	2.5	1.6	2.5	3.0
1.0	2.9	2.0	3.0	2.5	2.4	1.8	3.0	3.0
1.2	3.1	3.0	3.0	2.2	2.3	2.0	3.2	2.8
1.0	3.0	3.0	3.0	2.6	2.6	1.0	3.0	3.0
2.0	3.5	2.9	3.0	2.4	2.9	1.9	3.0	3.0
1.0	3.0	3.0	3.0	2.3	2.3	1.7	2.4	2.5
1.2	3.3	2.5	3.1	2.6	2.6	1.0	3.0	3.0
1.0	3.1	3.0	3.0	2.6	2.6	1.0	3.0	3.0
1.0	3.0	2.9	3.0	2.6	2.6	1.1	3.2	3.2
1.5	4.0	2.5	3.0	2.6	2.6	1.8	3.2	2.8
1.7	3.2	2.4	3.0	2.2	2.6	1.1	2.6	2.6
1.4	3.2	2.7	3.0	2.3	2.6	1.6	2.6	2.6
1.7	3.4	2.7	3.0	2.4	2.3	2.1	3.2	3.0
1.1	3.5	3.0	3.0	2.5	2.6	1.9	3.1	3.0
11.7	6.4	1.89	15.3	17.7	5.7	12.4	6.0	6.0

NOTE

Ground water table measurements are in feet from surface of the pavement.

Wells frozen from 5 February to 20 March 1947. Unable to obtain readings during this period.

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
GROUND WATER TABLE  
OBSERVATIONS  
TEST AREA D

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST, 1947

B

2

AREA E

BASE WELLS

SUBGRADE WELLS

DATE	BASE WELLS									SUBGRADE WELLS				
	T000a 3450 170° E	T001a 3450 120° E	T002a 3450 65° E	T003a 3450 Z	T004a 3450 60° S	T005a 3450 120° S	T006a 3450 170° S	T007a 3475 60° E	T008a 3475 120° E	T009a 3475 150° E	T010a 3475 65° E	T011a 3475 65° E	T012a 3475 65° E	T013a 3475 Z
12 June 46	0.8	1.5	5.0	5.2	5.3	1.3	1.2	5.0	5.2	5.3	5.3	2.4	5.0	5.2
28 June 46	1.7	1.6	5.2	5.3	5.3	1.5	1.5	5.5	5.2	5.3	5.0	5.4	5.6	5.4
17 July 46	-	2.0	5.3 Mud	5.4 Mud	5.1	2.5	2.0	5.5	5.2	5.3	5.0	5.4	5.6	5.4
22 July 46	-	2.0	5.2	5.3 Mud	5.2	1.8	-	5.1	5.2	5.3	5.0	5.4	5.6	5.4
5 Aug 46	-	1.5	Dry	Dry	5.1	1.7	-	5.1	5.2	5.3	5.0	5.4	5.6	5.4
19 Aug 46	-	2.0	5.1	5.1	5.3	1.8	-	5.4	5.1	5.5	5.0	5.4	5.6	5.4
4 Sept 46	-	2.0	5.3	Dry	5.7	-	-	5.5	5.2	5.3	5.0	5.4	5.6	5.4
16 Sept 46	-	2.0	5.3	5.4	5.4	1.9	-	5.5	5.2	5.3	5.0	5.4	5.6	5.4
10 Oct 46	-	3.0	5.1	5.4	5.4	1.5	-	5.7	5.2	5.3	5.0	5.4	5.6	5.4
20 Oct 46	-	3.0	5.2	5.4	5.4	2.0	-	5.6	5.2	5.3	5.0	5.4	5.6	5.4
31 Oct 46	-	Dry	5.5	Dry	5.7	2.1	-	-	-	5.3	5.0	5.4	5.6	5.4
12 Nov 46	-	3.0	5.0	5.2	5.4	2.3	-	5.7	5.4	5.7	5.5	5.4	5.6	5.4
28 Nov 46	-	Dry	5.4	Dry	5.7	-	-	5.0	5.2	5.2	5.0	5.4	5.6	5.4
18 Dec 46	1.9	3.2	5.3	5.4	5.7	2.1	-	5.5	5.7	5.2	5.4	5.0	5.6	5.4
3 Dec 46	2.5	Dry	5.3	5.4	5.8	2.3	1.2	5.2	5.7	5.2	5.5	5.5	5.6	5.4
13 Dec 46	0.9	Dry	5.1	5.7	5.4	1.7	2.8	5.1	5.5	5.3	5.4	5.4	5.6	5.4
24 Dec 46	2.2 Mud	5.0 Ice	5.1	5.4	5.4	5.0 Ice	-	5.2	5.0	5.5	5.4	5.4	5.6	5.4
4 Jan 47	2.1 Ice	5.0 Ice	5.5	5.5 Ice	-	5.0 Ice	-	5.0	5.0	5.2	5.2	5.4	5.6	5.4
20 Jan 47	2.4 Ice	5.0 Ice	Dry	5.6 Ice	5.8 Ice	5.0 Ice	2.8 Ice	Dry	Dry	5.4	5.6	5.4	5.6	5.4
5 Feb 47	0.4	0.6 Ice	0.6 Ice	0.6 Ice	0.6 Ice	0.6 Ice	0.6 Ice	Dry	0.2 Ice	5.4	5.5	5.4	5.6	5.4
20 Feb 47	-	3.1	5.7	5.0	5.0	1.0	-	5.5	5.7	5.5	5.7	5.4	5.6	5.4
24 Mar 47	-	1.0	2.4	2.8	2.4	0.7	-	-	1.1	5.4	5.4	5.4	5.6	5.4
26 Mar 47	-	1.1	2.5	2.7	2.9	1.0	-	Dry	1.2	5.4	5.4	5.4	5.6	5.4
28 Mar 47	-	1.7	2.8	5.0	2.8	1.4	-	Dry	5.0	5.4	5.4	5.4	5.6	5.4
31 Mar 47	1.2	1.1	5.1	5.0	5.0	1.0	-	5.0 Mud	5.0	5.4	5.4	5.4	5.6	5.4
8 Apr 47	0.5	0.6	2.6	5.0	2.7	1.0	-	Dry	2.4	5.0	5.4	5.4	5.6	5.4
4 Apr 47	0.5	0.9	2.8	5.0	2.7	1.0	-	5.0	5.0	5.4	5.4	5.4	5.6	5.4
7 Apr 47	0.6	0.5	2.5	2.7	2.9	1.0	-	2.2	2.4	5.4	5.4	5.4	5.6	5.4
9 Apr 47	0.5	1.0	2.9	5.0	2.7	1.2	-	2.8	5.3	5.0	5.0	5.4	5.6	5.4
11 Apr 47	0.6	1.0	2.8	5.0	2.8	1.3	-	2.7	2.6	5.0	5.4	5.4	5.6	5.4
14 Apr 47	0.8	1.0	5.0	5.0	2.9	1.3	1.1	5.7	2.7	2.8	2.8	5.4	5.6	5.4
16 Apr 47	0.9	1.1	2.9	2.9	2.8	1.3	1.2	2.9	2.8	2.9	2.9	2.8	5.4	5.4
18 Apr 47	0.7	0.9	2.8	2.9	2.7	1.0	1.0	5.1	2.8	2.8	2.8	2.8	5.4	5.4
21 Apr 47	1.0	1.1	2.6	2.8	2.8	1.0	1.0	5.0	2.9	2.8	2.8	2.8	5.4	5.4
25 Apr 47	1.0	1.4	5.0	5.0	2.6	1.2	1.1	5.0	2.6	2.9	5.0	2.8	5.4	5.4
28 Apr 47	1.0	1.0	2.6	5.0	2.8	1.3	1.0	2.6	2.8	5.0	2.6	2.6	5.4	5.4
28 Apr 47	1.0	1.1	5.0	5.1	5.0	1.2	1.0	2.8	2.8	5.0	2.8	2.8	5.4	5.4
50 Apr 47	1.4	1.0	5.0	2.8	2.8	1.0	0.3	2.8	5.0	5.0	5.1	2.8	5.4	5.4
2 May 47	0.5	0.8	2.5	2.6	2.6	0.9	1.0	2.8	2.5	2.6	2.6	2.6	5.4	5.4
5 May 47	0.3	0.4	2.6	2.1	2.0	0.8	1.0	2.0	2.6	2.6	2.6	2.6	5.4	5.4
7 May 47	0.5	0.8	2.6	2.5	2.5	0.9	1.0	2.0	2.2	2.6	2.6	2.6	5.4	5.4
9 May 47	0.8	0.8	2.6	2.6	2.5	1.0	1.0	2.2	2.2	2.6	2.6	2.6	5.4	5.4
12 May 47	1.0	1.0	2.6	2.8	2.7	1.0	1.0	2.4	2.2	2.5	2.5	2.6	5.4	5.4
14 May 47	0.4	1.0	2.6	2.6	2.6	1.0	1.0	2.3	2.0	2.6	2.6	2.6	5.4	5.4
16 May 47	0.9	1.0	5.0	2.6	2.6	1.0	1.0	5.0	2.0	2.6	2.6	2.6	5.4	5.4
19 May 47	0.5	1.0	5.0	2.6	2.6	1.1	1.0	5.0	2.0	2.6	2.6	2.6	5.4	5.4
21 May 47	1.0	1.1	2.9	2.4	2.6	1.1	1.0	2.0	2.4	5.0	5.0	2.6	5.4	5.4
23 May 47	0.6	1.0	2.8	5.0	2.7	1.1	1.1	2.9	5.0	5.0	5.1	2.6	5.4	5.4
26 May 47	0.5	1.0	2.7	2.9	2.9	1.1	1.0	2.6	2.7	2.6	2.6	2.6	5.4	5.4
28 May 47	0.6	1.1	2.8	2.7	2.5	1.1	1.0	2.4	5.0	2.0	2.6	2.6	5.4	5.4
4 June 47	0.7	1.0	2.8	2.8	2.8	1.0	1.0	2.8	2.6	2.6	2.6	2.6	5.4	5.4
10 June 47	0.8	1.1	2.0	5.1	2.8	1.0	1.0	2.7	2.7	2.6	2.6	2.6	5.4	5.4
17 June 47	1.0	1.1	5.0	5.0	5.0	1.1	1.1	2.9	2.8	2.6	2.6	2.6	5.4	5.4
21 June 47	1.0	1.2	5.0	5.0	2.9	1.2	1.2	5.0	5.0	5.0	5.1	2.6	5.4	5.4

GRADE WELLS				AREA F							TURF AREA
				BASE WELLS			SUBGRADE WELLS				SUBGRADE WELLS
T900a 3/75 65'S	T899a 3/75 2	T898a 3/75 65'S	T897a 3/75 150'S	T917a 1/89 11'S	T916a 2/31 11'S	T919a 2/31 19'S	T921a 1/71 11'S	T920 a 1/71 11'S	T900a 2/49 11'S	T923a 2/49 11'S	T695a 13/76 26'S
3.0	3.2	3.0	0.8	1.5	1.4	1.4	3.8	2.9	1.2	1.2	-
3.6	3.4	3.3	1.2	1.5 Mud	1.5 Mud	1.9 Mud	3.2	3.4	1.2	1.2	-
3.4	4.0	3.4	1.9	1.4	1.4 Mud	-	4.2	4.0	2.0	2.0	5.0
3.4	4.0	3.3	1.4	-	-	Dry	4.2	4.0	2.0	2.0	6.2 Mud
3.3	3.4	3.0	1.2	1.4	1.4	1.5	3.8	3.4	1.2	1.2	5.5
3.6	4.0	2.4	1.6	1.4	1.4	1.5	3.8	3.4	1.7	1.4	-
4.0	4.2	3.6	2.7	1.5	2.0	1.7	3.5	3.2	1.2	1.2	-
3.9	4.1	3.6	2.6	1.9	2.1	1.9	4.0	3.9	1.2	1.5	-
3.5	4.0	3.5	2.7	Dry	-	-	4.2	4.0	1.2	2.0	-
3.5	4.0	3.7	3.4	1.4	2.0	1.4	3.9	3.7	1.4	1.2	-
3.6	4.0	3.6	2.6	1.8	2.0	1.8	3.6	3.2	1.2	1.2	-
2.1	3.4	3.4	2.4	0.7	1.0	0.6	2.6	2.0	1.0	0.7	4.5
4.0	4.0	4.0	3.0	1.4	2.0	1.5	2.8	3.1	1.5	1.2	7.0
4.0	4.1	3.1	2.8	1.2	2.0	1.5	3.0	2.1	1.4	1.2	1.0
3.2	4.2	3.5	3.0	2.0	1.9	2.0	3.4	3.7	2.1	2.0	0.5
3.2	3.4	3.5	2.6	0.0	0.4	0.4	2.4	2.7	2.1	2.0	1.6
3.2	4.1	3.4	0.2 Ice	2.0 Ice	0.2 Ice	0.4 Ice	4.0	4.2	0.2	0.2	0.1
4.0	6.0	2.8	- Ice	1.2 Ice	-	0.5 Ice	4.9	4.2	3.7	2.9	0.2 Ice
6.0	8.0	6.2	0.2 Ice	-	-	0.3 Ice	6.0	5.4	7.2	6.5	4.1
4.7	0.6 Ice	0.5 Ice	0.6 Ice	1.2 Ice	-	0.4 Ice	0.7 Ice	2.5 Ice	0.4	0.4	3.2
2.5	7.1	4.2	2.8	1.2	Dry	-	5.0	4.7	9.0	8.1	2.5
3.5	5.9	3.5	0.1 Ice	1.4	1.1	-	4.5	4.6	2.0 Ice	7.0	0.5
2.0	5.0	3.7	- Ice	- Ice	1.3	-	4.2	- Ice	0.7	6.0	4.4
3.4	5.2	3.4	5.0	1.5	1.9	1.3	4.2	4.3	3.6	7.0	1.4
3.0	5.1	3.2	2.0	1.0	1.2	1.0	4.1	4.1	5.6	1.0	1.0
3.0	4.2	3.0	1.0	0.5	1.0	0.6	3.7	3.0	0.5	0.5	1.2
3.0	4.1	3.1	2.2	0.7	-	0.5	3.9	-	0.5	0.6	1.0
3.0	3.4	2.9	0.4	0.5	0.7	0.8	2.9	2.6	0.5	0.5	0.0
2.9	3.5	3.0	1.5	0.9	1.2	0.9	2.4	2.7	1.3	1.4	0.0
3.7	3.1	3.0	1.0	0.8	1.5	0.9	2.1	2.5	1.0	1.1	0.0
3.1	3.3	3.0	1.1	1.2	0.8	1.0	2.1	2.2	0.8	0.4	0.0
3.1	3.1	3.0	1.1	1.2	1.2	1.1	2.4	2.4	1.2	0.8	0.0
3.0	3.0	3.0	0.9	1.1	0.7	0.7	2.0	2.2	0.5	0.7	0.2
3.0	3.1	3.0	1.0	1.4	1.1	1.1	2.6	1.6	1.4	1.0	0.4
2.8	3.5	3.0	1.4	1.8	1.2	1.1	2.6	3.0	1.2	1.0	0.4
3.0	3.0	3.1	1.0	1.6	1.0	1.1	2.8	3.0	0.8	0.6	0.9
3.0	3.1	3.1	1.0	1.4	1.0	1.0	2.8	3.0	1.1	1.0	1.4
2.8	3.0	3.0	0.5	1.1	0.8	0.5	1.8	1.6	0.6	0.4	0.6
2.8	3.0	3.0	0.3	1.0	0.6	0.5	2.0	2.0	0.4	0.3	0.2
2.6	2.8	3.0	0.2	0.8	0.4	0.4	1.6	2.0	0.5	0.3	0.2
2.2	2.6	2.8	0.6	1.1	0.6	0.9	2.0	1.6	0.4	0.4	0.2
2.8	2.7	2.9	1.0	1.3	1.1	1.0	2.1	2.1	1.5	0.8	0.4
3.0	3.0	3.0	1.0	1.6	1.0	1.0	2.5	2.5	1.0	0.9	1.5
2.7	2.3	3.0	0.6	0.9	0.9	0.9	2.0	2.0	0.4	0.3	0.3
2.8	2.9	3.0	1.0	1.4	1.0	1.0	2.2	2.5	1.0	1.1	1.0
3.0	2.8	3.0	0.9	1.0	0.6	1.0	1.0	2.2	0.6	0.6	0.9
3.1	3.0	3.1	0.9	1.5	0.9	1.0	2.3	2.1	1.0	1.0	0.9
2.8	2.9	3.0	0.6	1.2	0.8	0.9	2.0	2.0	0.6	0.6	0.6
2.2	2.9	3.0	0.3	1.1	0.5	0.8	2.0	2.1	0.5	0.5	0.5
3.0	2.9	3.0	0.8	1.5	1.0	1.0	2.2	2.4	0.8	0.9	1.5
2.0	2.0	2.0	0.9	1.1	0.7	0.7	2.0	1.3	0.6	0.6	0.9
2.0	3.0	3.0	1.1	1.0	0.9	1.0	2.1	2.1	0.7	0.6	0.5
3.0	3.0	3.0	1.1	1.7	1.0	1.2	2.6	2.6	1.1	1.0	1.0
3.0	3.0	3.1	0.7	1.7	1.1	1.1	2.7	2.7	1.0	1.0	3.4

**NOTES**  
 Ground water table measurements are in feet from surface of the pavement.  
 Wells frozen from 5 February to 20 March 1947. Unable to obtain readings during this period.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
**GROUND WATER TABLE OBSERVATIONS**  
 TEST AREAS E, F AND TURF AREA  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

SUMMARY OF THERMOMETER DATA

THERMOMETER NO.	DEPTH IN FEET	JUNE 12	JUNE 20	JULY 17	JULY 22	AUGUST 5	AUGUST 12	OCTOBER 10	OCTOBER 18	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 15	NOVEMBER 22	NOVEMBER 27	DECEMBER 2	DECEMBER 6	DECEMBER 9	DECEMBER 12	
1	0.7	76.0	82.0	76.0	69.0	76.0	70.0	56.0	48.0	50.0	53.0	46.0	46.5	39.0	40.0	43.0	35.0	31.0	30.0	32.0
2	1.3	71.0	82.0	76.0	72.0	76.0	76.0	58.0	50.0	-	55.0	-	-	-	-	-	34.0	32.0	32.0	35.0
3	2.2	65.0	77.0	77.0	75.0	75.0	73.0	62.0	56.5	55.0	56.5	47.5	49.0	45.0	44.0	46.0	39.0	37.0	36.0	36.0
4	3.1	63.0	72.0	76.0	75.0	76.0	76.0	64.0	66.0	57.0	58.0	52.0	51.0	49.0	47.0	46.0	43.5	41.5	39.0	39.0
5	4.1	60.0	66.0	71.0	73.0	72.0	71.0	61.5	61.0	58.0	58.5	55.0	52.0	51.0	49.5	47.0	46.5	45.0	43.0	43.0
6	5.2	56.5	62.0	66.0	66.0	69.0	69.0	64.0	62.0	59.0	58.5	57.0	56.0	53.0	52.0	50.0	49.0	48.5	46.0	45.0
7	6.0	55.0	59.5	65.0	66.0	66.0	66.0	64.0	62.0	60.0	59.0	58.0	55.0	54.0	52.0	51.5	50.5	49.0	48.0	48.0
8	8.1	50.0	53.5	59.0	58.0	61.0	63.0	61.5	60.0	60.0	59.0	58.5	57.0	56.0	56.0	55.0	54.0	53.5	53.0	52.0
Time	(A)	P.M. 4:00	A.M. 10:25	A.M. 10:00	A.M. 10:45	A.M. 10:55	A.M. 9:40	A.M. 11:05	-	A.M. 10:30	A.M. 11:30	P.M. 3:45	P.M. 3:40	P.M. 1:55	A.M. 9:20	P.M. 2:55	A.M. 11:05	P.M. 3:15	P.M. 3:25	P.M. 8:15
Ground Temperature	(B)	76.0	82.0	76.0	66.0	87.0	65.0	76.0	43.0	56.0	67.0	51.5	46.0	49.0	46.0	54.0	35.0	31.0	32.0	43.0
Air Temperature	(C)	76.0	80.0	76.0	65.0	75.0	66.0	66.0	40.0	55.0	64.5	54.0	45.0	50.0	45.0	67.0	35.0	35.0	35.0	45.0
Weather	(D)	Clear	Clear	Fair	Cloudy	Clear	Clear	Clear	Cloudy	Fair	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Cloudy	Clear	Rain	Clear
Snow Cover	(E)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	(F)	3 SW	None	-	2 NE	-	3 SW	-	2 E	2 SW	2 SW	2 W	2 E	3 SW	2 E	2 E	4 NE	2 SW	1 E	2 E

THERMOMETER NO.	DEPTH IN FEET	FEBRUARY 28	MARCH 5	MARCH 7	MARCH 11	MARCH 17	MARCH 20	MARCH 23	MARCH 25	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29	MAY 2
1	0.7	26.0	29.5	31.0	31.0	32.0	32.0	35.0	39.0	32.0	35.0	37.0	42.0	36.0	41.0	41.0	42.0	46.0	39.0	40.0
2	1.3	26.0	30.5	31.0	31.0	33.0	32.0	36.0	39.0	32.0	36.0	39.0	43.0	39.0	43.0	42.0	43.0	46.0	39.0	42.0
3	2.2	29.0	31.0	31.5	31.5	32.0	32.0	32.0	36.0	35.0	35.0	39.5	43.0	41.0	45.0	43.5	44.0	47.0	47.0	45.0
4	3.1	30.5	31.5	31.5	32.0	32.0	32.0	32.0	36.0	32.0	32.0	37.5	40.0	41.0	45.0	43.5	44.0	46.0	46.0	45.0
5	4.1	32.5	33.0	33.0	32.5	34.0	33.0	33.0	33.5	36.0	35.0	37.5	39.0	40.5	43.0	43.5	44.0	45.0	46.0	46.0
6	5.2	35.0	34.5	-	35.0	35.0	35.0	35.0	35.0	35.0	35.0	37.5	39.0	40.5	43.0	43.5	44.0	45.0	46.0	46.0
7	6.0	37.0	37.0	-	36.5	37.0	36.0	36.0	36.0	36.0	36.0	37.5	39.0	39.0	41.0	40.0	43.0	43.0	44.0	44.0
8	8.1	41.0	40.5	40.5	40.0	40.0	40.0	40.0	39.0	39.5	39.5	40.0	40.0	40.0	41.0	41.5	42.0	42.5	43.0	43.0
Time	(A)	A.M. 10:30	A.M. 10:20	A.M. 10:20	A.M. 9:35	A.M. 9:50	A.M. 9:25	A.M. 9:50	A.M. 9:30	A.M. 11:30	A.M. 9:15	A.M. 9:25	A.M. 9:50	A.M. 9:05	A.M. 11:30	A.M. 9:40	A.M. 9:35	A.M. 9:40	A.M. 9:50	A.M. 9:45
Ground Temperature	(B)	26.0	36.0	35.0	35.0	35.0	33.0	37.0	42.0	34.0	30.0	37.0	52.0	41.0	43.0	55.0	40.0	46.0	40.0	39.0
Air Temperature	(C)	27.0	32.0	37.0	28.0	32.0	30.0	36.0	41.0	27.0	28.0	32.0	50.0	42.0	41.0	51.0	41.0	47.0	35.0	36.0
Weather	(D)	Clear	Clear	Cloudy	Clear	Clear	Clear	Clear	Rain	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Clear	Cloudy	Clear
Snow Cover	(E)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	(F)	2 W	2 W	3 SW	3 SW	None	3 SW	2 NE	3 NE	4 W	3 SW	3 SW	3 W	2 SW	2 E	3 SW	2 NE	2 SW	2 E	1 NE

LOCATION OF INSTALLATION:

E - W Runway, Test Area D  
Miscellaneous concrete pavement  
Station 8 of 65, 55' E of E

NOTES:

- (A) Time of reading thermometers within 15 minute period.
- (B) Reading of mercury thermometer placed on surface of ground.
- (C) Reading of mercury thermometer suspended in air in shade.
- (D) Weather at time readings were obtained.
- (E) No distinction made between snow and ice cover.
- (F) Approximate wind intensity and direction at time of reading.

A

INVESTIGATION  
 BANGOR, MAINE.  
 DATA AT INSTALLATION TW-3

DECEMBER 12	DECEMBER 13	DECEMBER 14	DECEMBER 15	DECEMBER 16	DECEMBER 17	DECEMBER 18	JANUARY 1	JANUARY 7	JANUARY 11	JANUARY 15	JANUARY 19	JANUARY 23	JANUARY 27	FEBRUARY 1	FEBRUARY 5	FEBRUARY 9	FEBRUARY 13	FEBRUARY 17	FEBRUARY 21	FEBRUARY 25
30.0	30.0	25.0	30.0	18.0	26.0	24.0	28.0	20.0	26.0	26.0	=	30.0	29.0	=	23.0	26.0	25.0	19.0	30.5	21.0
33.0	32.0	25.0	31.0	21.0	26.0	24.0	25.0	20.0	26.0	26.0	17.0	30.0	30.0	22.0	26.0	26.0	26.5	20.0	30.0	22.0
36.0	36.0	35.0	34.0	34.0	31.5	32.0	36.0	27.0	=	25.0	30.0	31.0	28.0	28.0	31.0	30.0	28.0	31.0	28.0	28.0
39.0	39.0	38.0	34.0	36.0	35.0	34.0	34.0	31.0	31.0	30.0	31.0	31.5	31.0	31.0	31.0	32.0	31.5	31.0	31.0	30.5
42.0	42.0	41.0	40.0	39.5	38.5	36.0	36.0	35.0	34.0	34.0	34.0	33.0	33.0	32.5	33.0	33.0	33.0	33.0	33.0	33.0
45.0	45.0	44.0	43.0	42.5	41.0	40.0	40.0	39.0	37.0	37.0	37.5	36.5	36.0	36.0	36.0	36.0	36.0	36.0	36.0	35.5
48.0	47.0	46.0	45.0	45.0	44.0	44.0	42.0	41.5	40.0	39.0	39.0	39.0	39.0	38.5	38.0	38.0	39.0	38.0	38.0	37.0
50.0	51.0	50.0	50.0	49.0	48.0	48.0	47.0	46.5	=	44.0	44.0	43.0	43.0	43.0	43.0	43.0	42.0	42.0	42.0	41.0
P.M. 2:10	P.M. 2:00	P.M. 2:10	A.M. 9:40	P.M. 1:30	P.M. 3:15	A.M. 10:10	P.M. 2:50	A.M. 10:15	A.M. 11:15	P.M. 1:55	A.M. 9:45	A.M. 10:45	P.M. 1:45	A.M. 10:25	P.M. 9:45	A.M. 10:20	A.M. 10:20	A.M. 10:40	A.M. 10:40	A.M. 11:05
43.0	47.0	30.0	35.0	9.0	16.0	20.0	29.0	12.0	35.0	10.0	32.0	23.0	25.0	25.0	36.0	23.0	27.0	21.0	36.0	25.0
45.0	22.0	31.0	35.0	9.0	16.0	20.0	30.0	11.0	42.5	12.0	31.0	23.0	29.0	39.0	23.0	29.0	23.0	37.0	23.0	21.0
Clear	Clear	Clear	Overcast	Clear	Cloudy	Clear	Fair	Clear	Clear	Clear	Fog	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
0.0	0.0	0.0	3.0	3.0	5.0	2.0	2.5	1.5	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.5
2 S	3 SW	2 SW	2 SW	2 SW	1 SE	1 W	2 SW	2 S	2 SW	2 SW	2 SW	None	3 SW	2 SW	1 SW	3 SW	3 SW	4 SW	2 SW	1 W

MAY 2	MAY 6	MAY 9	MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24
40.0	46.0	44.5	62.0	49.0	49.0	54.0	63.0	52.0	55.5	64.0	72.0
47.0	46.0	44.0	61.0	51.0	52.0	54.0	64.0	52.0	54.0	64.0	73.0
45.0	46.0	49.0	55.0	57.0	57.0	56.0	62.0	59.0	58.0	65.0	71.5
45.0	46.0	48.0	51.0	54.0	54.0	54.0	58.0	59.0	59.0	65.0	67.0
46.0	45.0	46.0	48.0	51.0	53.0	53.0	55.0	58.0	58.0	60.0	65.0
44.0	44.0	45.0	46.0	48.0	50.0	50.0	52.0	55.0	55.5	56.0	58.5
44.0	44.0	44.5	45.0	46.0	47.0	48.0	50.0	52.0	54.5	55.5	56.5
43.0	44.0	44.0	44.0	46.0	45.0	46.0	48.0	49.5	50.5	52.0	52.0
A.M. 9:45	A.M. 10:45	A.M. 9:10	A.M. 9:20	A.M. 9:10	A.M. 9:10	A.M. 9:20	A.M. 9:00	A.M. 10:00	A.M. 9:15	A.M. 8:50	A.M. 9:30
39.0	35.0	46.0	66.0	51.0	47.0	67.0	68.0	62.0	60.0	66.0	75.0
36.0	50.0	46.5	68.0	52.0	46.0	68.0	67.0	58.0	55.0	61.5	70.0
Cloudy	Cloudy	Cloudy	Cloudy	Clear	Fair	Cloudy	Cloudy	Clear	Fair	Cloudy	Clear
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 SW	1 S	3 W	1 W	2 SW	1 SE	1 SW	2 W	3 W	2 W	1 SW	2 SW

15 minute period.  
 at on surface of ground at installation.  
 in air in vicinity of installation.  
 ed.  
 ice cover.  
 at time readings were obtained.

B

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 THERMOMETER  
 RECORD OF SUBSURFACE  
 TEMPERATURES  
 INSTALLATION TW-3  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

TABLE 5

2

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
SUMMARY OF THERMOCOUPLE DATA AT IN

THERMOCOUPLE No.	DEPTH IN FEET	JUNE 13	JUNE 20	JULY 22	AUGUST 5	AUGUST 19	SEPTEMBER 16	OCTOBER 10	OCTOBER 18	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 13	NOVEMBER 15	NOVEMBER 19	NOVEMBER 22	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9	DECEMBER 12
0	0.15	76.0	96.0	72.5	84.0	76.5	73.0	58.5	56.0	53.0	56.0	56.1	59.0	50.2	47.0	40.5	51.8	28.0	32.0	32.2	30.6
1	0.40	76.8	90.0	70.0	79.5	72.5	69.5	56.0	55.8	53.0	55.8	56.0	55.5	50.0	44.5	39.7	49.5	50.5	31.6	32.2	33.5
2	1.10	72.0	85.0	72.5	78.0	73.0	71.0	58.5	59.2	56.0	55.0	49.4	52.0	46.5	41.5	41.0	44.0	35.0	32.5	33.0	35.3
3	1.80	70.0	82.5	75.0	79.0	73.5	72.5	61.0	62.0	57.5	56.5	49.0	52.5	48.0	45.0	41.5	43.5	38.0	35.2	34.6	36.8
4	2.50	67.8	78.5	76.0	78.0	72.0	72.0	64.0	65.2	59.5	58.0	52.0	54.0	50.0	48.0	44.0	44.5	40.5	39.5	36.6	38.3
5	3.10	64.0	74.5	74.5	78.0	71.0	70.5	64.5	62.0	60.0	58.5	54.8	55.5	51.5	51.0	46.0	45.5	42.0	42.2	39.4	40.5
6	3.50	64.5	73.5	73.0	75.5	70.0	70.0	65.5	63.0	60.5	58.5	54.8	55.5	52.0	51.3	47.0	46.2	44.0	43.0	39.7	40.9
7	4.00	61.0	69.5	-	76.0	69.5	69.5	65.0	63.2	61.5	59.0	56.5	56.5	53.2	53.8	49.0	47.5	47.0	45.4	42.6	42.8
8	4.70	59.5	65.5	-	73.5	68.5	68.5	65.0	64.0	62.0	59.5	57.9	57.5	54.5	53.5	50.5	48.8	48.8	47.4	44.8	45.8
9	5.40	57.8	63.0	67.5	71.5	67.5	66.0	65.0	64.0	62.5	59.5	58.5	58.0	55.0	54.5	52.0	50.0	50.5	49.4	46.6	46.6
10	6.00	56.5	60.0	66.0	69.5	66.0	66.0	64.7	65.0	63.0	59.5	58.5	59.0	55.5	55.0	52.5	50.5	51.5	50.5	48.6	48.0
Time (A)		P.M. 2:00	A.M. 10:20	A.M. 10:10	A.M. 10:40	A.M. 10:10	A.M. 10:05	A.M. 9:25	A.M. 9:30	A.M. 9:45	A.M. 10:55	P.M. 3:20	P.M. 2:55	P.M. 2:30	P.M. 1:40	A.M. 9:15	P.M. 2:30	P.M. 2:05	P.M. 2:55	P.M. 2:05	P.M. 1:55
Ground Temperature (B)		67.0	97.0	66.8	86.0	73.0	71.8	56.0	47.0	55.0	69.0	51.5	48.0	44.0	50.0	47.0	54.0	17.0	31.0	32.5	43.0
Air Temperature (C)		66.0	80.0	63.8	75.0	67.0	65.0	55.0	40.0	55.0	61.0	54.0	45.0	41.0	48.0	47.0	51.0	15.0	35.0	38.0	45.0
Switch Box Temperature (D)		64.0	90.0	71.0	79.0	72.0	69.0	60.0	58.0	53.0	64.0	48.5	48.0	46.0	44.0	45.0	51.0	21.0	34.0	35.5	40.0
Indicater Temperature (E)		66.0	97.0	-	-	74.0	71.0	55.0	49.0	55.0	61.0	62.0	53.0	45.0	65.0	59.0	67.0	55.0	49.0	60.0	61.0
Weather (F)		Cloudy	Clear	Cloudy	Clear	Clear	Clear	Clear	Cloudy	Fog	Cloudy	Fair	Clear	Cloudy	Clear	Cloudy	Clear	Fair	Clear	Cloudy	Clear
Snow Cover (Inches) (G)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	2.6	0.0
Wind (Beaufort Scale) (H)		2 SW	None	2 SE	-	3 SW	2 SE	-	2 E	None	2 SW	2 SW	3 E	3 E	3 SW	2 S	2 S	4 SE	1 SW	1 E	2 E

THERMOCOUPLE No.	DEPTH IN FEET	FEBRUARY 10	FEBRUARY 21	FEBRUARY 25	FEBRUARY 28	MARCH 5	MARCH 11	MARCH 17	MARCH 19	MARCH 21	MARCH 25	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29
0	0.15	29.0	16.0	23.0	28.0	33.0	32.0	32.0	34.0	30.8	41.5	39.5	35.0	41.0	52.0	46.0	45.5	53.0	51.5	51.5	43.0
1	0.40	29.5	17.0	23.5	27.5	33.5	31.5	32.0	33.0	36.4	41.0	33.0	32.5	30.0	49.0	42.0	44.5	48.5	46.5	46.5	44.0
2	1.10	30.5	21.5	25.4	30.0	32.5	32.0	32.0	33.0	34.5	38.0	34.0	34.0	37.0	43.5	41.0	44.0	44.5	43.0	47.5	44.0
3	1.80	31.0	24.5	26.6	31.0	32.5	32.0	32.0	33.0	33.6	35.5	33.5	34.0	38.0	42.0	42.0	44.8	45.0	43.5	47.5	45.0
4	2.50	31.0	27.5	28.5	31.5	33.0	32.0	32.5	33.0	34.2	34.0	33.5	33.0	36.0	40.5	42.0	44.2	45.5	43.5	47.0	45.5
5	3.10	32.0	30.5	31.0	34.0	34.0	32.0	33.0	33.5	34.8	35.0	34.0	33.5	35.0	39.5	41.0	42.8	45.0	43.0	45.5	44.0
6	3.50	32.5	31.5	31.5	34.5	35.0	32.5	33.0	34.0	34.2	34.5	34.0	34.0	35.0	39.5	40.0	42.3	45.0	43.0	45.0	44.0
7	4.00	34.0	34.0	32.6	35.5	36.0	34.0	33.5	34.5	34.9	35.8	35.5	34.5	35.0	38.5	39.5	40.7	44.0	42.0	44.0	43.5
8	4.70	35.0	35.5	34.5	36.5	37.0	35.0	35.0	36.0	35.5	36.0	36.0	35.5	36.0	38.0	39.0	39.6	43.5	41.7	43.0	43.0
9	5.40	36.5	36.0	35.5	37.0	38.0	36.5	36.5	36.5	36.5	36.5	36.5	36.5	36.0	38.0	38.5	39.2	42.0	41.0	42.5	43.0
10	6.00	38.0	38.5	36.6	38.0	39.0	37.0	37.0	37.5	37.0	37.0	37.0	37.0	36.5	38.0	38.5	39.0	42.0	40.0	42.0	42.5
Time (A)		A.M. 9:40	A.M. 9:50	A.M. 11:15	P.M. 2:00	A.M. 11:00	A.M. 9:10	A.M. 9:00	A.M. 9:20	A.M. 10:00	A.M. 10:45	A.M. 11:25	A.M. 9:20	A.M. 9:25	A.M. 10:00	A.M. 9:15	A.M. 11:45	A.M. 9:55	A.M. 9:40	A.M. 9:45	A.M. 10:00
Ground Temperature (B)		30.0	11.0	28.0	30.0	37.0	29.5	30.0	33.0	41.0	42.0	33.0	35.0	38.0	54.0	42.0	42.0	55.0	47.0	48.8	40.0
Air Temperature (C)		33.0	9.0	25.0	32.8	38.1	28.5	29.0	30.0	35.0	41.8	28.0	30.0	32.0	50.0	42.5	39.8	54.0	41.0	48.8	35.0
Switch Box Temperature (D)		31.0	13.0	27.0	32.0	35.8	31.5	35.0	38.0	36.0	42.0	33.0	32.5	37.0	50.0	44.0	42.0	54.0	45.0	43.8	35.0
Indicater Temperature (E)		55.0	55.0	45.0	56.0	55.0	60.0	55.0	60.0	40.0	50.0	55.0	55.0	60.0	58.0	50.0	50.0	50.0	55.0	50.0	-
Weather (F)		Fair	Snow	Clear	Clear	Clear	Clear	Fair	Clear	Clear	Rain	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Clear	Cloudy	Clear
Snow Cover (Inches) (G)		0.2	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind (Beaufort Scale) (H)		2 SW	4 SE	1 W	1 W	2 W	3 SE	None	3 SW	3 SE	3 SE	4 W	3 SW	3 SW	3 W	2 SW	2 S	3 SW	2 SW	2 SW	2 E

LOCATION OF INSTALLATION:

D-W Runway, Test Area I  
Bituminous concrete pavement  
Station 2+90, 50' E of J

NOTES:

- (A) Time of reading thermocouples within 15
- (B) Reading of mercury thermometer placed o
- (C) Reading of mercury thermometer suspende
- (D) Reading of mercury thermometer placed m
- (E) Reading of mercury thermometer placed o
- (F) Weather at time readings were obtained.
- (G) No distinction made between snow and ic
- (H) Approximate wind intensity and directio

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FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE.  
 THERMOCOUPLE DATA AT INSTALLATION T886 po

DECEMBER 4	DECEMBER 9	DECEMBER 12	DECEMBER 16	DECEMBER 19	DECEMBER 24	DECEMBER 27	DECEMBER 31	JANUARY 4	JANUARY 7	JANUARY 13	JANUARY 17	JANUARY 23	JANUARY 28	FEBRUARY 1	FEBRUARY 4	FEBRUARY 5	FEBRUARY 7	FEBRUARY 10	FEBRUARY 13	FEBRUARY 14
32.0	32.2	30.6	32.0	32.6	30.4	16.0	20.5	23.5	24.5	16.0	30.0	11.0	31.0	29.0	26.0	33.5	22.0	25.0	19.0	33.4
31.6	32.2	33.5	31.0	30.9	30.4	17.5	29.0	24.0	24.0	16.5	30.0	11.5	30.5	29.5	25.4	32.2	21.5	24.0	17.0	31.6
32.5	33.0	35.3	33.0	31.2	31.5	20.0	30.0	29.0	27.5	21.0	30.0	19.0	30.5	30.5	27.0	30.4	26.0	25.5	20.5	27.5
35.2	34.6	36.2	36.0	33.0	33.0	32.0	31.0	31.0	30.0	25.0	30.0	24.5	30.0	30.0	20.5	30.2	28.5	20.0	24.5	20.4
39.5	36.6	38.3	38.0	34.9	34.8	34.5	33.0	33.5	33.0	20.0	30.0	28.0	30.5	30.0	30.8	30.5	30.5	30.0	27.0	30.3
42.2	39.4	40.5	40.5	37.5	37.1	36.0	34.5	35.0	36.0	32.5	32.0	31.5	32.5	31.5	34.0	33.2	32.0	32.0	30.5	34.2
43.0	39.7	40.9	41.0	38.0	37.5	36.5	35.5	36.0	37.5	33.0	32.8	32.0	33.0	32.5	34.5	34.4	32.0	32.5	31.0	34.6
45.6	42.6	42.8	45.0	39.0	39.6	39.0	37.5	38.0	38.0	35.0	35.0	34.5	35.0	33.5	36.0	36.5	33.5	34.0	32.5	35.7
47.6	44.8	45.0	45.5	42.0	41.6	40.5	39.0	40.0	40.0	37.5	36.5	36.0	36.5	35.0	37.5	37.0	35.0	35.5	34.5	36.0
49.4	46.6	46.6	46.5	44.0	43.0	43.0	41.0	41.0	41.5	39.0	38.5	38.0	38.0	36.5	38.5	38.5	37.0	37.0	36.0	37.6
50.5	48.6	48.0	48.0	45.4	44.5	44.5	43.0	42.5	42.5	40.5	39.5	39.0	39.0	38.5	39.0	39.2	38.0	38.0	37.0	38.2
P.M. 2:55	P.M. 2:05	P.M. 1:55	P.M. 2:35	P.M. 1:55	A.M. 9:20	P.M. 1:00	P.M. 3:35	A.M. 11:05	P.M. 3:40	A.M. 10:35	A.M. 10:30	A.M. 11:00	A.M. 9:25	A.M. 9:50	A.M. 11:00	A.M. 10:10	A.M. 9:30	A.M. 10:50	A.M. 10:00	-
31.0	32.5	43.0	24.5	31.0	35.0	6.0	22.0	20.0	29.0	11.0	26.5	5.0	32.0	23.0	36.0	43.0	20.0	20.0	21.0	-
35.0	38.0	45.0	21.0	32.0	35.0	9.0	15.0	23.0	30.0	13.0	27.0	7.0	30.0	23.0	41.0	44.0	21.0	30.0	22.0	-
34.0	35.5	40.0	30.5	34.0	35.0	19.0	22.0	22.0	20.0	20.0	33.0	9.0	31.0	29.0	35.0	40.0	22.0	27.0	22.0	-
49.0	60.0	61.0	54.0	60.0	48.0	51.0	54.0	53.0	51.0	65.0	60.0	48.0	48.0	57.0	55.0	44.0	55.0	48.0	53.0	-
Clear	Cloudy	Clear	Clear	Clear	Overcast	Clear	Cloudy	Clear	Cloudy	Clear	Clear	Clear	Fog	Clear	Clear	Overcast	Snow	Clear	Clear	-
0.2	2.0	0.0	0.0	0.0	3.0	3.0	5.0	3.0	2.5	22.0	2.0	2.5	1.0	2.0	1.0	0.0	0.5	0.0	0.0	-
1 SW	1 E	2 S	3 SW	2 NW	2 SW	2 NW	1 SE	1 W	1 SW	2 NW	1 W	2 SW	None	3 SW	2 SE	3 SW	3 SE	3 SW	4 SW	-

APRIL 22	APRIL 25	APRIL 29	MAY 2	MAY 6	MAY 9	MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24						
51.5	51.5	43.0	41.5	54.0	48.5	67.0	57.0	52.0	56.5	64.5	63.5	60.0	67.0	75.0						
46.5	49.5	40.5	41.0	53.0	48.0	64.0	54.5	53.5	55.0	64.5	59.5	57.5	66.5	72.5						
43.0	47.5	44.0	42.5	51.5	49.5	60.0	57.5	57.5	56.5	66.0	57.0	50.0	60.0	73.5						
43.5	47.5	45.5	44.0	50.0	50.0	58.0	58.5	58.0	57.0	65.0	60.5	59.0	60.0	72.5						
43.5	47.0	45.5	45.0	47.5	49.0	54.0	55.0	55.0	56.5	61.5	62.0	60.0	66.0	68.5						
43.0	45.5	44.0	45.0	45.5	47.5	50.5	52.0	52.5	55.0	58.0	62.0	60.0	63.5	64.0						
42.0	44.0	43.5	45.0	45.5	46.5	49.5	52.0	51.5	54.5	57.2	61.0	60.0	63.0	64.0						
41.7	43.0	43.0	44.0	44.0	44.5	45.5	48.0	48.5	51.0	52.7	57.0	57.0	59.5	57.5						
41.0	42.5	43.0	43.5	44.0	44.5	44.5	46.5	47.0	49.5	51.2	55.0	55.0	58.0	55.5						
40.0	42.0	42.5	44.0	43.5	44.5	44.0	46.0	47.0	48.5	50.0	55.0	54.0	56.5	54.0						
A.M. 9:40	A.M. 9:45	A.M. 10:00	A.M. 9:50	A.M. 10:25	A.M. 8:40	A.M. 9:30	A.M. 8:50	A.M. 8:40	A.M. 8:50	A.M. 8:45	A.M. 10:15	A.M. 9:30	A.M. 9:00	A.M. 9:20						
47.0	48.0	40.0	37.0	55.0	46.0	70.0	51.0	47.0	67.0	60.0	62.0	61.0	67.0	75.0						
41.0	48.0	35.0	36.0	50.0	40.5	66.0	52.5	46.0	68.0	67.0	58.5	55.0	60.5	70.0						
35.0	43.0	35.0	39.0	51.5	45.0	65.0	56.0	49.0	61.0	65.0	53.0	57.0	64.0	70.0						
40.0	-	55.0	50.0	60.0	50.0	65.0	60.0	50.0	60.0	65.0	50.0	50.0	59.0	70.0						
Clear	Cloudy	Clear	Cloudy	Cloudy	Cloudy	Cloudy	Clear	Rain	Cloudy	Cloudy	Clear	Fair	Cloudy	Clear						
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0						
SW	2 SW	2 E	1 SE	1 S	3 W	1 S	2 SW	1 SE	1 SW	2 W	3 W	2 E	1 SW	2 SW						

reading thermocouples within 15 minute period.  
 of mercury thermometer placed on surface of ground at installation.  
 of mercury thermometer suspended in air in vicinity of installation.  
 of mercury thermometer placed near rotary switch at time of obtaining thermocouple readings.  
 of mercury thermometer placed on potentiometer usually located in automobile.  
 at time readings were obtained.  
 distinction made between snow and ice cover.  
 of wind intensity and direction at time readings were obtained.

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FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 THERMOCOUPLE  
 RECORD OF SUBSURFACE  
 TEMPERATURES  
 INSTALLATION T886 po  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

TABLE 6

SUMMARY OF THERMOMETER DATA AT

THERMOMETER NO.	DEPTH IN FEET	JUNE 17	JUNE 20	JULY 17	JULY 22	AUGUST 5	AUGUST 19	OCTOBER 10	OCTOBER 16	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 15	NOVEMBER 19	NOVEMBER 20	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9	DECEMBER 17	DECEMBER 18	
1	0.0	70.0	82.0	78.0	69.0	78.0	72.0	56.0	50.0	50.0	54.0	46.0	47.0	39.0	41.0	40.0	34.0	31.0	31.0	31.0	30.0	30.0
2	1.5	68.0	82.0	78.0	70.0	76.0	72.0	56.0	54.0	50.0	54.0	46.0	47.0	40.0	41.0	40.0	34.0	31.0	31.0	31.0	30.0	30.0
3	2.0	67.0	77.5	77.0	75.0	75.0	75.0	62.0	59.0	55.0	56.5	47.0	47.0	40.0	41.5	45.0	39.0	37.0	36.0	37.0	36.0	36.0
4	3.0	64.0	74.0	75.0	75.0	74.0	72.0	64.0	61.5	58.0	58.5	51.5	50.5	48.0	46.5	45.0	43.0	41.0	37.0	36.0	36.0	36.0
5	4.0	60.0	67.0	71.0	74.0	72.0	72.0	64.0	61.5	58.0	58.5	55.0	52.0	51.0	49.5	47.0	46.0	45.0	42.5	41.5	41.5	41.5
6	5.0	56.0	62.0	67.0	69.0	69.0	69.5	65.5	62.0	59.0	58.5	50.0	54.0	53.0	52.0	50.0	49.0	48.0	45.5	45.0	46.0	46.0
7	6.0	55.0	59.0	65.0	66.0	66.0	66.0	65.5	62.0	60.0	59.0	57.5	56.0	54.0	54.0	52.0	49.0	48.0	45.5	45.0	46.0	46.0
8	8.1	51.0	54.0	59.0	60.0	62.0	64.0	65.0	62.0	60.5	59.0	59.0	57.0	56.0	55.0	54.0	53.0	53.0	52.0	50.5	50.0	50.0
Time (A)		P.M. 2:00	A.M. 10:25	A.M. 9:50	A.M. 10:15	A.M. 10:45	A.M. 9:45	A.M. 9:50	A.M. 10:15	A.M. 10:40	A.M. 11:45	P.M. 5:30	P.M. 5:25	P.M. 1:45	A.M. 9:05	P.M. 2:55	A.M. 10:50	P.M. 3:00	P.M. 1:55	P.M. 2:00	P.M. 2:40	P.M. 2:40
Ground Temperature (B)		67.0	97.0	77.0	66.0	86.0	89.0	56.0	47.0	55.0	68.5	41.5	45.0	50.0	47.0	54.0	29.0	31.0	32.0	43.0	44.5	
Air Temperature (C)		66.0	80.0	76.0	64.0	75.0	65.0	55.0	40.0	57.0	65.0	54.0	45.0	48.0	47.0	67.0	15.0	35.0	37.0	45.0	21.0	
Weather (D)		Cloudy	Clear	Fair	Cloudy	Clear	Clear	Clear	Cloudy	Fair	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Cloudy	Clear	Cloudy	Clear	Clear	
Snow Cover (Inches) (E)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.1	2.0	0.0	0.0	
Wind (Beaufort Scale) (F)		2 SW	None	-	2 NE	-	3 SW	-	2 E	2 SW	2 SW	2 SW	2 W	2 SW	2 S	2 S	4 NE	1 SW	1 E	2 E	3 SW	

THERMOMETER NO.	DEPTH IN FEET	FEBRUARY 21	FEBRUARY 25	FEBRUARY 26	MARCH 5	MARCH 11	MARCH 17	MARCH 19	MARCH 21	MARCH 25	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29	MAY 2
1	0.0	18.0	20.0	26.0	30.0	31.0	27.0	31.0	32.0	30.0	31.0	32.0	35.0	41.0	37.0	43.0	43.0	40.0	42.0	41.0	40.0
2	1.5	22.0	23.0	26.0	30.0	31.0	27.0	31.0	32.0	30.0	32.0	32.0	36.0	41.0	37.0	41.0	42.0	42.0	43.0	42.0	40.0
3	2.0	27.0	26.5	27.0	30.5	31.5	30.0	32.0	32.0	32.0	32.0	32.5	35.0	36.0	39.5	40.0	42.0	43.0	42.0	42.0	40.0
4	3.0	30.0	29.5	30.0	31.0	31.5	32.0	32.0	32.0	32.0	32.0	32.5	35.0	36.0	39.5	40.0	42.0	43.0	42.0	42.0	40.0
5	4.0	33.0	32.0	32.0	32.0	32.5	32.0	32.5	33.0	33.0	33.5	33.0	35.0	36.0	40.0	41.0	42.0	43.0	42.0	42.5	41.0
6	5.0	35.0	34.0	34.0	34.0	-	-	-	-	-	-	33.5	35.0	37.5	41.0	41.0	44.0	42.0	45.0	45.0	45.0
7	6.0	37.0	36.5	36.0	-	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	40.0	41.0	42.0	43.5	44.0
8	8.1	40.0	39.5	39.0	38.5	38.0	39.0	38.0	39.0	38.0	38.0	38.0	38.5	38.0	38.5	39.0	40.0	41.0	42.0	42.5	43.0
Time (A)		A.M. 10:10	A.M. 11:25	P.M. 2:15	A.M. 11:00	A.M. 9:40	A.M. 9:10	A.M. 9:10	A.M. 10:10	A.M. 10:45	A.M. 11:40	A.M. 9:25	A.M. 9:50	A.M. 10:05	A.M. 9:15	A.M. 11:50	A.M. 10:00	A.M. 9:35	A.M. 10:15	A.M. 9:50	A.M. 10:00
Ground Temperature (B)		13.0	26.0	30.0	37.0	29.0	38.0	33.0	41.0	42.0	33.0	35.0	36.0	54.0	42.0	40.0	54.0	47.0	46.0	40.0	37.0
Air Temperature (C)		9.0	25.0	32.0	38.0	28.0	29.0	30.0	35.0	41.0	28.0	30.0	32.0	50.0	42.5	41.0	54.0	41.0	40.0	40.0	37.0
Weather (D)		Snow	Clear	Clear	Clear	Clear	Fair	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Snow Cover (Inches) (E)		0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind (Beaufort Scale) (F)		4 SW	1 W	1 W	2 W	3 SE	None	3 SW	3 SE	3 SE	4 W	3 SW	3 SW	3 W	2 SW	2 S	2 SW	2 SW	2 SW	2 E	1 SE

LOCATION OF INSTALLATION:  
DOW Runway, Test Area 2  
Station 500, 55' S of E

- NOTES:
- (A) Time of reading thermometers within 25 minute period.
  - (B) Reading of mercury thermometer placed on surface of ground.
  - (C) Reading of mercury thermometer suspended in air in vicinity.
  - (D) Weather at time readings were obtained.
  - (E) No distinction made between snow and ice cover.
  - (F) Approximate wind intensity and direction at time readings.

A

INVESTIGATION  
 BANGOR, MAINE.  
 DATA AT INSTALLATION TW-2

	DECEMBER 1	DECEMBER 16	DECEMBER 21	DECEMBER 26	DECEMBER 31	JANUARY 4	JANUARY 7	JANUARY 13	JANUARY 17	JANUARY 21	JANUARY 25	JANUARY 29	FEBRUARY 1	FEBRUARY 4	FEBRUARY 7	FEBRUARY 10	FEBRUARY 14	FEBRUARY 17	FEBRUARY 20	FEBRUARY 23	
1	30.0	30.0	29.0	30.0	21.0	28.0	24.0	23.0	16.0	-	26.0	16.0	19.0	24.0	24.0	24.0	21.0	18.0	25.0	30.0	30.0
2	32.0	32.0	26.0	31.0	24.0	30.0	26.0	21.0	19.0	-	27.0	16.0	29.0	30.0	25.0	26.0	26.0	22.0	24.0	30.0	30.0
3	34.0	36.0	35.0	34.0	33.5	33.0	32.0	30.0	24.0	25.5	28.0	24.0	25.5	30.0	27.0	30.0	25.0	31.5	26.0	31.0	31.0
4	36.0	38.0	37.0	36.0	35.5	35.0	34.0	33.5	30.0	31.0	30.0	29.0	30.0	31.0	29.5	31.0	31.0	30.0	29.0	31.0	31.0
5	41.5	41.5	40.0	39.5	39.0	36.0	37.0	36.0	35.0	33.5	35.0	33.0	33.0	33.0	33.0	33.0	33.0	33.0	32.5	33.0	33.0
6	45.0	44.0	44.0	42.0	42.0	41.0	40.0	39.0	38.0	-	36.0	36.0	35.5	-	35.0	35.0	35	35.0	35.0	35.0	35.0
7	47.5	46.5	46.0	45.0	44.0	43.0	42.0	42.0	41.0	-	39.0	39.0	38.0	38.0	38.0	37.5	37.0	37.0	37.0	37.0	37.0
8	50.5	50.0	49.0	48.0	48.0	47.0	46.0	45.0	45.0	-	43.0	42.5	42.0	41.0	40.5	41.0	40.0	40.0	40.0	40.0	40.0
9	P.M. 2:00	P.M. 2:40	P.M. 2:05	A.M. 9:50	P.M. 1:15	P.M. 3:40	A.M. 9:50	P.M. 2:10	A.M. 10:25	A.M. 10:10	A.M. 11:10	P.M. 2:15	A.M. 9:50	A.M. 10:25	A.M. 10:45	A.M. 9:55	A.M. 10:05	A.M. 10:10	A.M. 10:10	A.M. 10:00	A.M. 10:00
10	43.0	24.5	31.0	35.0	6.0	22.0	20.0	29.0	11.0	26.5	34.5	9.0	32.0	23.0	36.0	20.0	28.0	21.0	-	30.0	30.0
11	45.0	21.0	32.0	35.0	9.0	15.0	19.0	31.0	13.0	27.0	42.5	12.0	30.0	23.0	40.0	21.0	30.0	22.0	-	33.0	33.0
12	Clear	Clear	Clear	Overcast	Clear	Cloudy	Clear	Fair	Clear	Clear	Clear	Clear	Clear	Fog	Clear	Clear	Snow	Clear	Clear	-	Fair
13	0.0	0.0	0.0	3.0	2.0	4.0	3.0	2.0	1.0	2.0	2.0	0.0	0.0	0.5	0.0	0.5	0.0	0.0	-	0.0	0.0
14	2 S	3 SW	2 SW	2 SW	2 SW	1 WE	1 W	2 SW	2 SW	2 W	2 SW	2 SW	None	3 SW	2 SE	3 WE	3 SW	4 SW	-	2 SW	2 SW

	APRIL 29	MAY 2	MAY 6	MAY 9	MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24
1	41.0	40.0	45.0	43.5	60.0	48.0	48.0	52.0	62.0	50.0	54.0	62.5	71.0
2	42.0	40.0	47.0	46.0	59.0	49.0	49.0	54.0	64.0	54.0	55.0	64.0	73.0
3	46.0	43.0	47.0	49.0	55.0	56.0	56.0	56.0	62.0	54.0	58.0	65.0	71.5
4	45.5	44.0	45.0	47.0	51.0	54.0	54.0	54.0	58.0	54.0	58.5	62.5	67.0
5	45.0	45.0	44.0	45.5	47.0	50.0	51.0	52.0	54.0	55.0	58.0	59.0	62.0
6	43.5	44.0	43.0	44.0	45.5	47.0	49.0	50.0	52.0	55.0	55.5	57.0	59.0
7	42.5	43.0	43.0	44.0	45.5	47.0	48.0	49.0	52.0	55.0	54.0	56.0	56.0
8	42.0	42.0	43.0	43.0	44.0	44.0	45.0	46.0	47.0	49.0	50.5	52.0	53.5
9	A.M. 9:50	A.M. 10:00	A.M. 10:30	A.M. 9:00	A.M. 9:35	A.M. 9:00	A.M. 8:50	A.M. 9:05	A.M. 8:55	A.M. 10:20	A.M. 9:40	A.M. 9:30	A.M. 9:35
10	40.0	37.0	55.0	46.0	70.0	51.0	47.0	67.0	68.0	62.0	61.0	67.0	75.0
11	35.0	36.0	50.0	46.5	66.0	52.5	46.0	66.0	67.0	58.5	59.0	60.5	70.0
12	Clear	Cloudy	Cloudy	Cloudy	Cloudy	Clear	Main	Cloudy	Cloudy	Clear	Fair	Cloudy	Clear
13	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	2 S	1 SW	1 S	3 W	1 W	2 SW	1 SE	1 SW	2 W	3 S	2 S	1 SW	2 SW

in 15 minute period.  
 placed on surface of ground at installation.  
 suspended in air in vicinity of installation.  
 obtained.  
 and ice cover.  
 direction of time readings were obtained.



FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 THERMOMETER  
 RECORD OF SUBSURFACE  
 TEMPERATURES  
 INSTALLATION TW - 2  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

TABLE 7

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
SUMMARY OF THERMOCOUPLE DATA AT INSTA

THERMOCOUPLE NO.	DEPTH IN FEET	JUNE 12	JUNE 28	JULY 17	JULY 22	AUGUST 5	AUGUST 20	SEPTEMBER 10	OCTOBER 10	OCTOBER 18	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 11	NOVEMBER 19	NOVEMBER 22	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9	DECEMBER 12	DECEMBER 16
0	0.30	90.0	91.5	73.0	67.5	77.0	75.0	61.5	66.5	50.7	51.0	53.5	52.1	52.0	41.0	39.0	49.0	29.0	30.0	33.0	37.0	27.0
1	0.65	76.5	86.5	72.0	67.0	76.0	68.5	65.0	59.0	53.5	51.5	52.5	47.0	50.5	38.0	36.0	44.5	32.0	32.0	32.1	33.5	29.0
2	1.00	72.0	86.0	73.5	68.0	75.0	68.0	64.0	59.0	55.0	52.5	52.5	46.5	50.0	37.0	39.0	43.0	32.5	33.0	32.9	34.0	30.0
3	1.35	68.5	86.0	74.0	69.5	75.5	68.5	65.5	61.0	56.5	54.0	53.5	46.5	51.0	36.7	40.0	43.0	33.5	34.1	33.6	35.1	32.5
4	1.65	66.5	85.0	75.0	70.5	76.0	70.0	66.0	63.0	57.5	56.0	56.5	46.0	52.5	33.0	40.5	43.0	35.0	35.6	35.0	36.3	33.5
5	1.95	66.5	81.5	76.0	71.0	76.0	70.0	65.5	64.0	57.5	56.5	55.0	46.5	52.5	32.5	41.0	43.5	36.5	36.5	35.8	37.0	34.0
6	2.65	64.0	75.5	70.0	73.5	73.5	69.5	64.5	66.0	58.5	58.0	56.0	52.0	54.0	36.0	46.0	46.0	39.0	39.0	38.5	39.6	36.5
7	3.45	60.7	71.0	67.5	69.5	71.5	68.0	64.0	66.0	60.0	59.0	56.5	54.0	55.0	38.5	46.5	46.5	43.0	42.6	41.3	42.0	38.5
8	4.30	57.5	66.0	64.5	66.0	70.0	65.0	64.0	66.0	60.5	60.5	56.5	56.0	56.0	49.5	49.0	48.5	46.5	45.0	44.1	44.6	41.5
9	5.15	55.0	61.0	62.0	62.5	67.5	63.5	63.0	65.5	61.0	61.5	57.5	58.0	58.0	51.7	50.5	50.5	48.0	48.6	46.9	47.5	44.5
10	6.00	52.0	57.5	58.0	60.0	63.5	62.0	62.5	63.5	61.0	62.0	57.5	58.0	59.0	52.5	53.0	52.0	50.0	50.0	48.0	49.0	46.5
Time (A)		P.M. 5:15	A.M. 10:30	A.M. 9:20	A.M. 9:50	A.M. 10:50	A.M. 11:00	A.M. 9:05	A.M. 11:50	A.M. 9:50	A.M. 9:30	A.M. 10:20	P.M. 2:40	P.M. 2:45	P.M. 1:30	A.M. 9:10	P.M. 2:05	P.M. 2:20	P.M. 2:25	A.M. 9:30	P.M. 1:45	P.M. 2:50
Ground Temperature (B)		80.0	105.0	76.5	71.0	79.0	74.0	64.0	70.0	47.0	55.0	63.0	54.0	46.0	46.0	45.0	50.0	17.0	27.5	31.0	42.0	23.0
Air Temperature (C)		77.0	80.0	76.0	69.0	74.0	-	63.0	68.0	40.0	57.0	58.0	53.0	46.0	53.0	47.0	50.0	15.0	35.0	30.0	46.0	20.0
British Box Temperature (D)		72.0	85.0	75.0	70.0	79.0	70.0	65.0	65.0	57.0	56.0	61.0	50.0	49.0	47.0	45.0	48.0	22.0	37.5	37.0	45.0	31.0
Indicator Temperature (E)		81.0	100.0	76.0	-	-	75.0	65.0	65.0	60.0	57.0	60.0	66.0	51.0	-	60.0	67.0	56.0	60.0	58.0	60.0	52.0
Weather (F)		Clear	Clear	Fair	Cloudy	Clear	Clear	Clear	Clear	Cloudy	Fog	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Fair	Clear	Snow	Clear	Clear
Snow Cover (Inches) (G)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.5	0.0	0.0
Wind (Beaufort Scale) (H)		SW	None	-	2 NW	-	3 E	2 NE	-	2 E	None	2 SW	2 NW	3 W	3 SW	2 S	2 S	4 NE	1 NW	1 E	2 S	3 W

THERMOCOUPLE NO.	DEPTH IN FEET	FEBRUARY 20	FEBRUARY 25	MARCH 5	MARCH 7	MARCH 11	MARCH 15	MARCH 17	MARCH 19	MARCH 21	MARCH 25	MARCH 27	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29
0	0.30	25.5	26.0	30.5	32.5	33.0	39.5	31.5	27.5	36.5	41.0	27.5	40.5	34.5	37.0	50.0	41.0	40.0	47.5	48.5	47.0	40.0
1	0.65	25.5	27.3	30.0	32.0	34.0	34.5	35.0	31.7	33.3	38.5	30.5	33.5	33.0	33.5	43.5	36.5	41.0	40.5	42.0	43.0	38.5
2	1.00	26.0	28.0	30.0	32.0	34.0	34.0	36.0	32.0	33.5	38.0	30.5	34.0	33.0	34.5	42.5	37.0	41.0	41.0	42.0	43.7	40.0
3	1.35	27.0	28.2	31.5	32.0	33.0	34.0	36.0	32.0	33.8	36.0	31.0	34.0	33.0	35.0	41.0	37.5	41.0	41.5	43.5	44.5	40.0
4	1.65	29.0	29.2	31.5	32.0	33.0	34.0	35.0	31.5	33.6	35.0	30.5	34.0	33.0	34.0	40.5	37.5	41.2	42.0	44.5	44.5	43.0
5	1.95	29.5	29.2	31.5	31.5	32.5	34.5	35.5	31.0	33.8	35.5	31.0	34.0	33.0	33.0	39.0	37.0	41.0	42.5	44.5	44.5	43.0
6	2.65	31.5	31.3	32.5	32.5	34.0	34.5	36.0	32.0	33.8	35.0	31.0	34.0	33.5	32.0	36.0	34.0	39.0	42.0	44.5	44.5	43.0
7	3.45	33.5	33.1	33.5	34.0	34.5	35.0	37.0	33.0	34.8	35.0	32.0	35.0	34.0	33.0	36.5	35.0	37.0	40.5	43.5	42.5	43.0
8	4.30	35.5	35.0	35.0	35.5	36.0	36.5	37.5	34.5	35.8	36.0	34.0	36.0	35.0	34.5	36.5	36.0	36.0	39.5	41.5	39.5	41.0
9	5.15	38.0	36.8	37.5	37.5	38.0	38.0	40.0	36.0	37.1	37.5	35.5	37.0	37.0	36.0	37.0	36.5	36.0	39.0	40.5	38.5	40.5
10	6.00	36.5	36.5	39.0	38.5	40.0	39.0	40.5	37.5	38.5	38.5	36.5	38.5	38.0	37.0	38.5	38.0	36.5	39.0	40.0	38.5	40.0
Time (A)		P.M. 2:45	A.M. 9:40	A.M. 10:35	A.M. 10:50	A.M. 9:50	A.M. 9:20	A.M. 10:15	A.M. 8:05	A.M. 10:15	A.M. 11:00	A.M. 8:40	P.M. 1:30	A.M. 9:50	A.M. 9:45	A.M. 10:10	A.M. 9:20	A.M. 10:40	A.M. 10:15	A.M. 9:50	A.M. 10:00	A.M. 10:15
Ground Temperature (B)		30.0	27.0	35.0	34.0	30.0	44.0	35.0	29.0	40.0	41.0	24.0	36.0	36.0	37.0	52.0	44.0	43.0	53.0	48.0	48.0	36.0
Air Temperature (C)		31.0	41.0	35.0	38.0	28.0	45.0	36.0	29.0	36.0	42.0	21.0	29.0	30.0	32.0	51.0	44.0	40.0	50.0	41.0	47.0	39.0
British Box Temperature (D)		27.0	33.0	35.0	-	33.5	44.0	33.0	41.0	37.0	40.0	31.5	43.0	38.0	38.0	49.0	42.0	44.0	44.0	46.0	48.0	38.0
Indicator Temperature (E)		30.0	35.0	45.0	60.0	60.0	55.0	55.0	50.0	40.0	50.0	50.0	50.0	50.0	57.0	50.0	50.0	55.0	55.0	50.0	-	55.0
Weather (F)		Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Hail	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy	Clear
Snow Cover (Inches) (G)		0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind (Beaufort Scale) (H)		2 W	1 W	2 W	3 NW	2 NE	2 W	None	3 NW	3 NE	3 NE	4 W	4 W	3 NW	3 NW	3 W	2 NW	2 S	3 SW	2 NW	2 NW	2 E

LOCATION OF INSTALLATION:

5-W Runway, Test Area F  
 Cement concrete pavement  
 Station - 5 / 57. 30' S of E

NOTES:

- (A) Time of reading thermocouples within 15 minutes
- (B) Reading of mercury thermometer placed on surface
- (C) Reading of mercury thermometer suspended in air
- (D) Reading of mercury thermometer placed near surface
- (E) Reading of mercury thermometer placed in protected position
- (F) Weather at time readings were obtained.
- (G) No distinction made between snow and ice cover.
- (H) Approximate wind intensity and direction at time

TEMPERATURE DATA AT INSTALLATION T 697 p

	DECEMBER 8	DECEMBER 9	DECEMBER 12	DECEMBER 16	DECEMBER 19	DECEMBER 20	DECEMBER 27	DECEMBER 31	1947 JANUARY 6	JANUARY 7	JANUARY 13	JANUARY 17	JANUARY 21	JANUARY 28	FEBRUARY 4	FEBRUARY 11	FEBRUARY 18	FEBRUARY 25	FEBRUARY 28	
30.0	33.0	37.0	27.0	31.0	31.0	26.0	20.0	21.5	22.0	15.5	29.5	11.0	30.0	28.0	26.0	20.0	21.0	15.0	29.0	16.0
30.0	32.1	33.5	29.0	30.2	31.6	29.0	23.5	26.0	22.5	17.0	30.0	15.0	30.5	30.0	25.0	20.5	22.0	16.5	29.5	18.5
35.0	32.0	31.2	32.0	30.0	31.0	30.0	26.5	26.0	23.0	18.0	30.0	17.0	30.5	29.5	26.0	23.0	23.0	17.0	29.5	20.0
34.1	33.6	35.1	32.5	30.9	32.3	31.5	27.0	27.5	25.0	21.0	30.0	19.5	30.0	30.0	27.5	25.0	25.0	19.5	30.0	21.0
35.6	35.0	36.3	33.5	31.1	33.6	32.0	31.0	30.5	28.0	22.5	30.0	26.0	30.5	29.5	30.0	28.0	27.5	21.0	30.0	21.0
36.5	35.0	37.0	31.0	35.0	31.1	33.0	32.5	31.0	30.0	23.0	30.5	28.0	30.5	30.0	30.0	29.0	28.5	27.0	31.0	25.5
39.6	30.5	39.6	36.5	37.6	36.0	35.5	31.0	31.5	33.5	26.5	32.0	31.5	32.0	31.0	31.0	31.0	31.0	30.0	31.5	29.0
42.6	41.3	42.0	38.5	40.0	38.6	37.5	37.0	37.0	36.0	29.0	31.5	31.0	31.0	33.0	31.0	31.0	30.0	30.0	31.5	29.0
45.8	44.1	44.6	41.5	42.0	40.7	40.0	39.5	39.5	39.5	32.0	37.0	37.5	36.5	35.5	36.5	35.0	35.0	35.0	34.5	33.0
48.6	46.9	47.5	44.5	45.0	43.8	43.0	43.0	42.0	41.0	34.0	40.0	39.0	39.0	37.5	40.2	37.5	37.0	37.0	37.0	35.5
50.0	48.9	49.0	46.5	47.0	45.5	45.5	45.5	45.0	42.5	37.0	42.0	42.0	40.5	39.5	41.6	40.0	39.0	39.0	38.5	37.0
P.M. 2:25	A.M. 9:30	P.M. 1:45	P.M. 2:50	P.M. 1:30	A.M. 8:55	P.M. 12:00	P.M. 2:15	A.M. 11:15	P.M. 3:50	A.M. 10:45	A.M. 9:45	A.M. 11:15	A.M. 9:10	A.M. 10:00	A.M. 11:15	A.M. 9:10	A.M. 9:30	A.M. 9:40	A.M. 9:10	A.V. 9:15
27.5	31.0	42.0	23.0	35.0	35.0	10.0	16.0	20.0	27.0	11.0	25.0	7.0	31.0	29.0	36.0	21.0	26.0	21.0	30.0	9.0
35.0	30.0	46.0	20.0	32.0	35.0	10.0	14.0	21.0	31.0	14.0	27.0	7.0	30.0	29.0	40.0	21.0	28.0	20.0	31.0	8.0
37.5	37.0	45.0	31.0	31.0	39.0	32.0	19.0	21.0	28.0	20.0	33.0	15.0	33.0	26.0	35.0	29.0	26.0	26.0	37.0	13.0
60.0	58.0	60.0	52.0	62.0	50.0	50.0	42.0	50.0	52.0	50.0	55.0	55.0	58.0	55.0	50.0	48.0	48.0	48.0	60.0	60.0
Clear	Snow	Clear	Clear	Clear	Overcast	Fair	Cloudy	Fair	Cloudy	Fair	Fair	Fair	Fog	Fair	Fair	Snow	Fair	Fair	Cloudy	Snow
1.0	0.5	0.0	0.0	0.0	3.5	3.0	2.0	2.0	2.5	7.5	3.0	2.0	2.0	3.0	2.0	0.20	0.0	0.0	0.70	0.0
1 W	1 E	2 S	3 W	2 W	2 W	2 W	1 W	1 W	1 W	2 W	2 W	3 W	Sne	3 W	2 W	3 W	3 W	4 W	2 W	4 W

APRIL 18	APRIL 22	APRIL 25	APRIL 29	MAY 2	MAY 6	MAY 9	MAY 13	MAY 16	MAY 20	MAY 25	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24
47.5	48.5	47.0	40.0	40.0	53.0	44.5	80.0	51.0	51.0	53.0	61.5	61.0	59.5	61.0	66.5
40.5	42.0	43.0	38.5	40.0	51.0	45.5	71.0	51.5	51.5	53.0	60.0	58.0	55.0	61.0	67.5
41.0	42.0	43.7	40.0	42.0	51.0	46.0	68.5	52.5	55.0	56.5	63.0	53.0	56.0	61.5	68.0
41.5	43.5	44.5	42.0	42.0	50.0	47.0	66.0	53.5	54.5	58.0	63.0	51.0	57.0	65.0	68.5
42.0	44.5	44.5	43.0	43.0	49.0	47.0	61.0	52.5	51.0	58.0	61.5	56.5	58.5	61.5	66.5
42.5	44.5	44.5	43.0	44.0	47.5	47.0	63.5	52.0	53.5	57.0	60.5	58.0	59.0	61.0	65.5
42.0	43.5	42.5	43.0	44.0	44.5	45.0	58.5	49.0	51.0	55.5	55.5	59.0	59.0	61.0	60.0
40.5	42.5	40.5	42.0	43.5	43.0	44.0	51.5	46.0	48.5	53.5	52.0	57.5	58.0	58.5	56.5
39.5	41.5	39.5	41.5	42.0	42.0	43.0	51.5	44.0	46.5	51.5	49.0	55.0	56.0	56.0	51.0
39.0	40.5	38.5	40.5	42.0	41.5	41.5	49.0	42.0	44.5	50.0	47.0	51.5	53.0	53.5	51.0
39.0	40.0	38.5	40.0	42.0	41.0	41.5	47.0	41.0	43.0	48.0	46.0	49.5	51.5	51.5	49.0
A.M. 10:15	A.M. 9:50	A.M. 10:00	A.M. 10:15	A.M. 10:10	A.M. 10:15	A.M. 8:50	P.M. 2:45	A.M. 8:30	A.M. 8:30	A.M. 8:20	A.M. 8:15	A.M. 10:45	A.M. 9:40	A.M. 9:20	A.M. 8:50
53.0	48.0	48.0	36.0	38.0	50.0	41.0	80.0	59.0	47.0	59.0	65.0	60.0	58.0	65.0	71.0
58.0	41.0	47.0	35.0	39.0	51.0	40.5	77.0	52.0	45.0	60.0	61.0	58.0	59.0	60.0	70.0
41.0	46.0	48.0	30.0	38.0	52.0	41.5	70.0	56.0	52.0	55.0	61.5	62.0	58.0	61.0	71.0
55.0	50.0	-	55.0	50.0	60.0	50.0	65.0	60.0	50.0	60.0	65.0	58.0	60.0	59.0	70.0
Fair	Clear	Cloudy	Clear	Cloudy	Cloudy	Cloudy	Cloudy	Clear	Rain	Cloudy	Cloudy	Clear	Fair	Cloudy	Clear
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 W	2 W	2 W	2 E	1 W	1 S	3 W	1 W	2 W	1 W	1 W	2 W	3 E	2 E	1 W	2 W

reading thermocouples within 15 minute period.  
 of mercury thermometer placed on surface of ground at installation.  
 of mercury thermometer suspended in air in vicinity of installation.  
 of mercury thermometer placed near rotary switch at time of obtaining thermocouple readings.  
 of mercury thermometer placed potentiometer usually located in automobile.  
 at time readings were obtained.  
 location made between snow and ice cover.  
 date wind intensity and direction at time readings were obtained.



FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 THERMOCOUPLE  
 RECORD OF SUBSURFACE  
 TEMPERATURES  
 INSTALLATION T 697 p  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947  
 TABLE 8

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
SUMMARY OF THERMOMETER DATA AT IN

THERMO- METER NO.	DEPTH IN FEET	JUNE 12	JUNE 28	JULY 17	JULY 22	AUGUST 5	AUGUST 12	OCTOBER 10	OCTOBER 18	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 11	NOVEMBER 19	NOVEMBER 22	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9	DECEMBER 12	DECEMBER 16	DECEMBER 20
1	0.8	74.0	82.0	76.0	70.0	78.0	74.0	58.0	57.0	-	56.0	-	-	-	-	42.0	32.0	31.0	32.0	31.0	30.0	28.0
2	1.3	70.0	80.0	76.0	71.0	76.0	74.0	58.0	58.0	-	54.0	-	-	-	39.0	44.0	33.0	32.0	32.0	32.0	32.0	32.0
3	2.2	63.0	76.0	75.0	74.0	74.0	73.0	60.0	58.0	53.5	55.0	46.0	48.0	44.9	43.0	44.0	38.0	37.0	35.5	35.5	35.5	35.5
4	3.2	60.0	68.0	71.0	72.0	71.0	71.0	62.0	59.0	55.0	56.0	51.0	50.0	48.0	46.0	45.0	44.0	41.0	38.5	39.0	38.5	38.5
5	3.9	57.0	63.0	68.0	68.0	68.0	65.0	62.0	60.0	57.0	56.5	54.0	51.0	50.0	49.0	47.0	47.0	45.0	42.5	42.0	41.5	41.5
6	5.2	54.5	60.0	65.0	65.0	67.0	73.0	62.0	60.0	58.0	57.0	55.0	53.0	52.0	51.0	49.0	49.0	47.0	45.5	45.0	44.0	44.0
7	6.1	51.0	56.0	62.0	62.0	64.0	65.0	62.0	59.5	58.5	57.0	56.0	54.5	53.0	52.5	51.0	50.0	49.5	47.5	47.0	46.0	46.0
8	8.0	49.0	51.0	57.0	56.0	59.0	59.5	60.0	59.0	58.0	57.5	56.0	55.5	55.0	54.0	54.0	53.0	52.0	51.0	50.5	50.0	50.0
Time	(A)	P.M. 3:30	A.M. 10:45	A.M. 9:30	A.M. 9:55	A.M. 10:35	-	A.M. 11:40	A.M. 9:45	A.M. 10:50	P.M. 1:45	P.M. 3:00	P.M. 3:45	P.M. 1:35	A.M. 9:10	P.M. 2:15	A.M. 10:45	P.M. 2:35	A.M. 9:45	P.M. 1:45	P.M. 3:00	
Ground Temperature	(B)	80.0	105.0	76.0	71.0	79.0	-	72.0	47.0	57.0	61.0	54.0	47.0	46.0	45.0	50.0	24.0	27.5	31.0	42.0	23.0	
Air Temperature	(C)	77.0	80.0	76.0	65.0	75.0	-	68.0	40.0	58.0	63.0	53.0	45.0	53.0	47.0	67.0	15.0	35.0	31.0	46.0	20.0	
Weather	(D)	Clear	Clear	Fair	Cloudy	Clear	Clear	Clear	Cloudy	Fair	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Cloudy	Clear	Snow	Clear	Clear	
Snow Cover (Inches)	(E)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.0	0.5	0.0	0.0	
Wind (Beaufort Scale)	(F)	3 SW	None	-	2 NE	-	3 E	-	2 E	2 SW	2 SW	2 SW	2 E	3 SW	2 S	2 S	4 NE	1 NW	1 E	2 S	3 W	2

THERMO- METER NO.	DEPTH IN FEET	FEBRUARY 25	FEBRUARY 28	MARCH 5	MARCH 7	MARCH 11	MARCH 15	MARCH 17	MARCH 19	MARCH 21	MARCH 25	MARCH 27	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29	
1	0.8	24.0	25.0	30.0	32.0	31.0	33.0	32.0	31.0	31.0	37.0	31.0	32.0	31.0	34.0	40.0	35.0	40.0	39.0	40.0	42.0	44.0	44.0
2	1.3	23.0	25.0	30.0	30.0	30.0	32.0	32.0	31.0	31.0	35.0	31.0	31.0	31.0	34.0	38.0	35.0	40.0	39.0	40.0	42.0	44.0	44.0
3	2.2	28.0	29.0	30.5	31.0	31.5	32.0	32.0	32.0	31.5	32.0	32.0	32.0	32.0	34.5	36.0	36.0	42.0	41.0	42.0	45.0	47.0	47.0
4	3.2	31.0	31.0	31.0	31.5	31.5	31.0	32.0	31.5	31.5	31.5	32.0	32.5	31.5	32.0	32.0	33.5	39.0	40.0	41.0	42.0	44.0	44.0
5	3.9	33.5	33.5	33.5	33.5	33.5	33.5	34.0	33.5	33.5	33.5	33.5	33.5	33.5	34.0	34.5	37.0	39.0	42.0	41.0	42.0	44.0	44.0
6	5.2	35.0	35.0	35.0	35.0	35.0	35.0	34.0	34.5	34.5	35.0	34.0	35.0	35.0	35.0	35.0	35.0	37.0	38.5	39.0	40.0	42.0	42.0
7	6.1	37.0	37.0	37.0	37.0	37.0	37.0	37.0	36.0	36.5	36.5	-	-	36.0	36.5	36.0	36.0	37.0	38.5	39.0	40.0	42.0	42.0
8	8.0	40.5	40.0	40.0	40.0	39.5	39.5	40.0	39.5	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.0	39.5	40.0	40.0	42.0	42.0
Time	(A)	P.M. 2:55	A.M. 10:00	A.M. 10:45	A.M. 10:40	A.M. 10:00	A.M. 9:50	A.M. 10:50	A.M. 8:30	A.M. 10:20	A.M. 11:10	A.M. 8:40	P.M. 1:40	A.M. 9:40	A.M. 9:50	A.M. 10:15	A.M. 9:25	A.M. 10:50	A.M. 10:00	A.M. 9:55	A.M. 9:50	A.M. 10:00	
Ground Temperature	(B)	30.0	27.0	35.0	34.0	30.0	45.0	35.0	29.0	40.0	41.0	-	36.0	36.0	37.0	52.0	44.0	43.0	53.0	48.0	48.0	48.0	
Air Temperature	(C)	31.0	24.0	35.0	38.0	28.5	45.0	36.0	29.0	36.0	42.0	-	29.0	30.0	32.0	51.0	44.0	40.0	52.0	41.0	47.0	47.0	
Weather	(D)	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Rain	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Clear	Cloudy	
Snow Cover (Inches)	(E)	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Wind (Beaufort Scale)	(F)	2 W	1 W	2 W	3 SW	2 NE	2 W	None	3 SW	3 NE	3 SE	4 W	4 W	3 SW	3 SW	3 W	2 SW	2 S	3 SW	2 SW	2 SW	2 SW	

LOCATION OF INSTALLATION:

E-W Runway, Test Area F  
Corner concrete pavement  
Station 547. 3/4 S of E

NOTE:

- (A) Time of reading thermometers with
- (B) Reading of mercury thermometer plus
- (C) Reading of mercury thermometer over
- (D) Weather at time readings were obt.
- (E) No distinction made between snow
- (F) Approximate wind intensity and di

A

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
THERMETER DATA AT INSTALLATION TW-1

DECEMBER 1	DECEMBER 2	DECEMBER 12	DECEMBER 16	DECEMBER 19	DECEMBER 24	DECEMBER 27	DECEMBER 31	1947 JANUARY 4	JANUARY 7	JANUARY 13	JANUARY 17	JANUARY 21	JANUARY 23	JANUARY 28	FEBRUARY 1	FEBRUARY 4	FEBRUARY 7	FEBRUARY 10	FEBRUARY 13	FEBRUARY 16	FEBRUARY 21
1.0	32.9	31.9	30.9	24.0	30.0	19.0	22.0	24.0	21.0	19.0	-	28.0	15.0	29.0	28.0	24.0	24.0	25.0	18.0	30.0	19.0
2.0	32.0	32.0	32.0	26.0	30.0	24.0	26.0	26.0	25.0	20.0	-	-	16.0	29.0	20.0	23.0	25.0	24.0	20.0	30.0	22.0
7.0	35.5	35.5	35.5	35.0	34.0	33.0	31.5	30.0	28.0	21.0	29.0	29.0	25.0	29.5	30.0	28.0	30.0	29.0	27.0	30.5	28.0
14.0	36.5	39.0	36.5	36.0	37.0	36.0	35.0	34.0	33.5	32.0	31.5	31.0	31.0	31.0	31.0	31.5	31.0	31.5	31.0	31.0	31.5
5.0	42.5	42.0	41.5	41.0	40.0	40.0	38.0	38.0	37.0	36.0	35.0	35.0	35.0	34.5	34.0	34.0	34.0	34.0	34.0	33.0	34.0
7.0	45.5	45.0	44.0	43.0	42.5	42.0	41.0	40.0	40.0	39.0	-	38.0	37.5	36.5	36.0	36.0	36.0	36.0	36.0	35.5	36.0
9.5	47.5	47.0	46.0	46.0	45.0	44.0	43.5	44.0	42.0	41.0	-	39.0	39.0	39.0	38.0	38.5	38.0	38.0	38.0	37.5	37.5
2.0	51.0	50.5	50.0	49.0	48.0	48.0	47.0	47.0	46.0	45.5	-	-	43.0	43.0	42.5	42.0	42.0	43.0	42.0	41.0	41.0
P.M. 2:35	A.M. 9:45	P.M. 1:45	P.M. 3:00	P.M. 1:40	A.M. 9:05	P.M. 12:45	P.M. 1:40	A.M. 9:30	P.M. 2:25	A.M. 11:00	A.M. 9:55	A.M. 11:00	P.M. 2:15	A.M. 9:20	A.M. 10:15	A.M. 11:30	A.M. 9:20	A.M. 9:40	A.M. 9:50	A.M. 9:20	A.M. 9:25
27.5	31.0	42.0	23.0	35.0	35.0	10.0	16.5	20.0	29.0	11.0	25.0	34.0	10.0	31.0	25.0	36.0	24.0	26.0	21.0	30.0	9.0
35.0	31.0	46.0	20.0	32.0	35.0	12.0	14.0	18.0	31.0	14.0	27.0	42.5	12.0	30.0	25.0	40.0	21.0	28.0	20.0	31.0	8.0
Clear	Snow	Clear	Clear	Clear	Overcast	Clear	Cloudy	Clear	Fair	Clear	Clear	Clear	Clear	Fog	Clear	Clear	Snow	Clear	Clear	Fair	Snow
1.0	0.5	0.0	0.0	0.0	3.5	7.0	4.0	2.0	2.5	1.5	3.0	2.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	2.0	0.0
1 SW	1 E	2 E	3 W	2 SW	2 SW	2 SW	1 SE	1 W	2 SW	2 SW	2 W	2 SW	2 SW	None	3 SW	3 SE	3 SE	3 SW	4 SW	2 SW	4 SW

APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29	MAY 2	MAY 6	MAY 9	MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24
40.0	39.0	40.0	42.0	40.0	40.0	45.0	46.0	44.0	46.0	49.0	53.0	62.0	52.0	52.0	62.0	71.0
40.0	39.0	40.0	42.0	41.0	40.0	45.0	46.0	60.0	47.0	48.0	54.0	64.0	52.0	54.0	64.0	72.0
42.0	41.0	42.0	45.0	45.0	43.0	47.0	44.0	53.0	55.0	55.0	54.0	61.0	57.0	57.5	64.0	70.0
39.0	40.0	41.0	42.0	44.0	44.0	44.0	45.0	48.5	51.0	51.5	52.0	55.0	57.0	57.0	60.0	65.5
37.0	39.0	42.0	41.0	42.5	42.0	42.0	44.0	45.0	47.0	49.0	49.5	51.0	55.0	55.0	56.0	58.0
37.0	36.5	39.0	40.0	42.0	42.0	42.0	43.0	44.0	45.0	47.0	48.0	49.0	52.0	53.0	55.0	56.0
37.0	38.5	39.0	40.0	41.0	41.0	42.0	42.0	43.0	44.0	45.0	46.0	47.0	50.0	51.0	52.0	53.5
39.0	39.5	40.0	40.0	41.0	41.0	-	42.0	42.0	43.0	43.0	44.0	45.0	46.0	48.0	48.0	50.0
A.M. 6:50	A.M. 10:00	A.M. 9:55	A.M. 9:50	A.M. 10:20	A.M. 10:20	A.M. 10:20	A.M. 8:35	P.M. 2:50	A.M. 8:40	A.M. 8:35	A.M. 8:30	A.M. 8:30	A.M. 11:00	A.M. 9:45	A.M. 9:15	A.M. 8:40
43.0	53.0	48.0	48.0	36.0	37.0	50.0	44.0	80.0	99.0	47.0	99.0	65.0	60.0	58.0	65.0	71.0
40.0	52.0	41.0	47.0	35.0	39.0	51.0	40.5	77.0	52.0	45.0	60.0	64.0	50.0	59.0	60.0	70.0
Cloudy	Fair	Clear	Cloudy	Clear	Cloudy	Cloudy	Cloudy	Cloudy	Clear	Rain	Cloudy	Cloudy	Clear	Fair	Cloudy	Clear
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 E	3 SW	2 SW	2 SW	2 E	1 SE	1 E	3 W	1 SE	2 SW	1 SE	1 SW	2 W	3 E	2 E	1 SW	2 SW

- (A) Time of reading thermometers within 15 minute period.
- (B) Reading of mercury thermometer placed on surface of ground at installation.
- (C) Reading of mercury thermometer suspended in air in vicinity of installation.
- (D) Weather at time readings were obtained.
- (E) No distinction made between snow and ice cover.
- (F) Approximate wind intensity and direction at time readings were obtained.

**FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
THERMOMETER  
RECORD OF SUBSURFACE  
TEMPERATURES  
INSTALLATION TW - 1**

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
SUMMARY OF THERMOCOUPLE DATA AT IN

THERMO-COUPLE NO.	DEPTH IN FEET	JUNE 12	JUNE 20	JULY 22	AUGUST 5	AUGUST 19	SEPTEMBER 6	SEPTEMBER 16	OCTOBER 10	OCTOBER 18	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 13	NOVEMBER 19	NOVEMBER 22	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9	DECEMBER 17
0	0.2	78.0	84.0	67.5	76.0	65.5	71.5	57.5	5.0	49.0	49.5	52.5	43.4	47.0	36.5	41.0	43.2	32.0	31.7	31.4	30.9
1	0.8	65.0	76.0	65.5	68.0	65.5	62.0	56.5	51.0	53.5	47.5	51.0	41.5	47.0	37.2	39.7	41.0	33.0	34.0	33.4	33.0
2	1.4	58.5	72.0	67.5	66.5	68.0	61.5	58.5	53.5	55.0	51.5	51.5	43.2	47.5	40.5	41.0	40.2	37.0	36.7	35.8	36.0
3	2.0	56.5	67.0	67.5	67.5	66.5	62.0	57.0	55.0	55.5	52.5	52.0	47.0	50.0	44.0	44.0	43.0	39.5	39.5	38.0	37.5
4	2.7	54.5	61.5	65.0	66.0	65.5	61.2	57.0	56.0	57.7	53.0	52.0	49.2	50.5	46.0	46.0	42.5	40.0	41.4	40.3	39.4
5	3.4	54.0	61.0	65.0	65.0	64.0	60.5	57.0	56.5	56.7	55.0	52.0	50.0	51.0	47.5	47.0	43.5	42.0	43.5	41.4	41.0
6	3.6	53.5	60.0	62.0	64.0	63.5	60.5	57.0	57.0	57.7	54.5	52.0	50.5	51.5	48.0	47.5	44.0	43.5	43.7	42.6	42.0
7	4.2	51.5	58.0	61.0	62.5	63.0	60.0	57.0	57.0	58.0	55.0	52.0	51.4	52.0	48.6	48.0	45.0	43.0	44.6	42.5	42.0
8	4.8	50.5	55.5	59.5	61.0	61.5	60.5	57.0	57.0	58.2	55.5	52.0	52.0	52.5	49.0	49.0	45.8	45.5	45.4	44.2	43.5
9	5.4	49.0	53.5	57.0	59.0	61.0	59.7	56.5	57.0	58.0	56.0	52.5	52.0	53.5	49.5	50.0	45.5	45.5	46.2	45.2	44.9
10	6.0	47.0	51.5	56.0	57.5	60.0	59.5	56.0	56.0	57.5	55.0	53.0	52.0	53.5	50.0	50.5	47.0	45.5	46.9	45.3	45.0
Time (A)		P.M. 4:20	A.M. 10:00	A.M. 10:25	A.M. 11:05	A.M. 9:15	P.M. 1:30	A.M. 9:30	A.M. 10:55	A.M. 9:15	A.M. 9:50	A.M. 10:45	P.M. 4:00	P.M. 3:20	P.M. 2:10	A.M. 9:30	P.M. 3:10	P.M. 1:35	P.M. 3:35	P.M. 2:25	P.M. 2:25
Ground Temperature (B)		74.0	86.0	71.5	90.0	65.0	78.0	65.0	77.0	43.0	53.0	64.0	46.0	46.0	46.0	47.0	46.0	17.0	25.0	32.0	40.0
Air Temperature (C)		74.0	80.0	65.0	75.0	65.0	74.0	64.0	65.0	40.0	57.0	60.0	48.0	45.0	48.0	48.0	49.0	15.0	29.0	32.0	42.0
Witch Box Temperature (D)		69.0	77.0	65.0	65.0	65.0	66.0	62.0	59.0	47.0	53.0	57.0	52.5	46.0	43.0	44.5	46.0	30.0	33.0	33.0	40.0
Indicator Temperature (E)		78.0	90.0	-	-	65.0	-	64.0	-	43.0	54.0	-	60.0	46.0	60.0	61.0	66.0	56.0	56.0	55.0	56.0
Weather (F)		Clear	Clear	Cloudy	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Fair	Clear	Cloudy	Cloudy
Snow Cover (Inches) (G)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	2.0	1.5	0.0
Wind (Beaufort Scale) (H)		3 SW	None	2 NE	-	3 SW	-	2 NE	-	2 E	2 SW	2 SW	2 SW	2 E	2 SW	2 E	2 E	4 NE	2 SW	1 E	2 S

THERMO-COUPLE NO.	DEPTH IN FEET	FEBRUARY 28	MARCH 5	MARCH 17	MARCH 19	MARCH 25	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 29	MAY 2	MAY 6	MAY 9	MAY 13	MAY 16
0	0.2	27.0	31.5	30.0	27.5	37.5	31.0	30.5	30.0	40.5	34.5	37.0	41.0	32.5	39.5	34.5	36.5	52.0	40.0	54.5	49.5
1	0.8	29.5	30.5	29.5	31.0	32.5	31.5	31.0	31.0	31.0	33.5	34.8	32.0	33.7	37.5	37.0	37.5	49.0	41.0	50.0	46.5
2	1.4	30.0	30.5	30.0	31.0	32.2	31.5	31.0	31.0	32.0	33.5	32.6	32.5	33.5	36.5	36.5	37.5	46.0	43.5	46.5	47.0
3	2.0	32.0	32.0	31.0	31.0	32.5	31.5	31.0	31.5	32.0	33.5	33.1	33.0	33.5	35.0	36.7	37.0	42.0	42.0	43.0	44.5
4	2.7	34.0	33.0	32.0	32.0	34.5	33.5	33.0	32.0	32.5	33.5	34.3	33.0	33.7	34.0	37.0	36.5	39.5	41.0	41.0	43.0
5	3.4	35.0	34.0	33.5	33.5	34.8	34.5	33.5	33.0	34.0	35.5	34.6	33.0	35.0	34.5	37.0	36.5	39.0	40.0	40.0	42.0
6	3.6	35.0	35.0	34.0	33.5	35.0	34.5	33.5	33.0	34.0	36.0	34.5	33.0	35.0	36.0	36.0	36.5	38.7	39.5	40.0	43.0
7	4.2	35.5	35.5	34.5	35.5	35.7	35.0	33.5	34.5	-	37.0	33.9	33.5	35.5	35.0	36.0	-	38.5	39.0	39.5	41.0
8	4.8	37.0	36.0	35.0	35.5	36.0	35.5	34.0	34.5	37.0	36.0	35.0	35.5	35.0	35.2	37.0	37.0	39.0	39.0	39.0	40.0
9	5.4	37.0	37.5	35.5	36.0	37.0	37.0	35.5	35.0	36.0	37.5	36.0	36.0	36.0	36.0	35.5	36.5	38.0	37.5	38.5	40.5
10	6.0	38.0	37.5	36.0	36.0	37.0	37.5	35.5	35.5	36.5	37.5	36.8	37.0	37.5	36.5	36.5	36.5	38.5	37.5	38.0	39.5
Time (A)		A.M. 10:45	A.M. 9:50	A.M. 9:20	A.M. 8:40	A.M. 10:30	A.M. 11:05	A.M. 9:00	A.M. 9:15	A.M. 9:30	A.M. 9:00	A.M. 11:10	A.M. 9:15	A.M. 9:15	A.M. 9:20	A.M. 9:00	A.M. 9:15	A.M. 9:15	A.M. 9:20	A.M. 8:45	A.M. 9:20
Ground Temperature (B)		32.0	34.0	32.0	28.0	41.0	28.0	30.0	32.0	47.0	41.0	40.0	44.0	40.0	40.0	40.0	38.0	51.0	40.5	65.0	49.0
Air Temperature (C)		27.0	31.0	29.0	28.0	41.0	28.0	32.0	32.0	45.0	42.0	41.0	50.0	41.0	47.0	38.0	35.0	53.0	40.5	66.0	52.5
Witch Box Temperature (D)		28.0	34.0	32.0	30.0	36.0	32.0	31.0	34.0	43.0	36.0	40.0	41.0	41.0	44.0	34.0	38.0	50.5	41.0	54.0	49.0
Indicator Temperature (E)		40.0	55.0	-	55.0	50.0	55.0	50.0	55.0	58.0	-	50.0	55.0	50.0	-	48.0	50.0	53.0	50.0	55.0	60.0
Weather (F)		Clear	Clear	Fair	Clear	Rain	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Clear	Cloudy	Clear	Cloudy	Cloudy	Cloudy	Cloudy	Clear
Snow Cover (Inches) (G)		0.5	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind (Beaufort Scale) (H)		2 W	2 W	None	3 SW	3 SE	4 W	3 SW	3 SW	3 W	2 SW	2 S	3 SW	2 NE	2 SW	2 E	1 NE	1 E	3 W	1 E	2 SW

LOCATION OF INSTALLATION:

S - W Runway, Turf Area  
Station 15/50, 235' S of E

NOTES:

- (A) Time of reading thermocouples within 15
- (B) Reading of mercury thermometer placed
- (C) Reading of mercury thermometer suspended
- (D) Reading of mercury thermometer placed
- (E) Reading of mercury thermometer placed
- (F) Weather at time readings were obtained
- (G) No distinction made between snow and
- (H) Approximate wind intensity and direction

INVESTIGATION  
BANGOR, MAINE.  
DATA AT INSTALLATION T 693 p

DECEMBER 4	DECEMBER 9	DECEMBER 12	DECEMBER 16	DECEMBER 19	DECEMBER 24	DECEMBER 27	DECEMBER 31	JANUARY 4	JANUARY 7	JANUARY 13	JANUARY 17	JANUARY 23	JANUARY 30	FEBRUARY 6	FEBRUARY 7	FEBRUARY 10	FEBRUARY 13	FEBRUARY 18	FEBRUARY 20	FEBRUARY 25
31.7	31.8	30.9	27.0	30.4	31.6	22.5	26.5	25.0	25.0	17.0	28.5	9.5	29.0	24.0	23.0	25.5	15.5	30.5	25.0	24.0
34.0	33.4	33.0	32.0	31.6	32.1	30.0	31.0	29.0	27.0	24.0	28.5	19.0	29.0	26.5	28.0	26.0	22.0	31.0	28.5	28.1
36.7	35.8	36.0	35.0	34.0	34.1	32.5	31.0	32.0	31.2	28.5	30.0	26.5	30.0	29.5	31.0	30.0	27.5	31.0	32.5	30.5
39.5	38.0	37.5	36.0	36.4	36.3	34.0	33.5	32.5	34.0	30.5	32.4	28.5	32.0	32.0	31.5	31.0	30.0	30.0	33.0	32.0
41.6	40.3	39.4	38.5	37.8	37.6	35.0	37.5	37.0	36.0	35.0	34.0	33.0	34.0	33.5	33.0	33.0	33.0	33.5	33.5	33.6
43.5	42.6	41.0	39.5	40.2	39.4	37.5	38.5	37.5	37.0	35.5	35.6	35.0	35.0	35.0	33.5	35.0	34.0	35.0	35.5	34.4
43.7	42.6	42.0	39.5	40.7	39.8	38.0	38.5	38.0	37.8	37.0	36.0	36.0	35.5	35.5	34.0	35.5	35.0	35.0	35.5	34.6
44.6	42.5	42.0	40.5	41.3	41.0	40.0	39.0	38.5	38.5	37.5	37.0	36.5	36.4	36.2	35.5	35.5	35.5	35.5	37.0	35.5
45.4	44.2	43.5	42.5	42.2	42.2	40.5	40.5	39.0	39.5	38.5	38.0	37.0	37.5	37.0	36.5	36.0	36.0	36.0	37.5	36.0
46.2	45.2	44.9	43.0	43.3	43.2	40.0	42.0	40.5	40.0	39.5	39.0	37.5	38.5	37.5	38.0	37.5	37.0	37.0	38.0	37.0
46.9	45.3	45.2	44.0	44.1	43.6	41.0	42.0	41.5	41.5	40.0	40.0	38.0	39.0	38.5	38.5	39.0	39.0	39.0	39.0	37.2
P.M. 5:35	P.M. 2:25	P.M. 2:35	P.M. 2:00	P.M. 2:40	A.M. 10:10	P.M. 1:45	P.M. 2:10	A.M. 11:30	P.M. 3:25	A.M. 10:00	A.M. 10:50	A.M. 10:40	P.M. 2:00	A.M. 9:55	A.M. 9:50	A.M. 10:15	A.M. 10:30	A.M. 11:05	A.M. 10:30	A.M. 10:30
25.0	32.0	40.0	26.5	30.0	35.0	11.0	16.5	22.0	29.0	14.0	29.0	4.0	30.0	36.5	23.0	25.0	21.0	34.0	10.0	23.0
29.0	32.0	42.0	23.0	34.0	36.0	10.0	11.0	25.0	33.0	12.0	29.0	6.0	27.0	37.5	23.0	26.0	24.0	37.0	12.0	20.5
33.0	33.0	40.0	29.5	30.0	35.0	22.0	17.0	24.0	28.0	20.0	31.0	9.0	30.0	30.0	24.0	28.0	24.0	33.0	20.0	25.0
56.0	55.0	58.0	60.0	54.0	45.0	47.0	55.0	63.0	50.0	50.0	59.0	39.0	45.0	51.0	56.0	60.0	57.0	55.0	-	45.0
Clear	Cloudy	Cloudy	Clear	Clear	Overcast	Clear	Cloudy	Clear	Cloudy	Clear	Clear	Clear	Overcast	Clear	Snow	Clear	Clear	Fair	Clear	Clear
2.0	1.5	0.0	0.0	0.0	4.0	3.0	12.0	2.5	2.0	1.0	2.0	0.5	2.0	3.0	0.5	0.0	0.0	4.0	6.0	0.5
2 SW	1 E	2 S	3 SW	2 SW	2 SW	2 SW	1 E	1 W	2 SW	2 SW	2 W	2 SW	1 E	1 SE	3 SE	3 SW	4 SW	2 SW	4 SW	1 W

MAY 9	MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24
40.0	54.5	49.5	49.5	56.5	60.0	53.0	50.0	58.5	67.0
41.0	50.0	46.5	50.5	49.7	56.2	50.5	50.0	59.0	62.5
43.5	46.5	47.0	50.0	50.0	55.0	52.5	52.0	57.5	62.0
42.0	43.0	44.5	47.0	48.0	51.5	52.5	51.0	55.0	58.5
41.0	41.0	43.0	45.5	46.0	49.5	51.0	50.0	53.0	55.5
40.0	40.0	42.0	44.5	45.0	47.0	50.0	49.0	51.0	53.5
39.5	40.0	43.0	44.0	44.0	46.0	49.5	49.0	50.0	53.0
39.0	39.5	41.0	43.0	43.5	46.0	48.5	48.5	49.5	52.5
39.0	39.0	40.0	42.5	42.5	44.5	47.5	46.5	48.5	51.0
37.5	38.5	40.5	42.0	42.0	43.5	47.0	46.5	47.5	50.0
37.5	38.0	39.5	41.5	41.5	43.0	45.5	46.0	47.0	49.0
A.M. 9:20	A.M. 8:45	A.M. 9:20	A.M. 9:10	A.M. 9:30	A.M. 10:10	A.M. 9:45	A.M. 8:50	A.M. 8:40	A.M. 9:40
40.5	65.0	49.0	48.0	65.0	66.0	52.5	53.0	60.0	74.0
40.5	66.0	52.5	46.0	44.0	69.0	57.0	55.0	61.5	71.0
41.0	54.0	49.0	47.0	57.0	58.0	52.5	53.0	58.0	70.0
50.0	55.0	60.0	50.0	60.0	65.0	67.0	60.0	59.0	70.0
Cloudy	Clear	Clear	Rain	Cloudy	Cloudy	Clear	Cloudy	Cloudy	Clear
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3 W	1 E	2 SW	1 SE	1 SW	2 W	3 E	2 E	1 SW	2 SW

reading thermocouples within 15 minute period.  
of mercury thermometer placed on surface of ground at installation.  
of mercury thermometer suspended in air in vicinity of installation.  
of mercury thermometer placed near rotary switch at time of obtaining thermocouple readings.  
of mercury thermometer placed on potentiometer usually located in automobile.  
at time readings were obtained.  
notation made between snow and ice cover.  
into wind intensity and direction at time readings were obtained.



FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
  
THERMOCOUPLE  
RECORD OF SUBSURFACE  
TEMPERATURES  
INSTALLATION T 693 p  
  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
SUMMARY OF THERMOCOUPLE DATA AT IN

THERMOCOUPLE NO.	DEPTH IN FEET	JUNE 12	JUNE 20	JULY 17	JULY 22	AUGUST 5	AUGUST 19	SEPTEMBER 6	SEPTEMBER 16	OCTOBER 10	OCTOBER 18	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 13	NOVEMBER 19	NOVEMBER 22	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9
0	0.2	75.0	73.0	66.5	66.0	70.0	63.0	66.0	56.5	52.0	58.5	47.0	50.0	46.5	46.5	36.5	40.0	38.0	35.5	32.0	32.0
1	0.8	64.0	71.5	64.5	65.0	67.0	66.5	62.0	58.0	53.0	56.0	48.5	51.5	46.5	47.0	38.0	40.5	37.0	35.0	33.5	33.0
2	1.3	61.5	70.0	67.5	66.0	68.5	67.0	63.5	60.5	55.5	56.0	49.5	50.5	45.7	47.5	40.5	41.0	37.0	36.0	35.0	34.6
3	1.8	61.0	67.0	61.5	66.0	67.0	66.0	65.5	61.0	58.0	57.0	51.0	53.0	48.5	49.0	43.0	43.5	37.0	37.5	37.0	36.1
4	2.3	61.0	63.5	64.5	65.0	66.5	65.0	65.0	60.5	59.5	58.0	53.5	53.5	51.0	49.5	45.5	45.0	38.0	39.5	39.1	38.0
5	2.8	59.5	60.5	65.0	64.0	65.0	63.5	65.5	60.0	60.0	58.0	54.5	53.5	50.7	50.0	46.7	47.0	38.0	40.0	40.4	38.6
6	3.2	58.0	58.5	63.0	62.5	64.0	63.0	64.5	60.0	60.5	58.0	54.5	53.5	50.7	50.0	46.7	47.0	38.0	40.0	40.4	38.6
7	3.9	55.0	56.0	60.0	61.0	62.0	62.0	62.5	59.5	60.0	58.0	54.5	53.5	50.7	49.5	46.5	47.5	39.0	40.5	41.2	39.7
8	4.6	52.5	53.5	58.5	59.5	60.5	60.5	61.0	58.5	58.5	59.5	55.0	53.5	54.2	50.5	46.5	48.5	39.8	42.0	42.6	41.1
9	5.4	50.0	51.5	55.5	57.0	58.5	59.5	59.5	58.0	57.5	59.5	55.0	53.5	54.2	51.0	48.5	49.0	40.8	43.5	43.4	42.6
10	6.0	48.5	49.0	52.5	55.0	56.5	-	57.5	57.0	56.5	60.0	55.0	53.5	55.0	51.5	49.0	49.5	41.2	44.0	44.9	43.9
Time (A)		P.M. 4:15	A.M. 9:45	A.M. 10:50	A.M. 10:40	A.M. 11:00	A.M. 9:10	P.M. 1:15	A.M. 9:25	A.M. 10:45	A.M. 9:00	A.M. 10:15	A.M. 10:30	P.M. 4:15	P.M. 3:00	P.M. 2:30	A.M. 9:50	P.M. 3:50	P.M. 1:55	P.M. 3:55	P.M. 3:10
Ground Temperature (B)		85.0	96.0	78.0	67.0	88.0	67.0	78.0	69.0	78.0	45.0	58.0	64.0	41.0	45.0	48.0	48.5	46.0	15.0	22.0	32.0
Air Temperature (C)		75.0	78.0	78.0	63.0	76.0	65.0	74.0	64.0	65.0	39.0	55.0	58.5	46.0	45.0	46.0	49.0	49.0	15.0	26.0	32.0
Switch Box Temperature (D)		69.0	74.0	74.0	64.0	82.0	65.0	69.0	63.5	66.5	48.0	51.0	60.0	46.0	49.0	45.0	47.0	46.0	21.0	32.0	33.0
Indicator Temperature (E)		78.0	94.0	78.0	-	-	66.0	-	64.0	-	55.0	56.0	-	46.0	43.0	65.0	61.0	65.0	54.0	52.0	55.0
Weather (F)		Clear	Clear	Fair	Cloudy	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Fair	Clear	Rain
Snow Cover (Inches) (G)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.0	1.0
Wind (Beaufort Scale) (H)		3 SW	None	-	2 SW	-	3 SW	-	2 SE	-	3 E	2 SW	2 SW	2 SW	2 SW	2 SW	2 S	2 S	4 SE	1 SW	1 E

THERMOCOUPLE NO.	DEPTH IN FEET	FEBRUARY 18	FEBRUARY 24	FEBRUARY 25	FEBRUARY 28	MARCH 5	MARCH 7	MARCH 11	MARCH 13	MARCH 15	MARCH 17	MARCH 19	MARCH 21	MARCH 25	MARCH 27	MARCH 31	APRIL 3	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 20
0	0.2	31.0	21.0	27.0	27.5	31.5	30.5	30.5	31.5	35.0	32.0	32.0	33.6	34.0	32.0	31.5	32.0	38.0	33.5	36.0	35.5	35.0
1	0.8	31.5	23.5	28.0	28.5	31.5	32.0	32.5	31.5	35.0	32.0	32.0	33.6	33.0	32.0	32.0	32.0	34.0	33.5	34.0	37.0	36.0
2	1.3	31.5	31.0	29.3	29.7	31.7	32.0	32.5	31.0	35.5	32.0	32.0	33.4	33.5	32.0	32.0	32.0	34.0	33.5	34.0	37.5	37.5
3	1.8	32.5	31.0	30.4	31.0	33.0	33.0	33.0	32.0	37.0	32.5	33.0	34.5	34.5	32.0	30.0	32.5	35.5	34.5	34.0	38.0	36.5
4	2.3	34.0	31.5	31.0	32.0	34.0	34.0	34.2	33.0	36.0	33.5	33.5	35.3	35.5	33.0	32.5	32.5	37.0	35.5	35.0	38.5	39.0
5	2.8	35.0	32.2	33.5	33.0	35.5	35.0	35.5	33.5	39.0	34.0	34.5	36.0	36.0	33.5	33.5	33.0	37.0	35.5	35.0	39.5	39.0
6	3.2	35.5	34.0	34.4	33.5	35.5	35.5	36.0	33.5	38.5	34.5	35.0	36.0	36.0	33.5	33.5	33.0	36.0	35.5	35.5	39.5	38.5
7	3.9	36.5	35.0	35.2	34.6	36.5	36.0	36.5	34.5	38.5	35.0	35.5	36.0	36.0	34.0	34.0	34.0	36.0	36.0	35.5	38.5	38.5
8	4.6	37.5	36.0	36.1	35.2	37.0	37.0	37.0	35.0	39.0	35.5	35.5	36.8	37.0	35.0	35.0	35.0	36.0	36.0	36.0	38.5	38.0
9	5.4	38.0	37.0	37.3	36.3	37.5	37.7	38.0	36.0	39.0	36.0	36.5	38.0	37.0	35.5	36.0	35.5	36.0	37.0	36.5	38.0	37.5
10	6.0	39.0	38.5	38.0	37.0	38.5	38.2	38.5	36.5	39.5	37.5	37.5	38.0	38.0	36.5	36.5	36.0	36.5	36.5	37.0	38.0	36.9
Time (A)		A.M. 10:50	A.M. 9:45	A.M. 10:15	A.M. 11:15	A.M. 9:30	A.M. 9:45	A.M. 9:00	A.M. 9:40	A.M. 10:00	A.M. 9:40	A.M. 9:35	A.M. 9:30	A.M. 9:40	A.M. 11:15	A.M. 8:45	A.M. 9:00	A.M. 9:50	A.M. 8:45	A.M. 11:25	A.M. 9:35	
Ground Temperature (B)		31.0	11.0	-	32.0	33.0	35.0	31.0	36.0	43.0	32.0	34.0	34.0	42.0	28.0	32.0	35.0	50.0	53.5	40.0	51.0	
Air Temperature (C)		37.0	10.0	-	26.0	31.0	37.0	28.0	38.0	47.0	29.0	32.0	34.0	43.0	26.0	31.0	32.0	45.0	41.0	41.0	51.0	
Switch Box Temperature (D)		35.0	20.0	33.0	29.0	32.0	30.5	32.0	37.5	36.0	31.0	35.0	34.0	33.0	32.0	33.0	40.0	43.0	41.0	41.0	48.0	
Indicator Temperature (E)		60.0	60.0	45.0	41.0	55.0	60.0	50.0	50.0	47.0	-	60.0	54.0	50.0	55.0	55.0	60.0	45.0	-	50.0	50.0	
Weather (F)		Cloudy	Clear	Clear	Clear	Clear	Cloudy	Clear	Clear	Clear	Fair	Clear	Clear	Rain	Clear	Clear	Clear	Clear	Clear	Clear	Cloudy	
Snow Cover (Inches) (G)		1.0	0.5	7.0	6.0	6.0	4.0	3.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Wind (Beaufort Scale) (H)		2 SW	3 SW	1 W	2 W	2 W	3 SW	3 SE	1 SW	2 W	None	3 SW	2 SW	3 SE	4 W	3 SW	3 SW	3 W	2 SW	2 S	3 SW	

LOCATION OF INSTALLATION:  
B-W Runway, Turf Area  
Station No. 50, 500' S of E

- NOTES:
- (A) Time of reading thermocouples within 15 minutes
  - (B) Reading of mercury thermometer placed on surface
  - (C) Reading of mercury thermometer suspended in air
  - (D) Reading of mercury thermometer placed near rotation
  - (E) Reading of mercury thermometer placed on potential
  - (F) Weather at time readings were obtained.
  - (G) No distinction made between snow and ice cover.
  - (H) Approximate intensity and direction of wind at

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FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
SUMMARY OF THERMOMETER DATA AT INS

THERMO- METER NO.	DEPTH IN FEET	JUNE 12	JUNE 20	JULY 17	JULY 22	AUGUST 5	AUGUST 19	OCTOBER 10	OCTOBER 15	OCTOBER 25	OCTOBER 31	NOVEMBER 7	NOVEMBER 13	NOVEMBER 20	NOVEMBER 27	DECEMBER 2	DECEMBER 4	DECEMBER 9	DECEMBER 12	DECEMBER 16	DECEMBER 25	
1	0.8	60.0	72.0	66.0	64.0	68.0	64.0	50.0	49.0	46.0	50.0	42.0	44.0	37.0	39.0	41.0	34.0	34.0	35.0	-	39.0	35.0
2	1.1	60.0	62.0	66.0	66.0	68.0	64.0	52.0	51.0	48.0	51.0	43.0	45.0	39.0	39.0	41.0	36.0	36.0	36.0	35.0	36.0	36.0
3	2.1	56.0	60.0	64.0	65.0	64.0	64.0	55.0	55.0	50.0	50.0	46.5	47.0	45.0	45.0	42.0	41.0	40.0	39.0	38.5	36.0	37.0
4	2.8	51.0	56.0	60.0	60.0	63.0	61.0	56.0	56.0	52.0	50.5	50.0	48.5	47.0	46.0	45.0	44.0	43.5	42.0	40.5	41.0	40.0
5	4.2	50.0	54.5	59.0	60.0	60.0	60.0	57.0	55.0	53.0	50.5	51.5	49.0	48.0	47.5	46.0	45.5	45.0	43.5	43.0	42.5	42.0
6	5.2	45.0	55.0	57.0	57.0	59.0	59.0	56.0	55.0	53.0	50.5	50.0	50.0	49.0	48.5	47.0	46.5	46.0	45.0	44.0	43.5	43.0
7	6.2	47.0	51.0	55.0	56.0	57.0	58.0	56.0	55.0	54.0	53.0	53.0	50.0	49.5	49.0	48.0	47.0	46.5	45.0	45.0	45.0	44.0
8	8.0	45.0	49.0	52.0	52.0	55.0	56.0	56.0	55.0	54.0	53.0	53.0	51.5	51.0	51.0	51.0	49.0	49.0	48.0	48.0	47.0	46.0
Time (A)		P.M. 4:25	A.M. 10:10	A.M. 10:15	A.M. 10:55	A.M. 11:15	A.M. 9:30	A.M. 11:00	A.M. 9:10	A.M. 10:00	A.M. 11:05	P.M. 4:05	P.M. 3:30	P.M. 2:05	A.M. 9:15	P.M. 3:35	A.M. 11:25	P.M. 5:45	P.M. 2:50	P.M. 2:40	P.M. 2:05	P.M. 2:50
Ground Temperature (B)		75.0	86.0	72.0	72.0	90.0	85.0	79.0	45.0	54.0	67.0	46.0	46.0	47.0	47.0	46.0	39.0	25.0	30.0	43.0	27.0	31.0
Air Temperature (C)		74.0	80.0	78.0	81.0	76.0	69.0	68.0	40.0	55.0	62.5	48.0	45.0	49.0	49.0	46.0	35.0	29.0	32.0	40.0	25.0	31.0
Weather (D)		Clear	Clear	Fair	Cloudy	Clear	Clear	Clear	Cloudy	Fair	Cloudy	Fair	Clear	Clear	Cloudy	Clear	Cloudy	Clear	Rain	Clear	Clear	Clear
Snow Cover (Inches) (E)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind (Beaufort Scale) (F)		3 SW	None	-	2 SE	-	3 SW	-	2 E	2 SW	2 SW	2 SW	2 E	2 SW	2 S	2 S	4 NE	2 SW	1 E	2 S	3 SW	3 SW

THERMO- METER NO.	DEPTH IN FEET	MARCH 17	MARCH 19	MARCH 25	MARCH 27	MARCH 31	APRIL 5	APRIL 7	APRIL 10	APRIL 14	APRIL 18	APRIL 22	APRIL 25	APRIL 28	MAY 2	MAY 6	MAY 9	MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	
1	0.8	27.0	31.0	35.0	31.0	31.0	31.0	34.0	32.0	35.0	33.0	32.0	36.0	37.0	35.0	44.0	41.0	45.0	43.0	47.0	49.0	56.0	56.0
2	1.1	30.0	31.0	31.0	31.0	32.0	31.0	32.0	32.0	34.0	34.0	32.0	36.0	36.0	36.0	44.0	42.0	45.0	44.0	46.0	50.0	54.0	54.0
3	2.1	32.0	32.0	31.5	32.0	32.0	32.0	32.0	32.0	33.5	34.0	36.0	36.0	36.0	36.0	44.0	42.0	45.0	44.0	46.0	47.5	51.0	51.0
4	2.8	34.0	33.5	33.0	33.0	33.5	33.5	32.5	34.0	34.0	34.0	35.0	36.0	37.0	36.0	39.0	39.0	40.0	41.0	43.0	45.0	46.0	46.0
5	4.2	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	35.0	36.0	37.0	36.0	39.0	39.0	40.0	41.0	42.0	43.0	44.0	44.0
6	5.2	36.0	36.0	35.0	36.0	35.5	35.5	35.5	35.0	35.0	35.0	35.0	36.0	37.0	36.0	39.0	39.0	40.0	41.0	42.0	43.0	44.0	44.0
7	6.2	37.0	36.0	36.0	36.0	36.0	36.0	36.5	36.0	36.0	36.0	36.0	36.0	37.0	36.0	39.0	39.0	40.0	41.0	42.0	43.0	44.0	44.0
8	8.0	-	-	-	-	-	-	38.0	37.0	37.0	37.0	38.0	37.0	37.5	37.0	37.0	39.0	40.0	40.0	41.0	42.0	43.0	44.0
Time (A)		A.M. 9:25	A.M. 8:50	A.M. 9:50	A.M. 11:10	A.M. 9:00	A.M. 9:20	A.M. 9:45	A.M. 9:00	A.M. 11:15	A.M. 9:50	A.M. 9:00	A.M. 9:00	A.M. 9:20	A.M. 9:10	A.M. 9:40	A.M. 9:30	A.M. 8:30	A.M. 9:30	A.M. 9:30	A.M. 9:45	A.M. 10:10	
Ground Temperature (B)		30.0	28.0	42.0	28.0	30.0	32.0	47.0	41.0	40.0	44.0	40.0	48.0	40.0	50.0	51.0	40.5	-	49.0	46.0	69.0	66.0	
Air Temperature (C)		29.0	28.0	43.0	26.0	29.0	30.0	45.0	42.0	41.0	50.0	41.0	47.0	50.0	55.0	55.0	40.5	-	50.0	46.0	66.0	69.0	
Weather (D)		Fair	Clear	Rain	Clear	Clear	Clear	Clear	Clear	Cloudy	Fair	Clear	Cloudy	Clear	Cloudy	Cloudy	Cloudy	Clear	Clear	Rain	Clear	Clear	
Snow Cover (Inches) (E)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Wind (Beaufort Scale) (F)		None	3 E	3 SE	4 W	3 SW	3 SW	3 W	2 SW	2 S	3 SW	2 NE	2 SW	2 E	1 NE	1 S	1 W	1 E	2 SW	1 SE	1 SW	2 W	

LOCATION OF INSTALLATION:

E-W Runway, Turf Area  
Station 13 of 60, 215' S of E

NOTES:

- (A) Time of reading thermometers within 15 minutes
- (B) Reading of mercury thermometer placed on surface
- (C) Reading of mercury thermometer suspended in air
- (D) Weather at time readings were obtained.
- (E) No distinction made between snow and ice cover
- (F) Appropriate wind intensity and direction at time

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FROST INVESTIGATION  
FIELD, BANGOR, MAINE.

TEMPERATURE DATA AT INSTALLATION TW-4

DECEMBER 4	DECEMBER 9	DECEMBER 12	DECEMBER 16	DECEMBER 19	DECEMBER 20	DECEMBER 27	DECEMBER 31	1947 JANUARY 4	JANUARY 7	JANUARY 11	JANUARY 23	JANUARY 30	FEBRUARY 4	FEBRUARY 7	FEBRUARY 10	FEBRUARY 13	FEBRUARY 18	FEBRUARY 20	FEBRUARY 25	FEBRUARY 26	MARCH 5
34.0	35.0	-	32.0	25.0	30.0	20.0	29.0	26.0	26.0	23.0	20.0	20.0	26.0	27.0	26.0	22.0	30.0	29.0	25.0	25.0	29.0
36.0	34.0	35.0	34.0	26.0	32.0	22.0	32.0	31.0	29.0	26.0	24.0	29.0	27.0	28.0	28.0	25.0	30.0	29.0	27.0	27.0	29.0
40.0	39.0	38.5	38.0	37.0	36.0	36.5	35.0	35.0	34.0	32.5	31.0	31.0	31.0	31.0	31.0	30.5	31.0	31.5	31.0	30.5	31.0
43.5	42.0	40.5	41.0	40.0	40.0	39.0	38.5	38.0	36.5	36.5	35.0	34.5	34.0	34.0	34.0	34.0	34.0	34.0	34.0	33.5	33.5
45.0	43.5	43.0	42.5	42.0	41.0	40.5	40.0	40.0	39.0	38.5	36.0	36.0	36.0	36.0	36.0	36.0	35.0	35.5	35.0	35.5	35.0
46.0	45.0	44.0	43.5	44.0	42.0	41.5	41.0	40.5	40.0	40.0	38.0	38.0	37.0	37.0	37.0	37.0	36.0	37.0	36.0	36.0	36.0
46.5	45.0	45.0	45.0	44.0	44.0	43.0	42.5	42.0	41.0	41.0	39.0	39.0	38.0	37.0	38.0	38.0	38.0	38.0	37.0	37.0	37.0
49.0	48.0	48.0	47.0	46.0	46.0	45.5	45.0	45.0	44.0	43.0	-	-	-	-	-	-	-	-	-	-	-
P.M. 5:45	P.M. 2:50	P.M. 2:40	P.M. 2:05	P.M. 2:50	A.M. 10:05	P.M. 1:50	P.M. 2:00	A.M. 10:50	P.M. 5:00	A.M. 10:05	P.M. 1:50	P.M. 1:45	A.M. 9:40	A.M. 10:00	A.M. 11:00	P.M. 10:45	A.M. 11:20	A.M. 10:45	A.M. 10:45	A.M. 10:55	A.M. 10:00
25.0	32.0	43.0	27.0	51.0	35.0	11.0	17.0	20.0	24.0	14.0	8.0	30.0	36.0	26.0	25.0	23.0	31.0	10.0	23.0	32.0	34.0
29.0	32.0	40.0	23.0	51.0	35.0	10.0	11.0	22.0	31.0	12.0	12.0	27.0	37.0	25.0	26.0	23.0	37.0	12.0	20.0	27.0	31.0
Clear	Rain	Clear	Clear	Clear	Overcast	Clear	Cloudy	Clear	Cloudy	Clear	Clear	Overcast	Clear	Snow	Snow	Clear	Fair	Clear	Clear	Clear	Clear
2.0	1.5	0.0	0.0	0.0	4.0	3.0	12.0	2.0	1.0	1.0	0.5	2.0	1.0	0.2	0.0	0.0	6.0	1.0	0.5	0.5	1.0
2 SW	1 E	2 S	3 NW	2 NW	2 SW	2 NW	1 NE	1 W	2 SW	2 NW	2 NW	1 E	1 SE	3 NE	3 SW	4 NW	2 NW	4 NW	1 W	2 W	2 W

MAY 13	MAY 16	MAY 20	MAY 23	MAY 27	JUNE 4	JUNE 10	JUNE 17	JUNE 24
45.0	43.0	47.0	49.0	54.0	49.0	49.0	54.0	61.0
45.0	44.0	46.0	50.0	54.0	50.0	50.0	56.0	61.0
44.0	45.0	46.0	47.5	51.0	51.5	50.5	55.0	58.0
41.0	43.0	44.0	45.0	46.0	48.0	49.0	51.0	53.0
41.0	42.0	43.0	44.0	45.0	48.0	48.5	50.0	51.5
40.0	41.0	42.0	43.0	44.0	46.5	47.0	47.0	50.0
40.0	41.0	41.5	42.0	43.0	46.0	46.0	46.0	49.0
40.0	40.0	41.0	41.0	42.0	44.0	45.0	45.0	47.5
A.M. 8:30	A.M. 9:30	A.M. 9:50	A.M. 9:45	A.M. 10:20	A.M. 9:55	A.M. 9:00	A.M. 8:30	A.M. 9:45
-	49.0	48.0	65.0	66.0	52.5	53.0	60.0	71.0
-	50.0	46.0	64.0	69.0	57.0	55.0	61.5	72.0
Clear	Clear	Rain	Cloudy	Cloudy	Clear	Fair	Cloudy	Clear
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1 E	2 SW	1 SE	1 NW	2 W	3 E	2 E	1 NW	2 SW

Time of reading thermometers within 15 minute period.  
 Reading of mercury thermometer placed on surface of ground at installation.  
 Reading of mercury thermometer suspended in air in vicinity of installation.  
 Weather at time readings were obtained.  
 Distinction made between snow and ice covers.  
 Precipitate wind intensity and direction at time readings were obtained.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 THERMOMETER  
 RECORD OF SUBSURFACE  
 TEMPERATURES  
 INSTALLATION TW-4  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



2

TABLE 12

# SUMMARY OF PLATE BEARING TESTS 1946-1947

TEST AREA D					TEST AREA A		
TEST NO.	DATE	LOAD (pounds)	DEFLECTION (inches)	AVG. DEFLECTION (inches)	TEST NO.	DATE	LOAD (pounds)
PBT 122	29 Oct 1946	20,000	0.0695	0.0775	PBT 110	28 Oct 1946	18,000
123	"	"	0.0735		111	"	20,000
124	"	"	0.0650		112	"	"
125	"	"	0.0890		113	"	"
126	"	"	0.0795		114	"	"
127	"	"	0.0850		115	"	"
128	"	"	0.0750		116	"	"
129	"	"	0.0965		117	"	"
130	"	"	0.0610		118	"	"
131	"	"	0.0995		119	"	"
132	"	"	0.0880		120	29 Oct 1946	"
133	"	"	0.0865		121	"	"
137	24 Mar 1947	20,000	0.1395		0.1463	134	21 Mar 1947
138	"	"	0.1405	135		"	"
139	"	"	0.1590	136		"	"
143	1 Apr 1947	20,000	0.0895	0.0950	140	28 Mar 1947	20,000
144	"	"	0.0835		141	"	"
145	"	"	0.1120		142	"	"
149	8 Apr 1947	20,000	0.0655	0.0937	146	4 Apr 1947	20,000
150	"	"	0.1040		147	"	"
151	"	"	0.1115		148	"	"
159	15 Apr 1947	20,000	0.0815	0.0768	155	11 Apr 1947	20,000
160	"	"	0.0800		156	"	"
161	"	"	0.0690		157	"	"
165	22 Apr 1947	20,000	0.1235	0.1108	162	18 Apr 1947	20,000
166	"	"	0.1470		163	"	"
167	"	"	0.0620		164	"	"
174	6 June 1947	20,000	0.0775	0.0928	168	25 Apr 1947	20,000
175	"	"	0.1010		169	"	"
176	"	"	0.1000		170	"	"
181	13 June 1947	20,000	0.0705	0.0747	177	6 June 1947	20,000
182	"	"	0.0905		178	"	"
183	"	"	0.0630		179	"	"
190	20 June 1947	20,000	0.0690	0.0708	184	13 June 1947	20,000
191	"	"	0.0805		185	"	"
192	"	"	0.0630*		186	"	"
198	27 June 1947	20,000	0.0870	0.0633	187	20 June 1947	20,000
199	"	"	0.0570		188	"	"
200	"	"	0.0550		189	"	"
204	2 July 1947	20,000	0.0815	0.0736	195	27 June 1947	20,000
205	"	"	0.0555*		196	"	"
206	"	"	0.0855		197	"	"
207	"	"	0.0720		201	2 July 1947	20,000
					202	"	"
					203	"	"

A

# BEARING TESTS

TEST AREA E			
DATE	LOAD (pounds)	DEFLECTION (inches)	AVG. DEFLECTION (inches)
28 Oct 1946	18,000	0.0675	0.0888
	20,000	0.0680	
	"	0.0855	
	"	0.0915	
	"	0.1345	
	"	0.0730	
	"	0.0685	
	"	0.0775	
	"	0.0780	
	"	0.0740	
29 Oct 1946	"	0.0950	
"	"	0.1315	
21 Mar 1947	21,200	0.1445	0.1483
"	"	0.1485	
"	"	0.1520	
28 Mar 1947	20,000	0.1350	0.1190
"	"	0.1310	
"	"	0.0910	
4 Apr 1947	20,000	0.1395	0.1390
"	"	0.1715	
"	"	0.1060	
11 Apr 1947	20,000	0.1065	0.1397
"	"	0.1775	
"	"	0.1350	
18 Apr 1947	20,000	0.1005	0.1128
"	"	0.1560	
"	"	0.0820	
25 Apr 1947	20,000	0.0870	0.1115
"	"	0.1275	
"	"	0.1200	
6 June 1947	20,000	0.0920	0.1140
"	"	0.0975	
"	"	0.1525	
13 June 1947	20,000	0.1110	0.1018
"	"	0.1150	
"	"	0.0795	
20 June 1947	20,000	0.0915	0.0750
"	"	0.0770	
"	"	0.0565	
27 June 1947	20,000	0.1165	0.1063
"	"	0.0995	
"	"	0.1030	
2 July 1947	20,000	0.0915	0.0862
"	"	0.0855	
"	"	0.0815*	

**NOTES:**

\* Questionable reading.

All tests conducted with a 30" diameter test plate.

All tests in each test area were made within 25' square sections.

For location of individual tests, see Plate 3.

Materials underlying test plate are as follows:

Area D 0.4' Bituminous Concrete pavement  
4.0' Sand and gravel base  
- Silty clay subgrade

Area E 0.4' Bituminous Concrete pavement  
3.2' Sand and gravel base  
- Silty clay subgrade

These depths represent the average logs of 5 auger holes excavated within each 25' square.

**FROST INVESTIGATION**  
**DOW FIELD, BANGOR, MAINE**  
  
**SUMMARY**  
**OF**  
**PLATE BEARING TESTS**  
**TEST AREAS D AND E**  
  
**SOILS LABORATORY**  
**NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947**

**TABLE 13**

# SUMMARY OF PLATE BE 1946-1947

TEST AREA	TEST NO.	DATE	TYPE OF TEST	STATION LOCATION	DEPTH (feet)	NEAREST EXPLORATION	MATERIAL UNDERLYING TEST PLATE (thickness in feet)		
							PAVEMENT	BASE	SUBGRADE
F	PBT 108	23 Oct 1946	Rupture	2/11	29 N of E T/yy A	T969pa	0.7 P.C.C.	1.8 GW	CL
F	PBT 152	9 Apr 1947	"	2/11	21 S " " "	T1003pa	0.7 P.C.C.	1.7 GW	CL
F	PBT 153	10 Apr 1947	"	2/09	51 N " " "	T1002pa	0.7 P.C.C.	1.5 GW	CL
F	PBT 171	4 June 1947	"	2/11	9 S " " "	T1003pa	0.7 P.C.C.	1.7 GW	CL
F	PBT 172	5 June 1947	"	2/11	39 S " " "	T1006pa	0.7 P.C.C.	1.3 GW	CL
F	PBT 193	24 June 1947	"	2/09	59 S " " "	T1006pa	0.7 P.C.C.	1.5 GW	CL
F	PBT 109	25 Oct 1946	Rupture Modulus	2/14	28 N " " "	T969pa			
F	PBT 154	11 Apr 1947		2/11	19 S " " "	T1003pa		1.8 GW	CL
F	PBT 158	14 Apr 1947		2/09	49 N " " "	T1002pa		1.7 GW	CL
F	PBT 173	5 June 1947		2/09	41 S " " "	T1006pa		1.5 GW	CL
F	PBT 180	10 June 1947		2/09	12 S " " "	T1003pa		1.3 GW	CL
F	PBT 194	26 June 1947		2/12	62 S " " "	T1006pa		1.7 GW	CL

A

# PLATE BEARING TESTS 1946-1947

TEST PLATE (feet)	DIAMETER OF TEST PLATE (inches)	TOTAL LOAD IN POUNDS			MAX. RATIO OF NORMAL TO FROST MELTING PERIOD LOAD FOR 0.10" DEFLECTION	AVG. THICKNESS OF PAVEMENT PLUS BASE (feet)	MAX. DEPTH OF FROST PENETRATION (feet)	THICKNESS OF FROZEN SUBGRADE (feet)
		0.05 inch Deflection	0.10 inch Deflection	0.20 inch Deflection				
SUBGRADE								
CL	24	16,500	28,000	45,000	2.1	2.2	3.7	
CL	24	17,500	25,000*	37,000				
CL	24	17,500	32,000	53,000				
CL	24	32,000	53,000*	(D)				
CL	24	11,000	28,500	49,000				
CL	24	31,000	47,500	(D)				
CL	30	7,000	11,500*	19,500	1.5	2.2	3.7	
CL	30	5,500	9,500	16,500				
CL	30	4,000	7,500*	14,000				
CL	30	4,000	8,000	11,500				
CL	30	5,000	9,500	16,500				
CL	30	6,500	10,500	18,000				

**NOTES:**

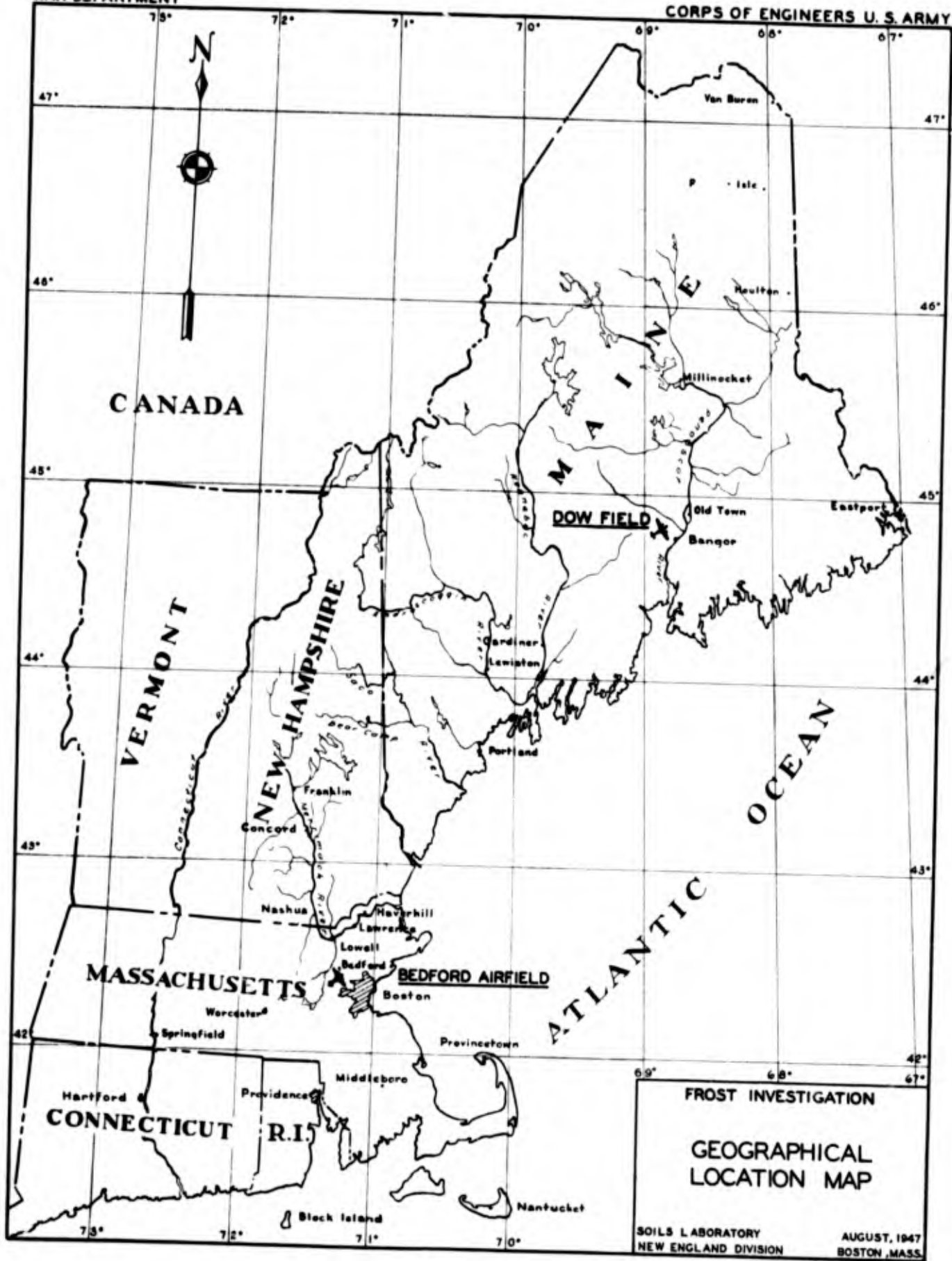
(D) Deflection not reached with maximum available load.

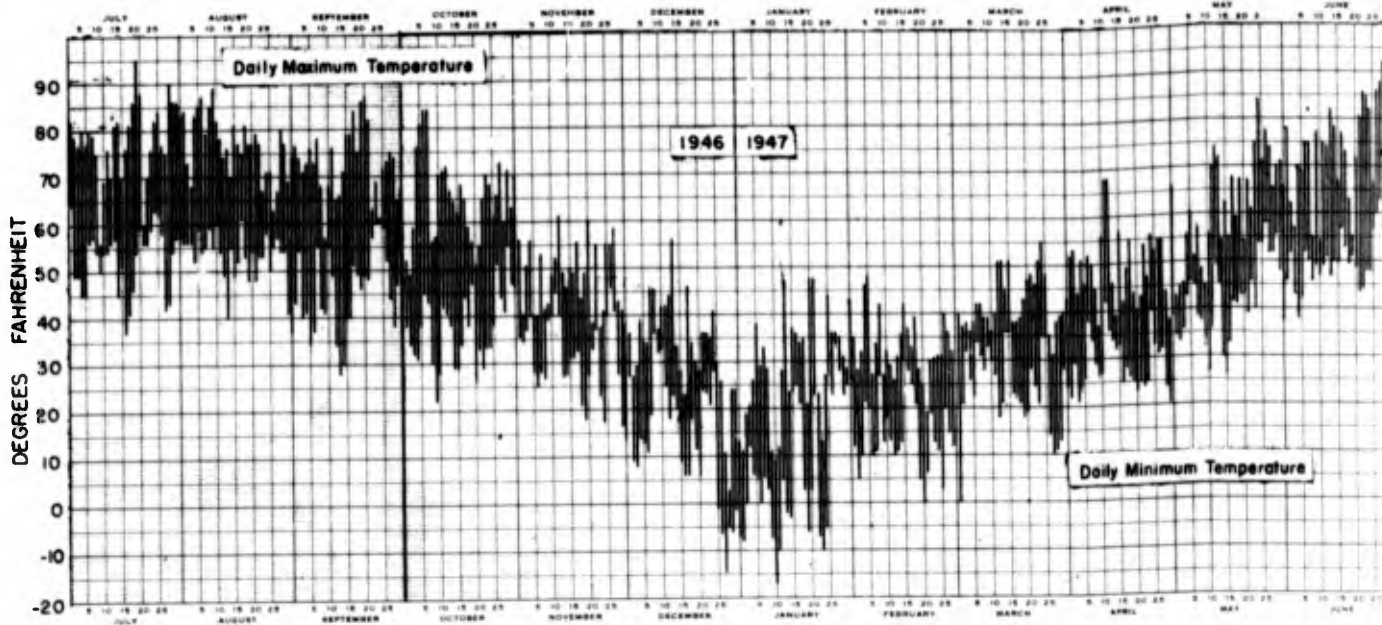
\* Values used to determine maximum ratios.

**FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
SUMMARY  
OF  
PLATE BEARING TESTS  
TEST AREA F**

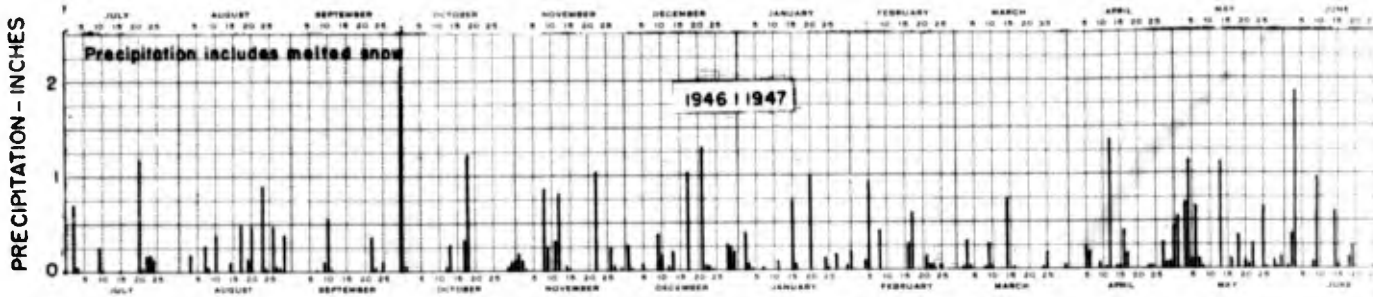
**SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947**

**TABLE 14**

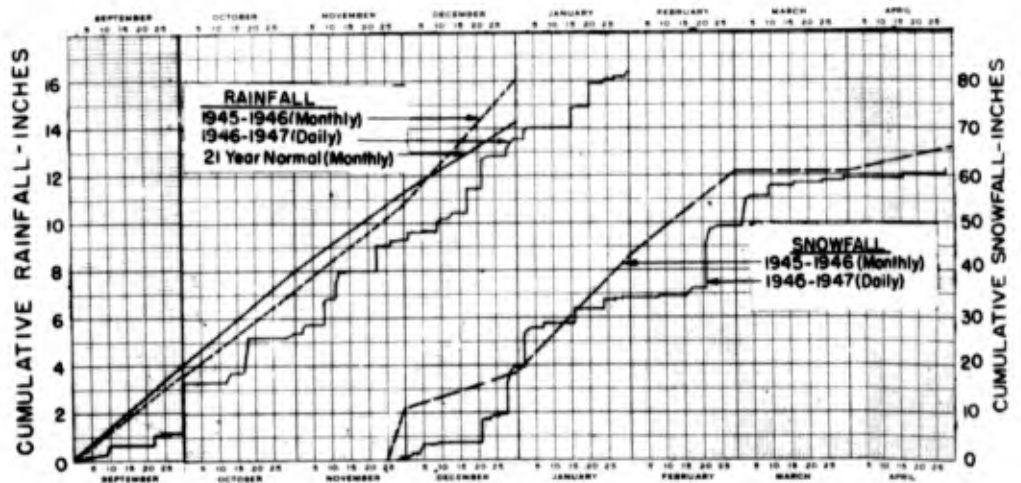




**DAILY TEMPERATURE**  
FIG. 1



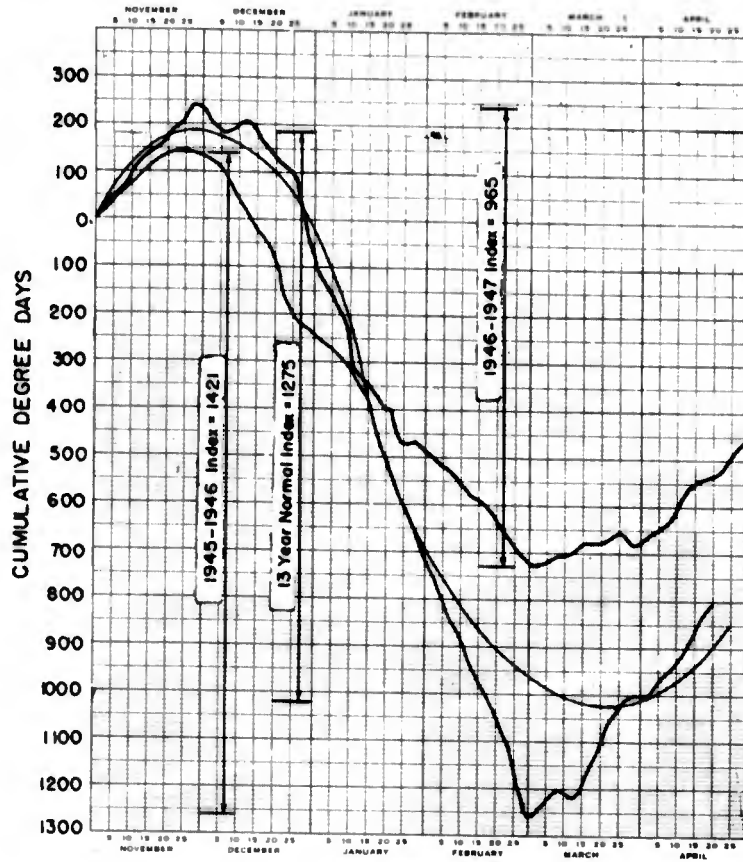
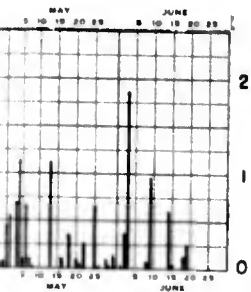
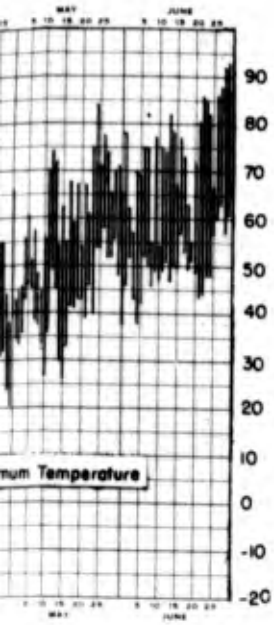
**DAILY PRECIPITATION**  
FIG. 2



**CUMULATIVE RAINFALL AND SNOWFALL**  
FIG. 3

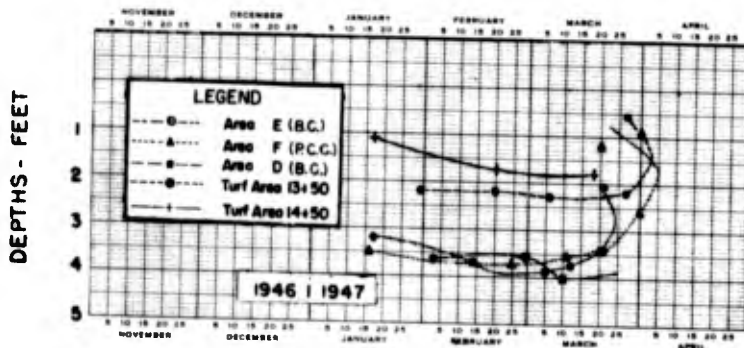
SOURCE OF  
FIG. 1  
U.S. Wea  
1 Jul  
N.E.D. T  
lobe  
FIG. 2  
C.A.A.  
FIG. 3  
C.A.A. W  
194  
U.S. Wea  
Mon  
pre  
FIG. 4  
N.E.D.  
& 15  
U.S. Wea  
Mon

A



**FREEZING INDEX**

FIG. 4



**FROST PENETRATION**

FIG. 5

**NOTES**

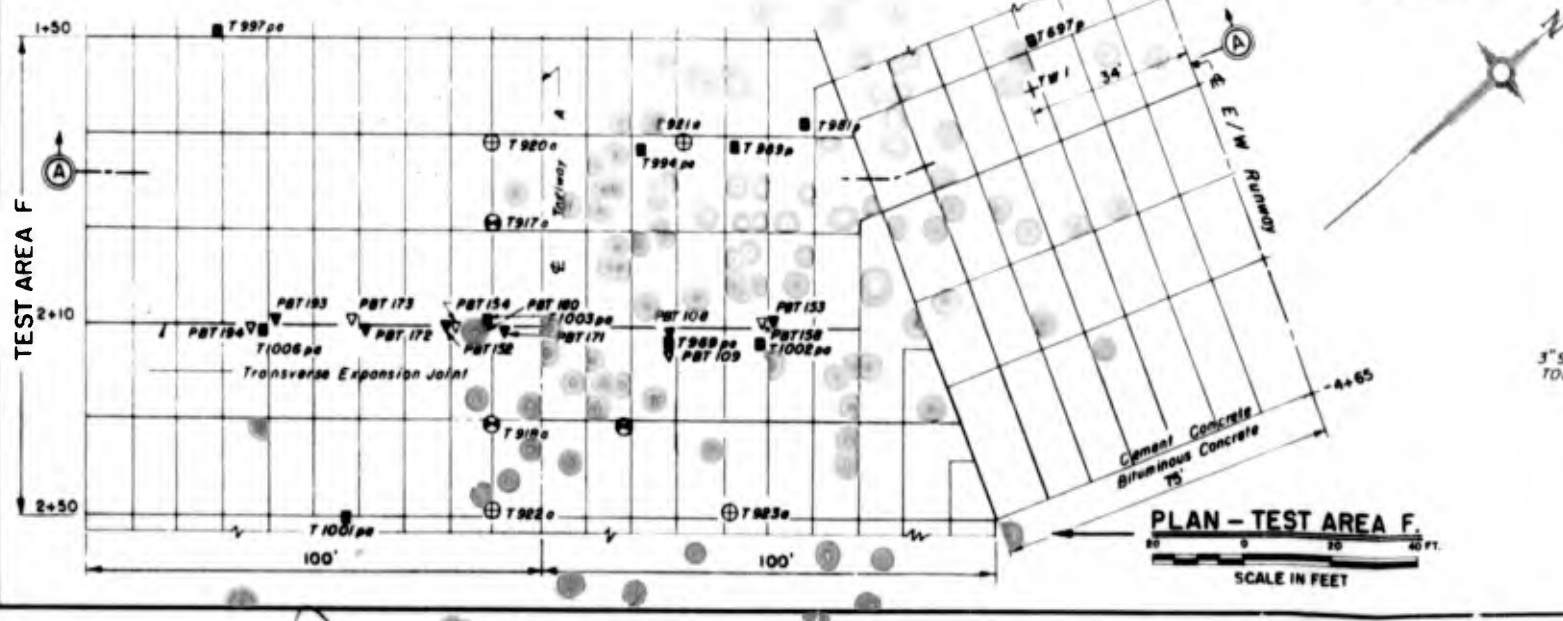
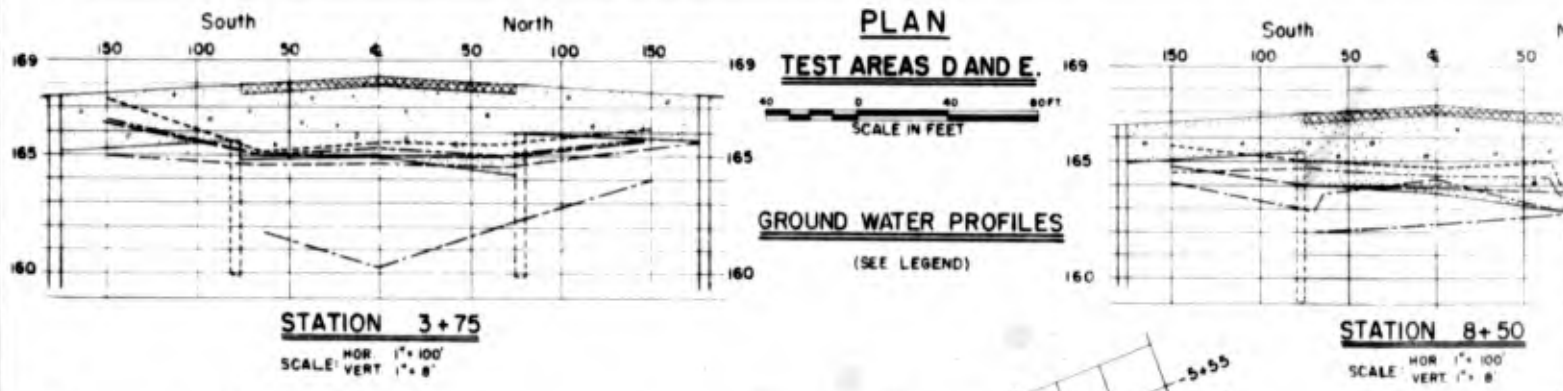
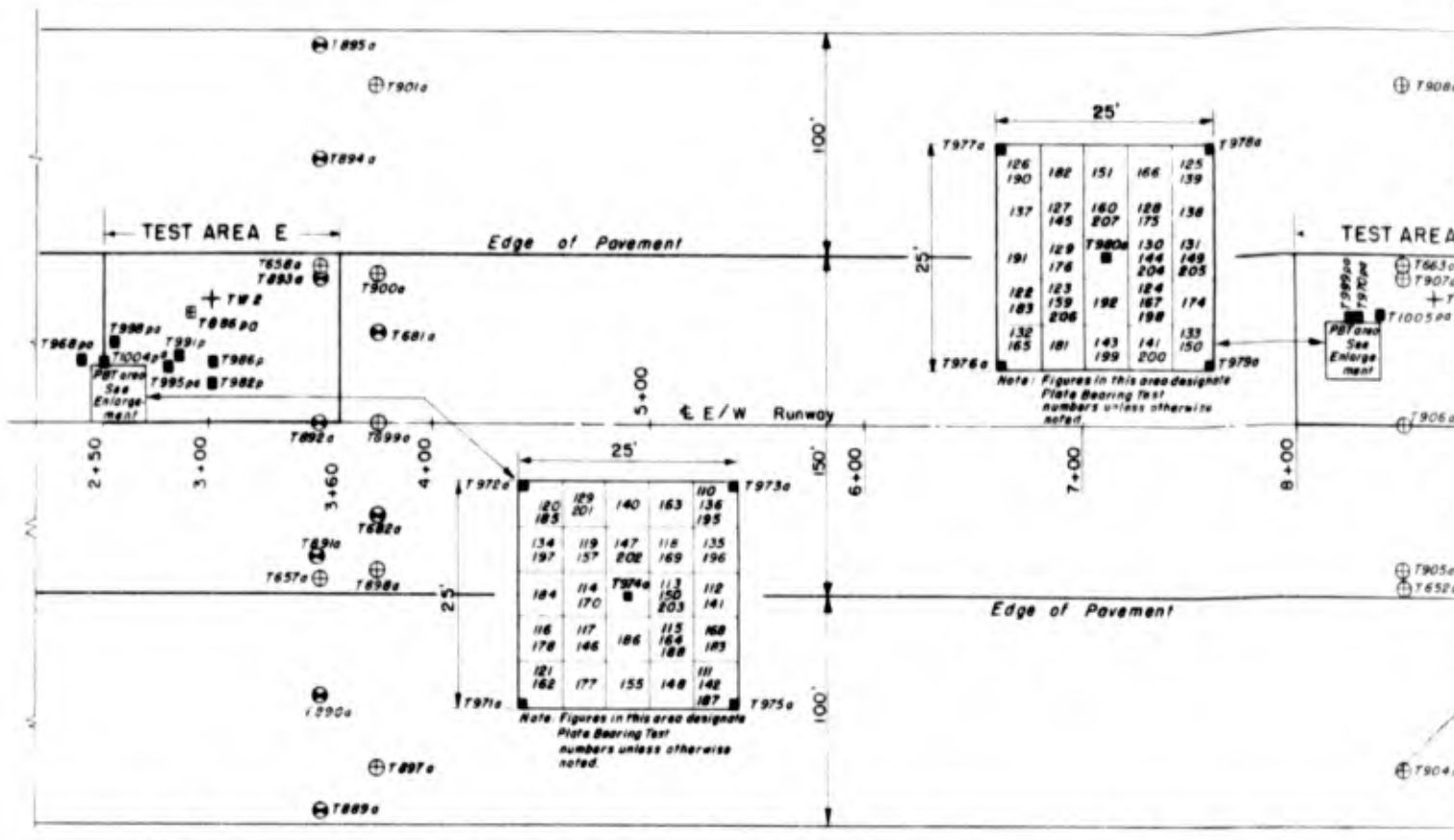
**SOURCE OF DATA**

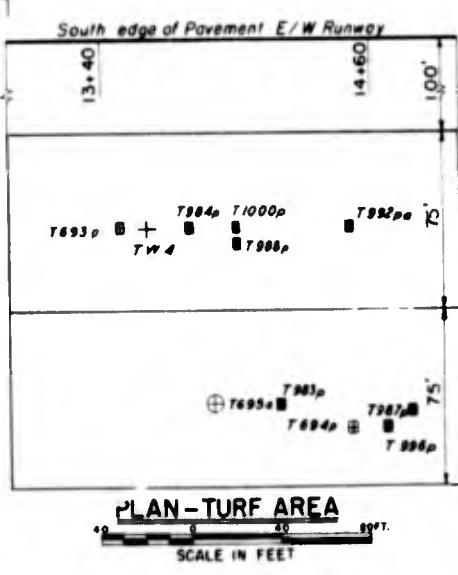
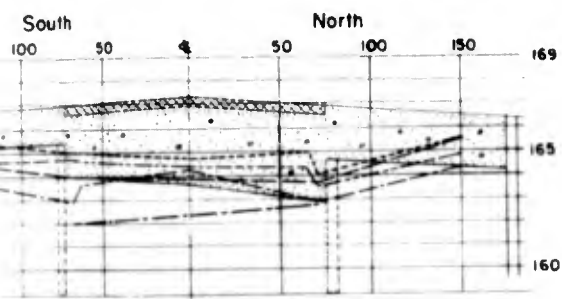
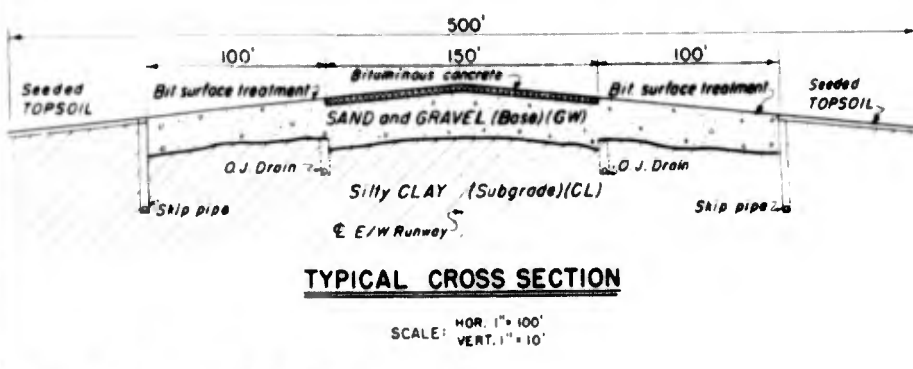
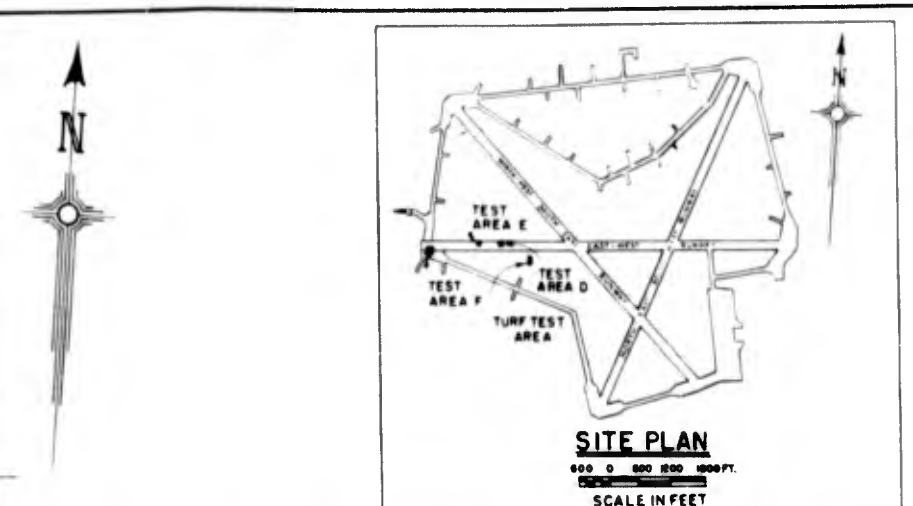
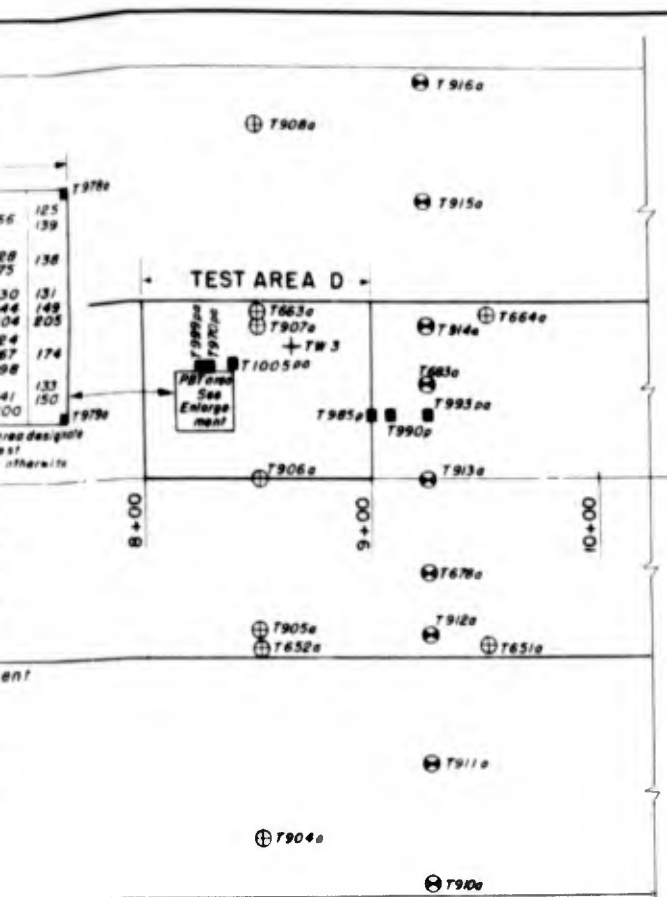
- FIG. 1  
U.S. Weather Bureau (Bangor Hydro-Elec. Co.)  
1 July - 10 October, 1946.  
N.E.D. Thermograph, continuous record, 11 October 1946 - 1 July 1947.
- FIG. 2  
C.A.A. Weather Bureau (Dow Field)
- FIG. 3  
C.A.A. Weather Bureau (Dow Field) for 1946-1947 curves.  
U.S. Weather Bureau (Bangor Hydro-Elec. Co.)  
Monthly mean precipitation for normal precipitation curve.
- FIG. 4  
N.E.D. Thermograph records for 1945-1946 & 1946-1947 curves.  
U.S. Weather Bureau (Bangor Hydro-Elec. Co.)  
Monthly mean temperature for normal curve.

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE

WEATHER AND FROST  
PENETRATION DATA

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST, 1947



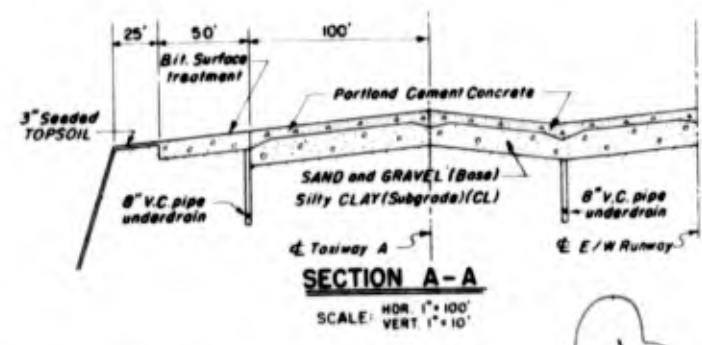
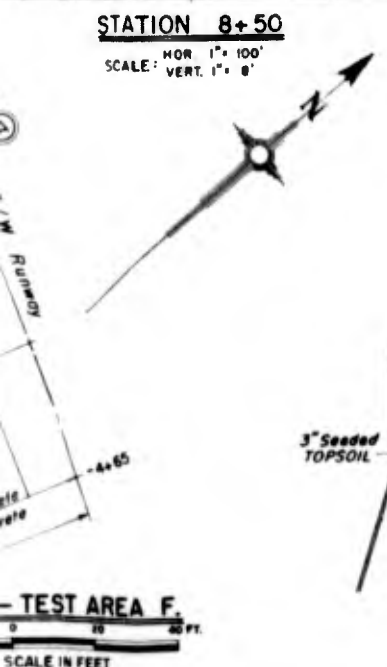


**LEGEND**

- ▼ PBT (RUPTURE)
- ⊕ TEST PIT
- ⊙ OBSERVATION WELL IN SUBGRADE
- ⊕ OBSERVATION WELL IN GRAVEL BASE
- ⊕ THERMOCOUPLE INSTALLATION
- ⊕ THERMOMETER WELL
- ▼ PBT (SUBGRADE MODULUS)

**Ground Water Profiles**

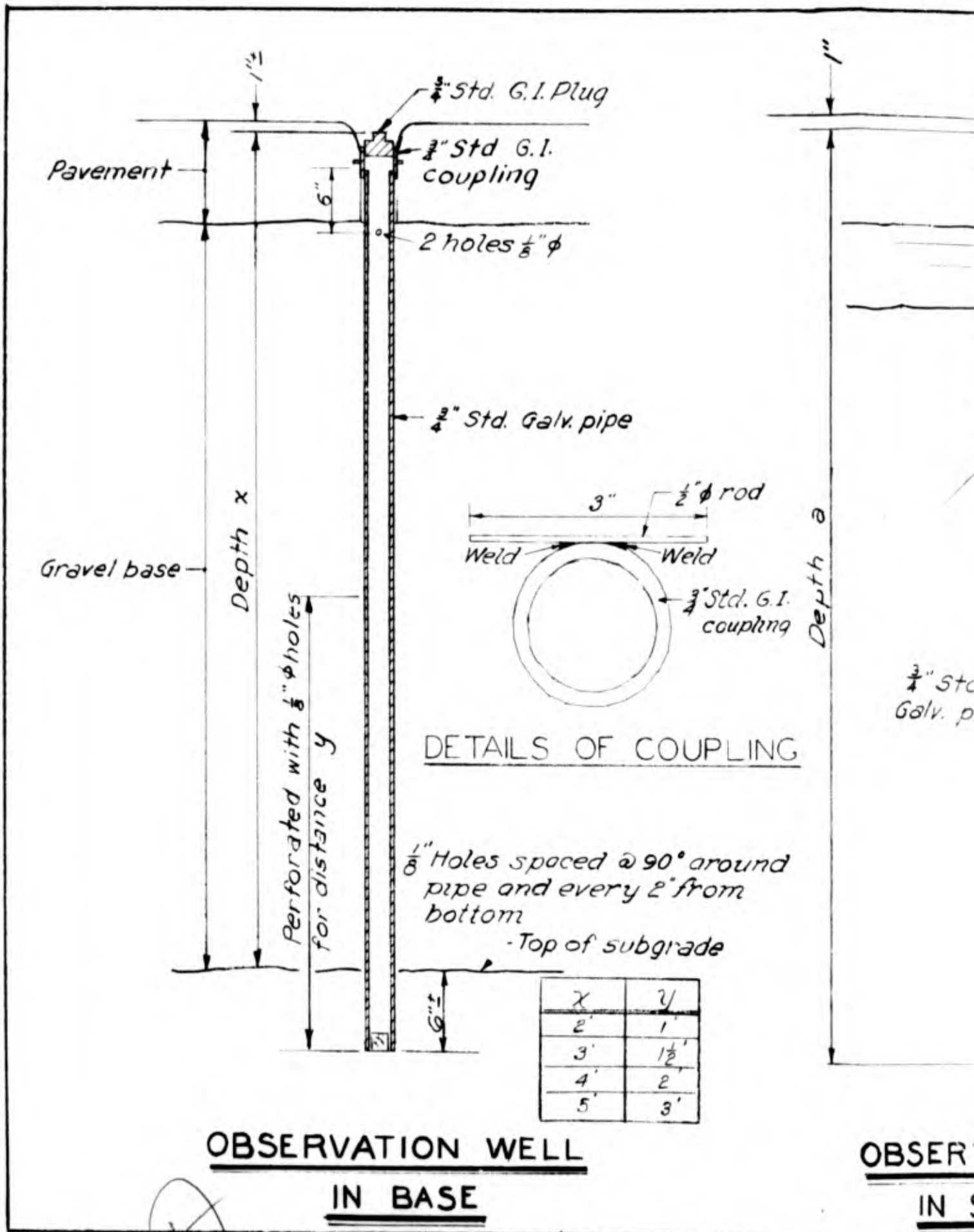
Legend	Date
-----	12 June 1946
-----	14 April 1947
-----	13 December 1946
-----	20 January 1947
-----	5 May 1947
-----	17 June 1947



FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.

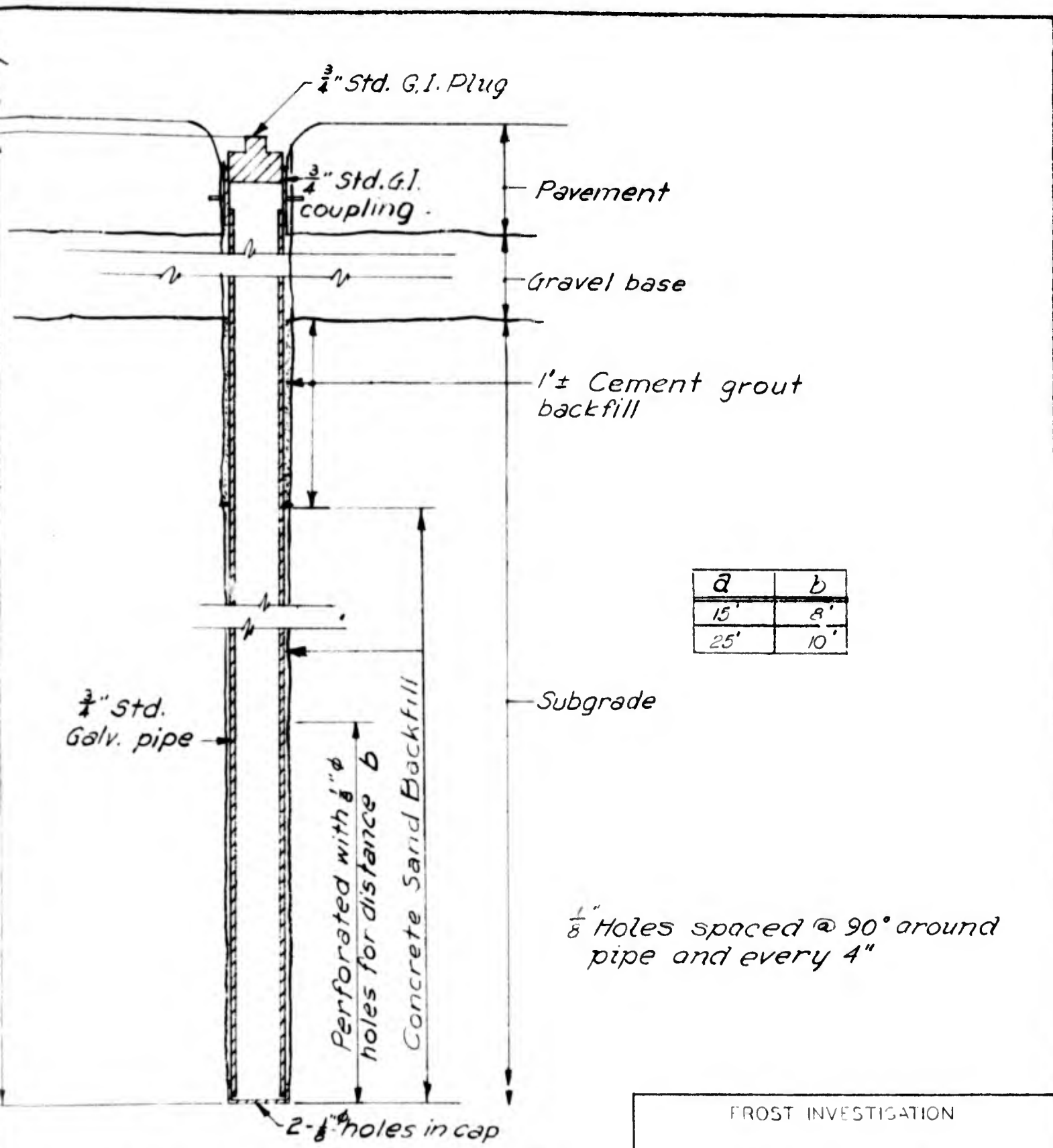
**PLANS AND SECTIONS  
TEST AREAS D, E, F  
AND  
TURF AREA**

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



**OBSERVATION WELL**  
**IN BASE**

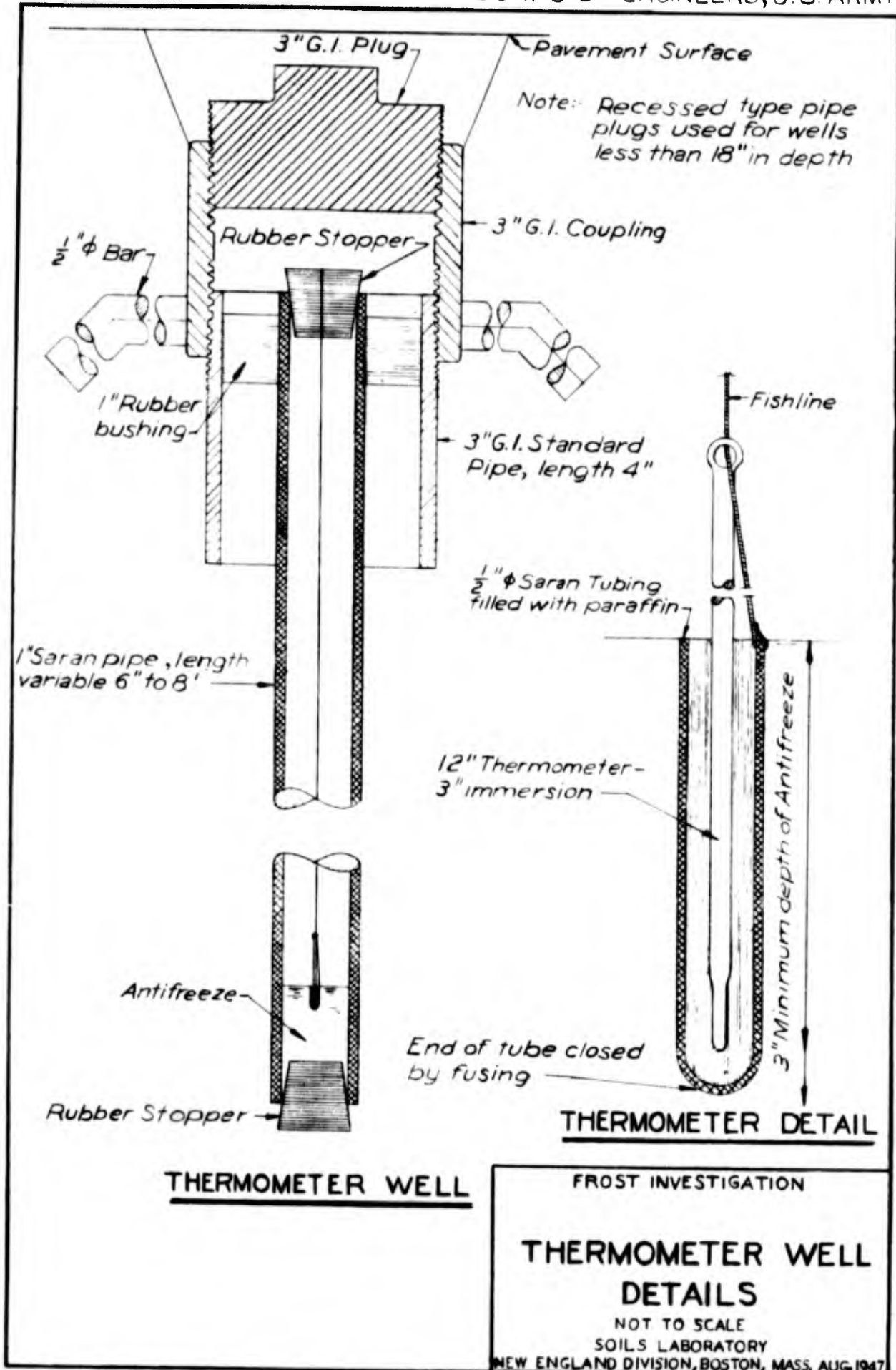
**OBSER**  
**IN S**

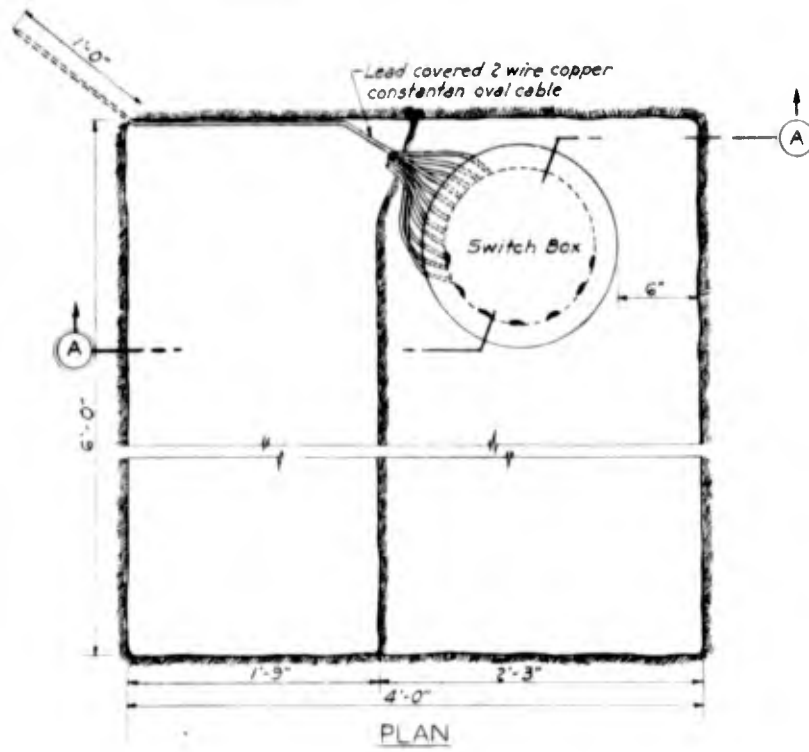


**OBSERVATION WELL**  
**IN SUBGRADE**

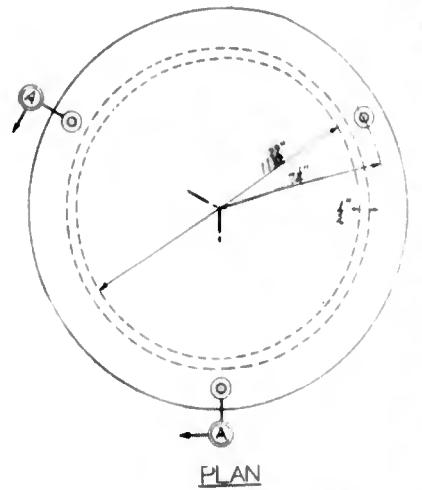


FROST INVESTIGATION  
 OBSERVATION WELL  
 DETAILS  
 SOILS LABORATORY  
 N. W. ENGL. DIVISION, BOSTON, MASS. AUGUST 1947



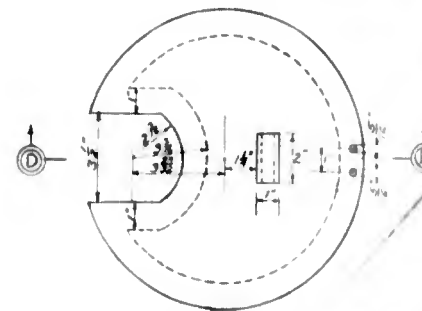


PLAN



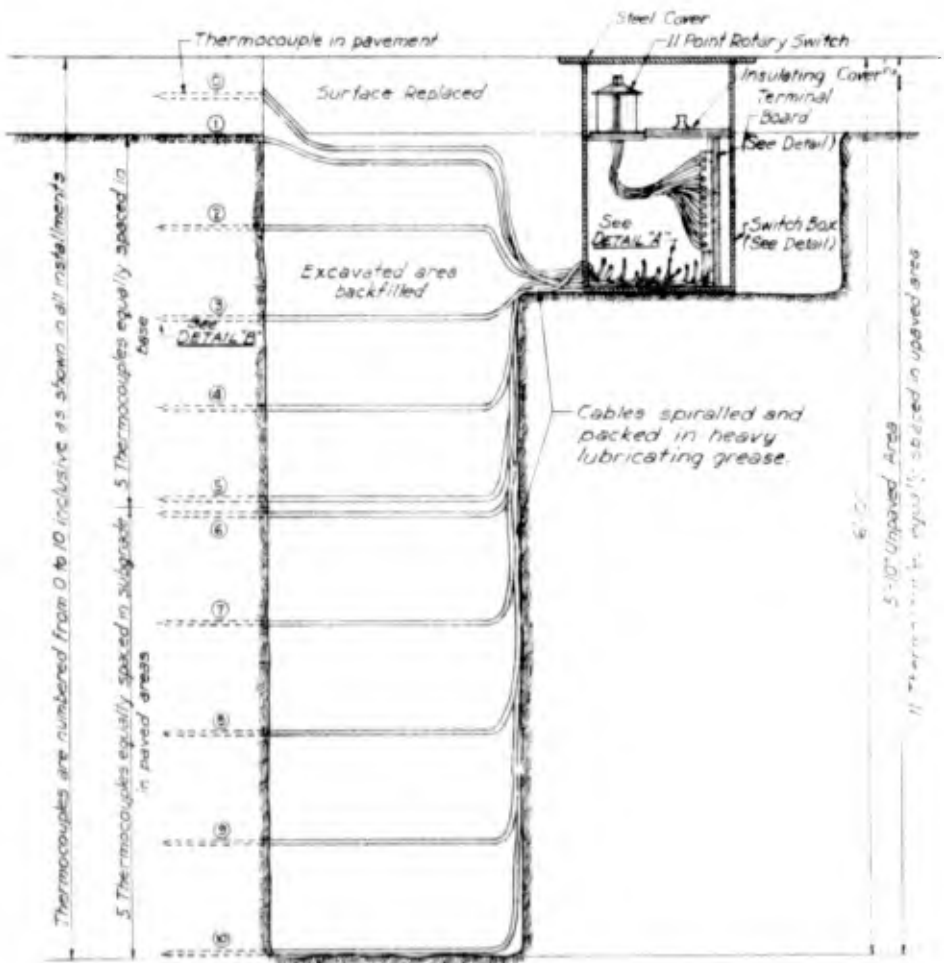
PLAN

STEEL COVER



PLAN

INSULATING COVER

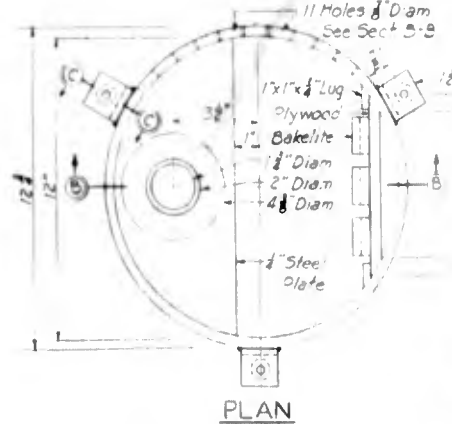


SECTION A-A

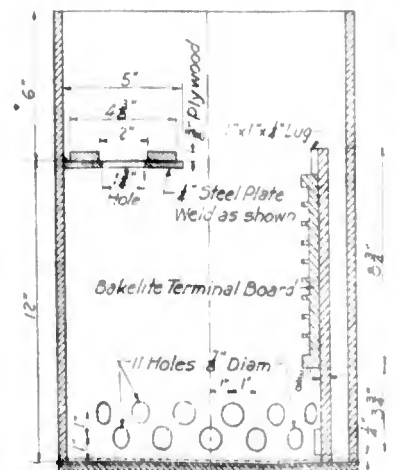
INSTALLATION OF THERMOCOUPLE EQUIPMENT

Scale 1 1/2" = 1'-0"

A

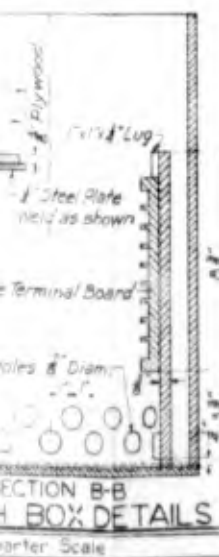
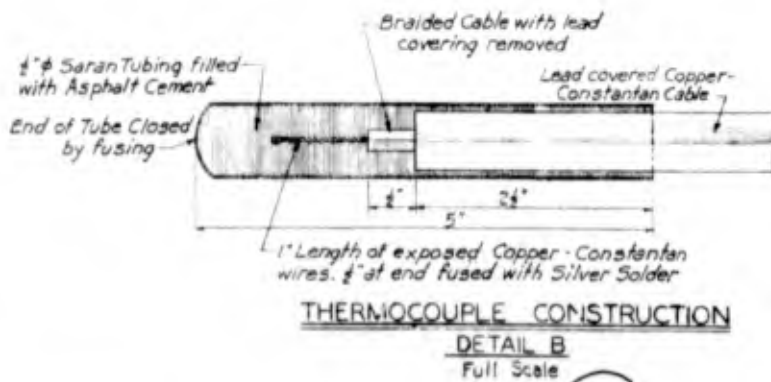
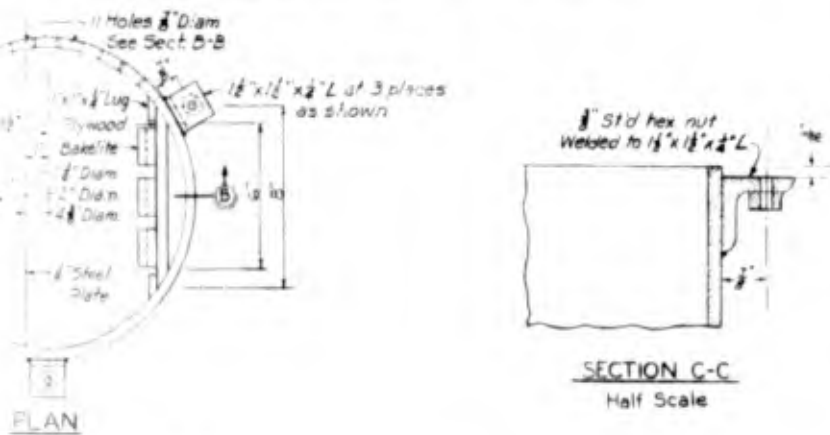
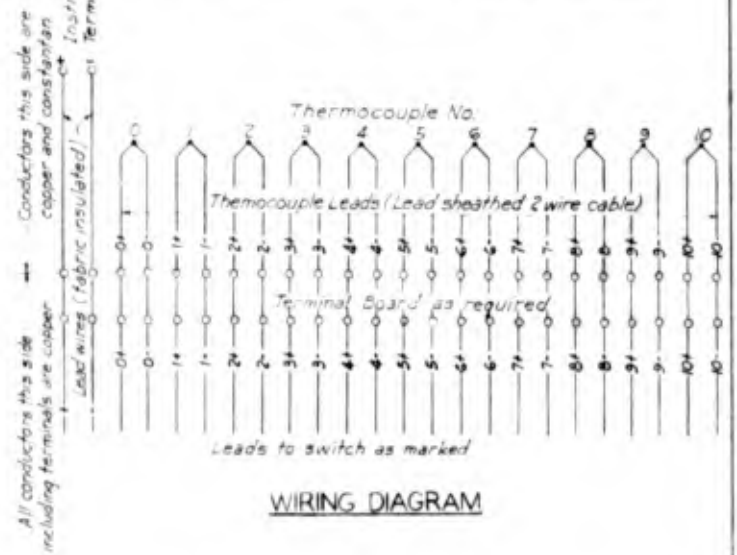
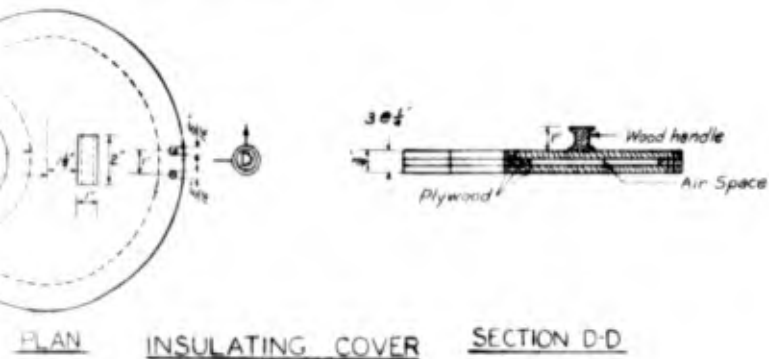
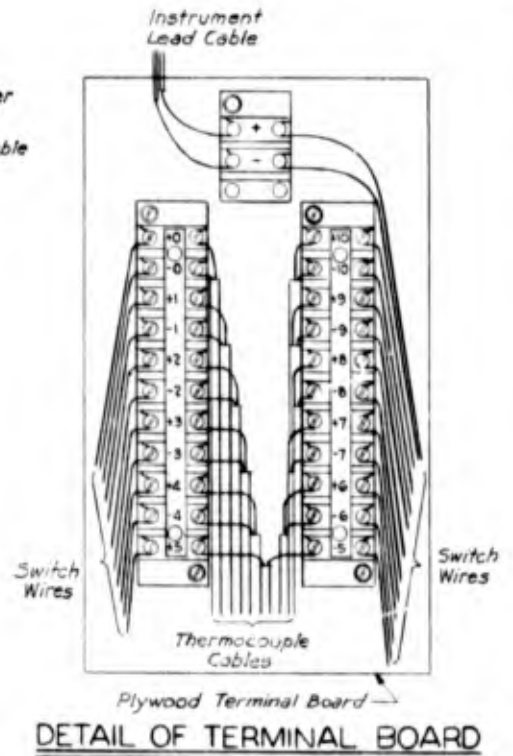
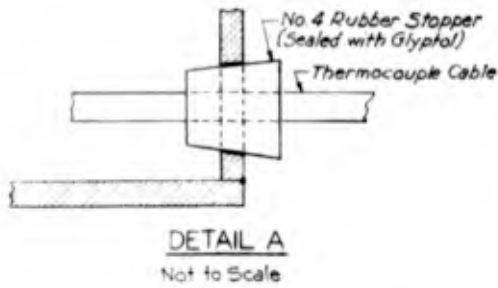
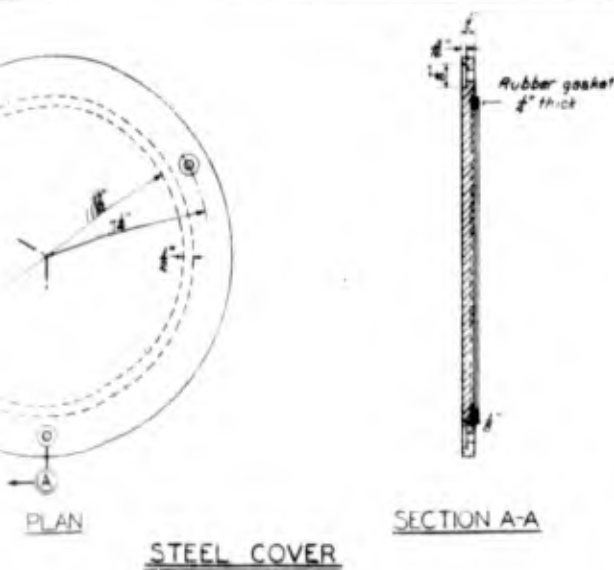


PLAN



SECTION B-B  
SWITCH BOX DETAILS

Quarter Scale



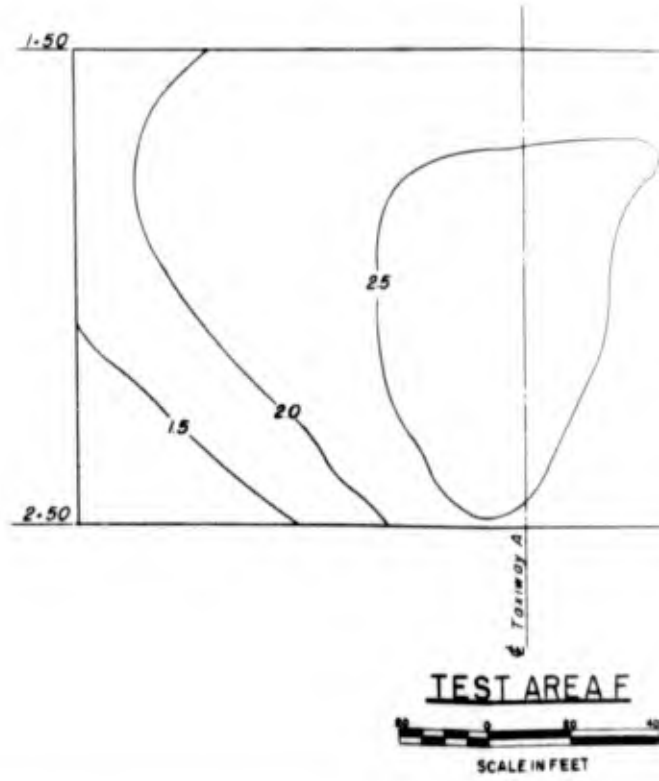
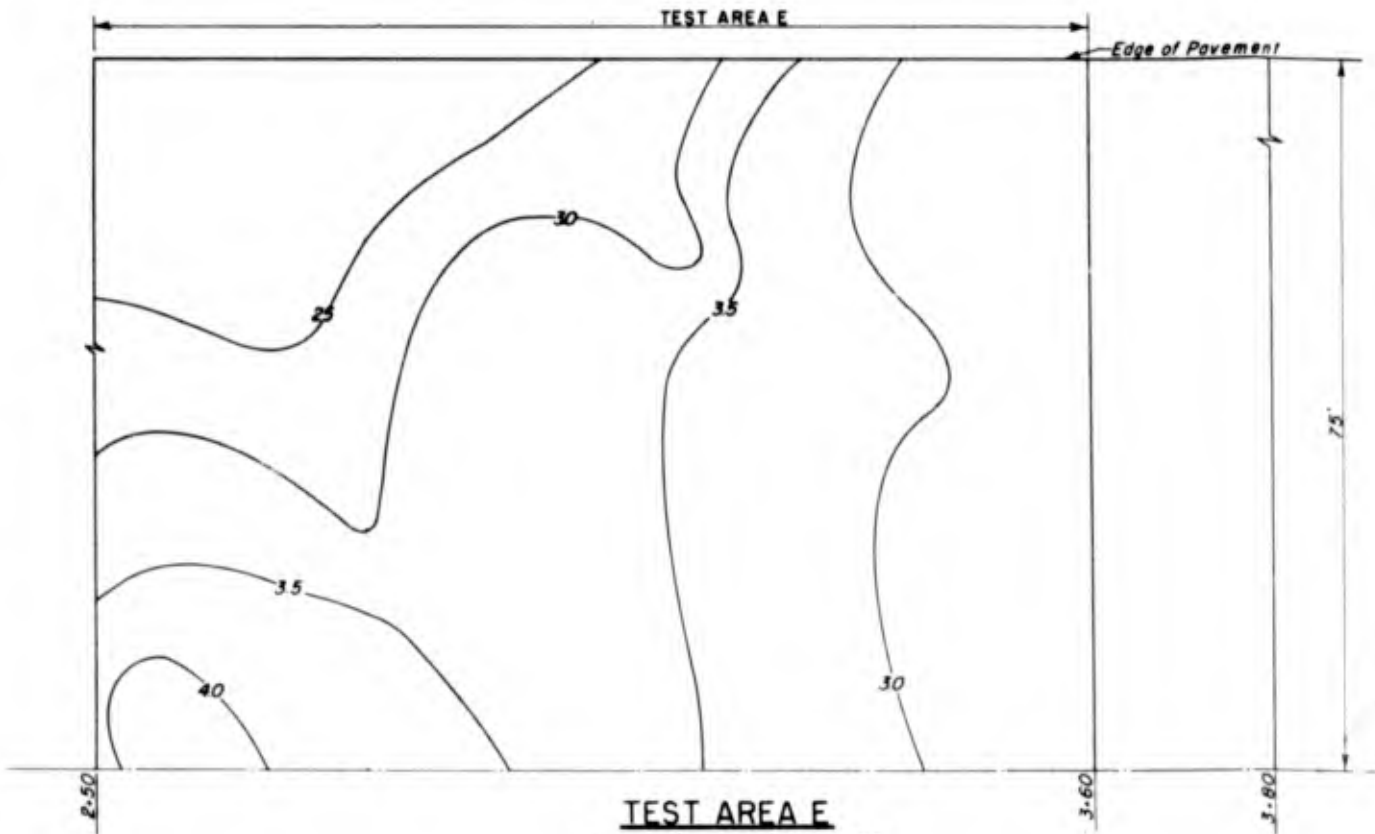
FROST INVESTIGATION

**THERMOCOUPLE INSTALLATION AND SWITCH BOX DETAILS**

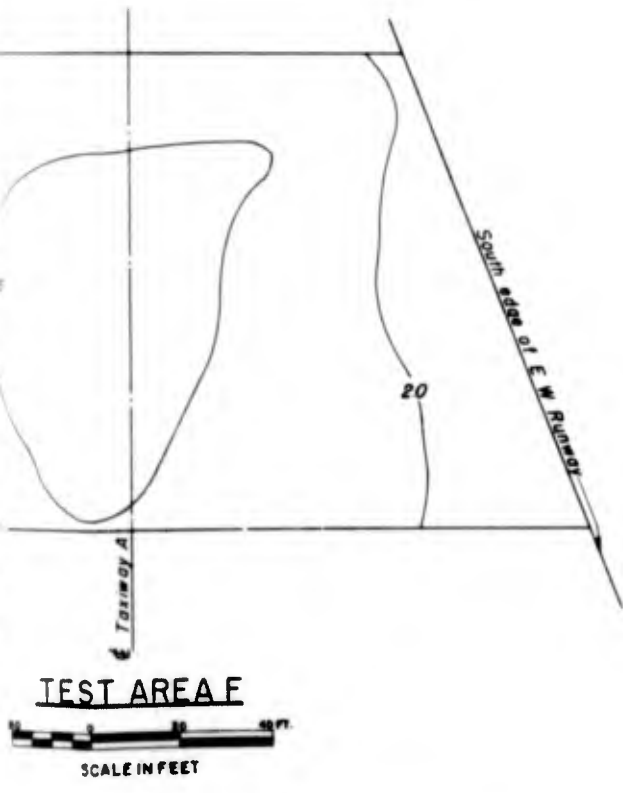
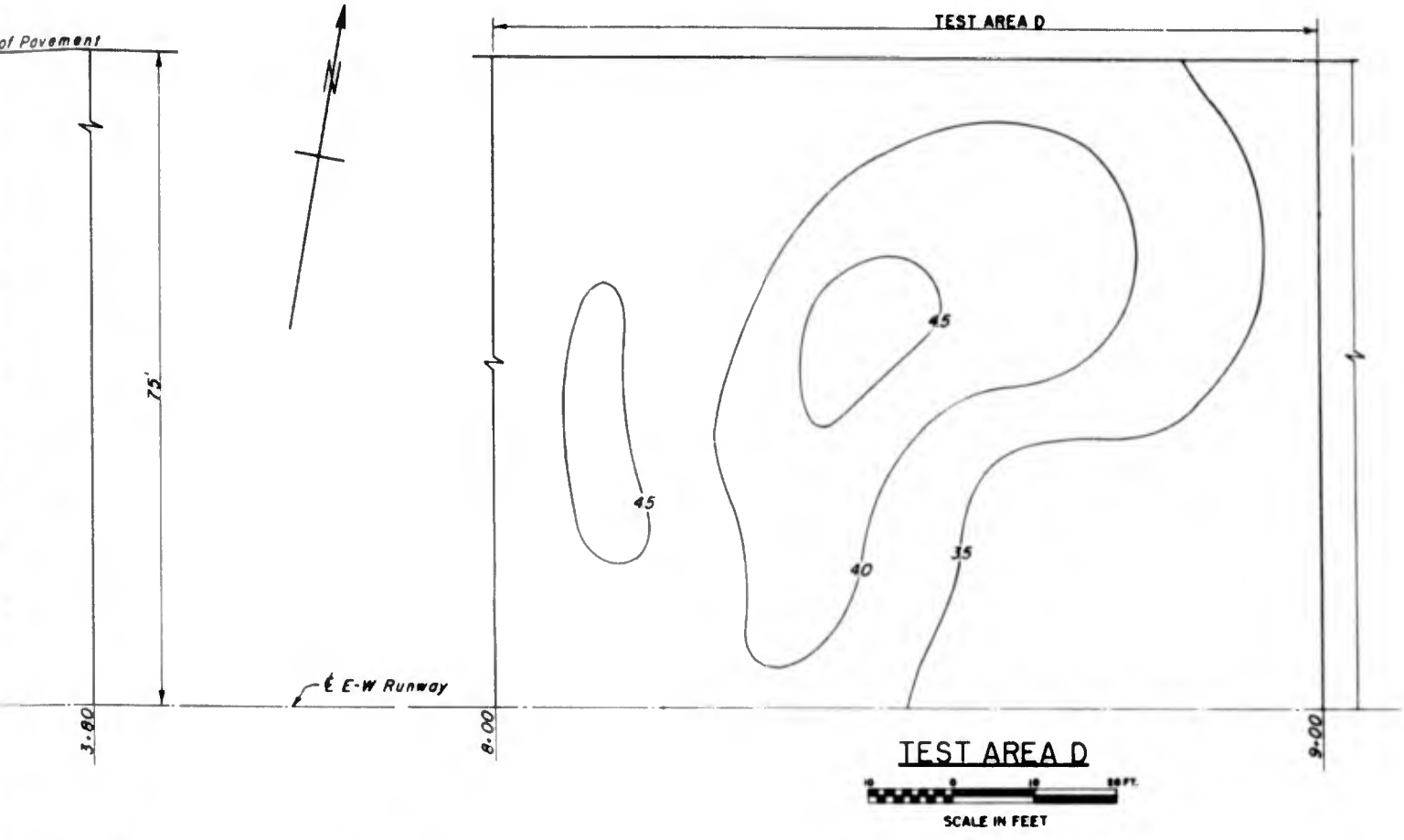
SCALE AS SHOWN  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

Handwritten initials or mark.

Handwritten number '2'.



A



NOTES  
 CONTOUR INTERVAL = 0.5'  
 CONTOURS IN FEET

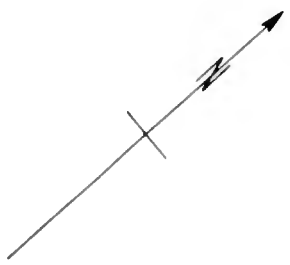
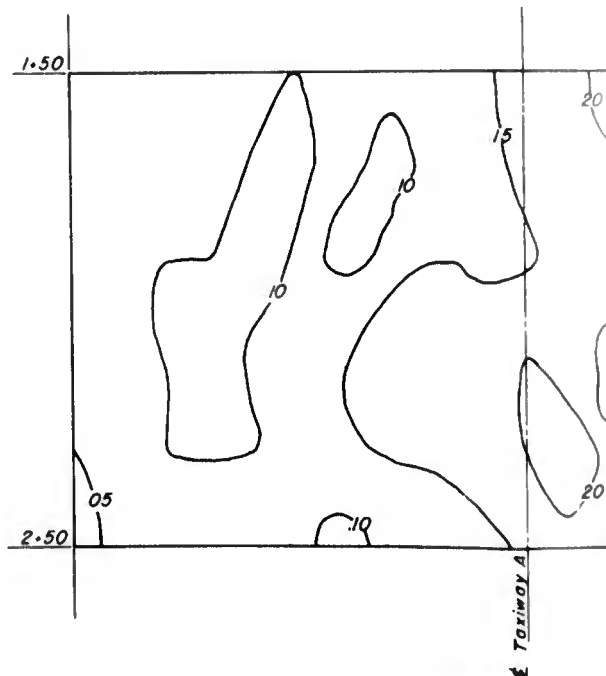
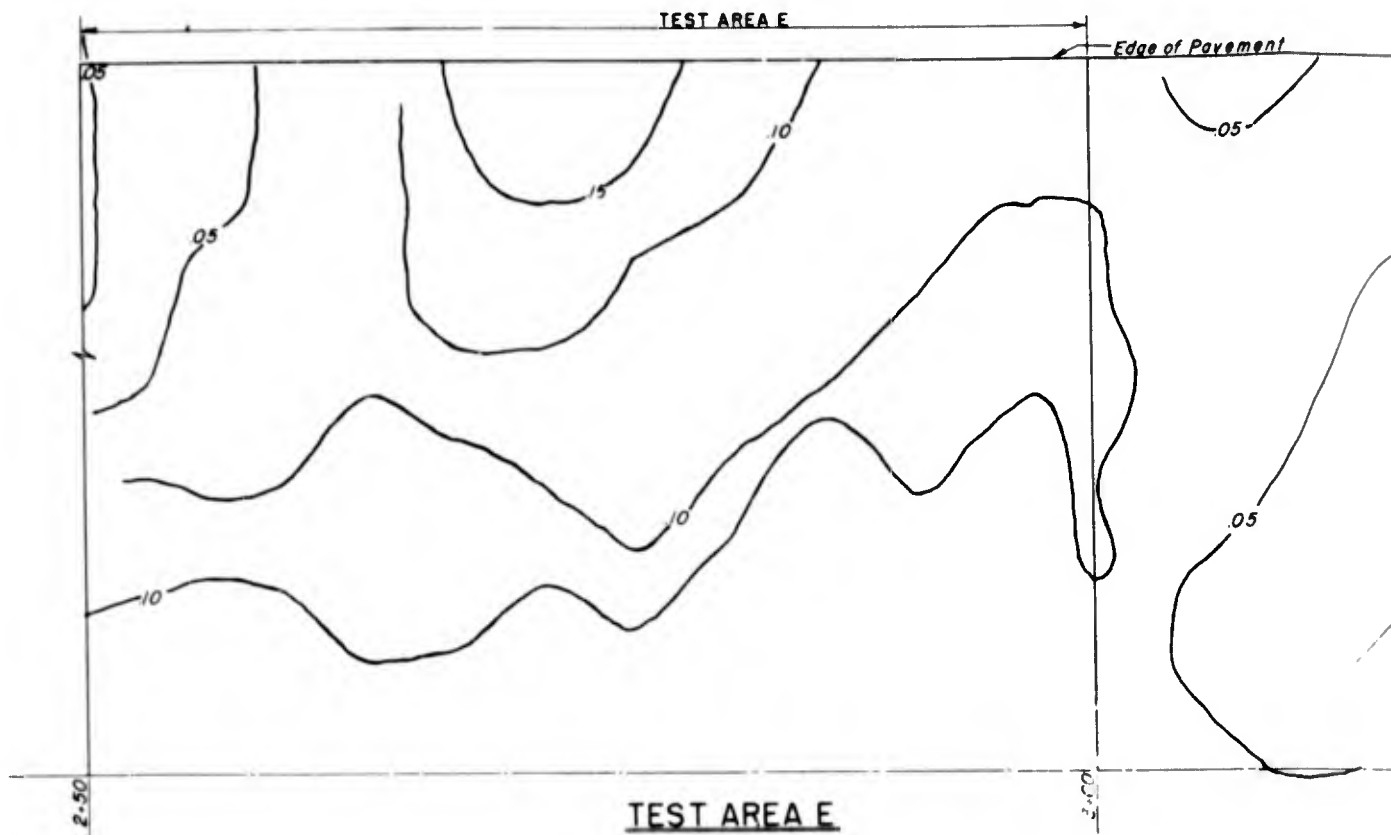
FROST INVESTIGATION  
 DOW FIELD BANGOR, ME.

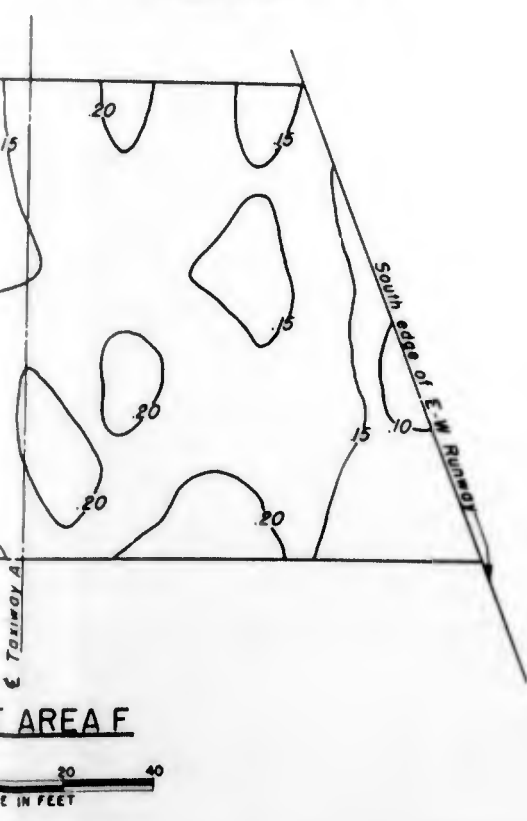
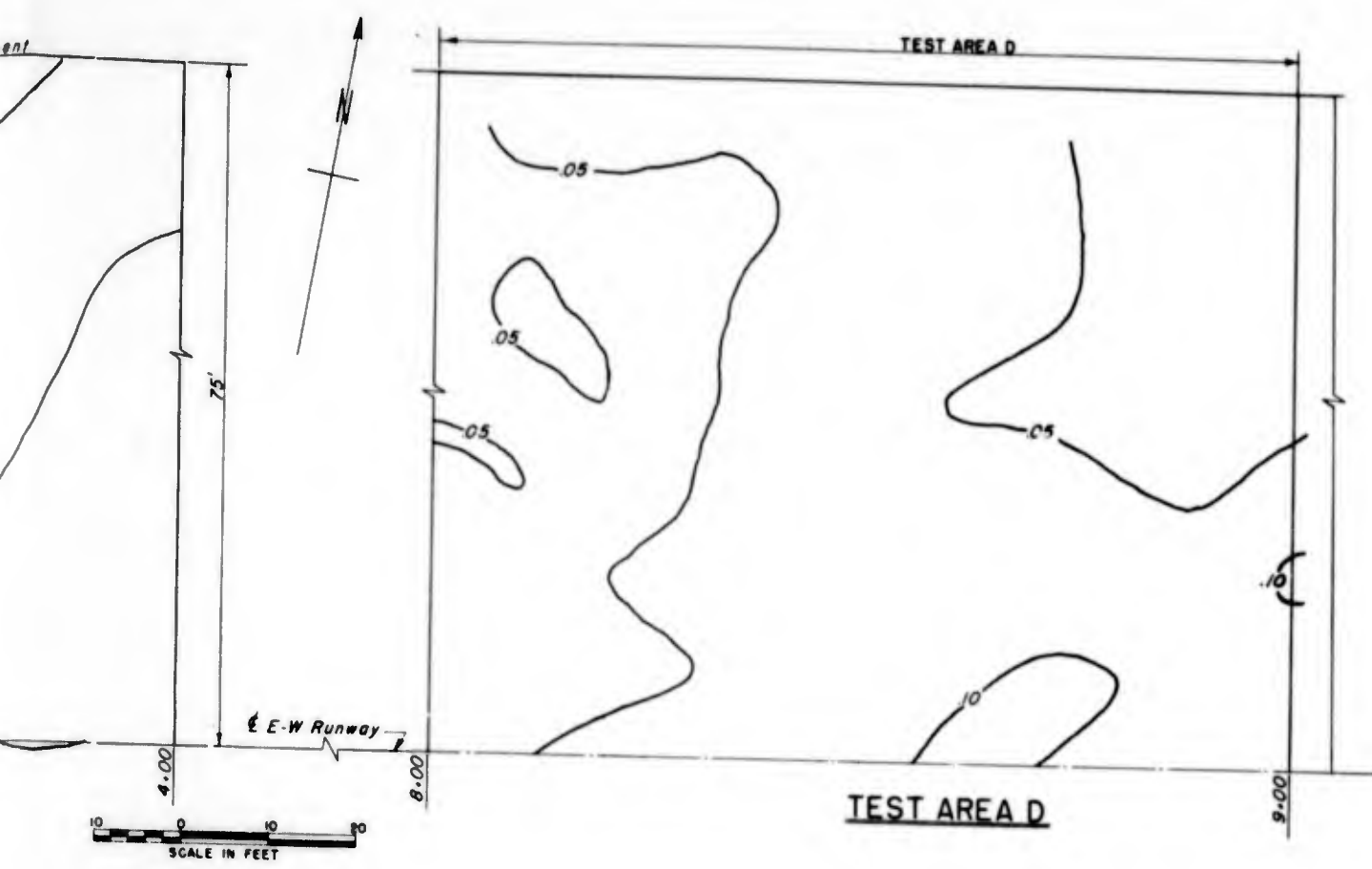
CONTOUR OF PAVEMENT AND  
 BASE THICKNESS  
 TEST AREAS D, E AND F

SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST, 1947

1

2





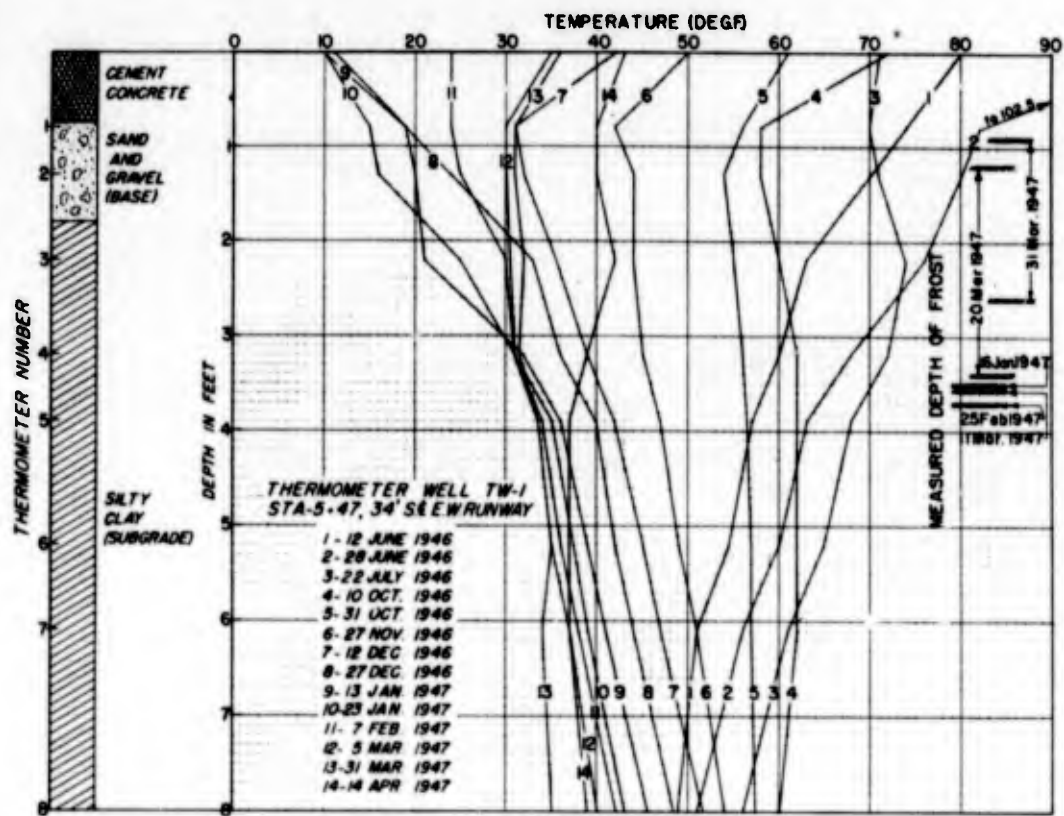
NOTES

SURVEY BEFORE FROST HEAVE WAS MADE 22 OCT 1946  
 SURVEY OF MAXIMUM FROST HEAVE FOUND ON 5 FEB 1947  
 CONTOUR INTERVAL = 0.05'  
 CONTOUR IN HUNDRETHS OF FEET

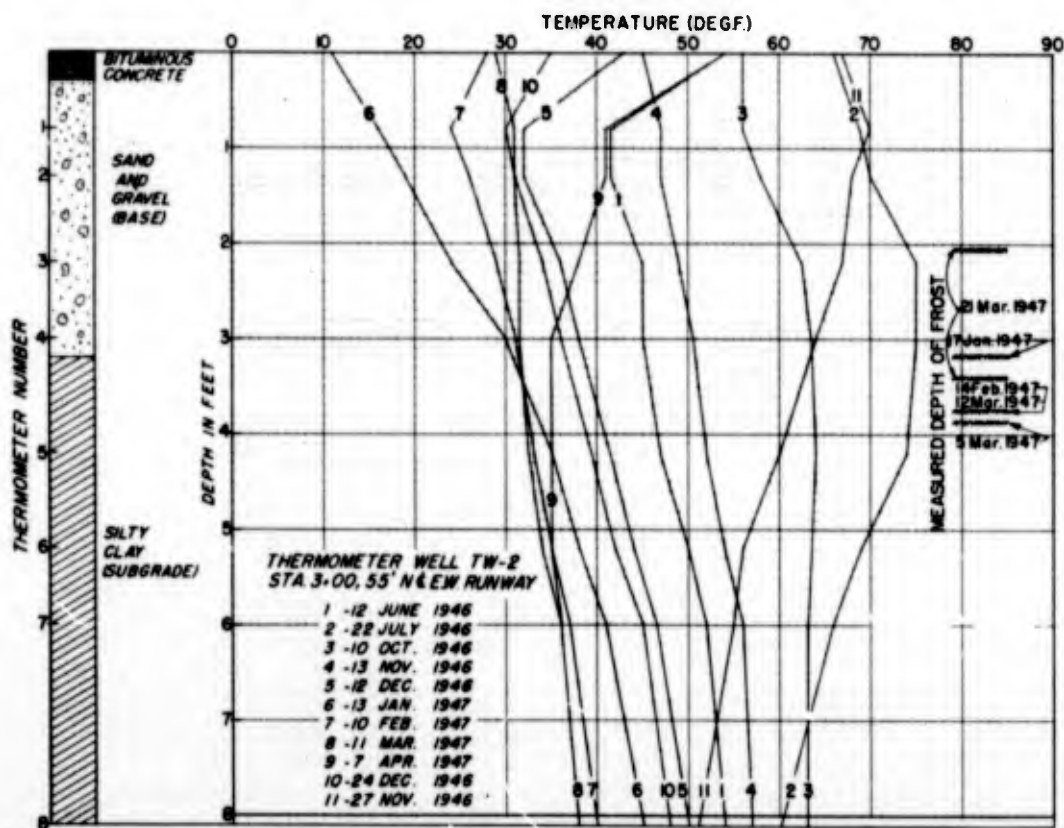
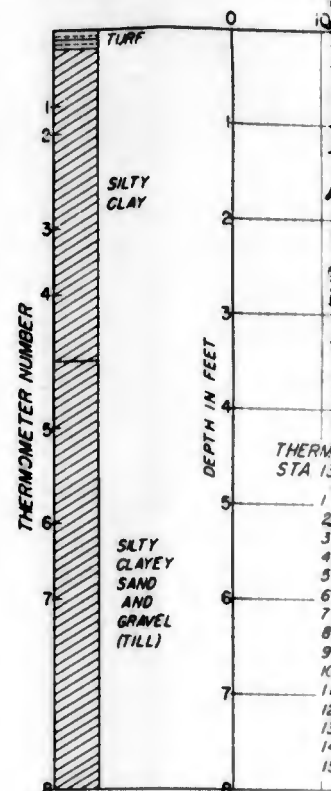
FROST INVESTIGATION  
 DOW FIELD BANGOR, ME

FROST HEAVE CONTOURS  
 TEST AREAS D, E AND F

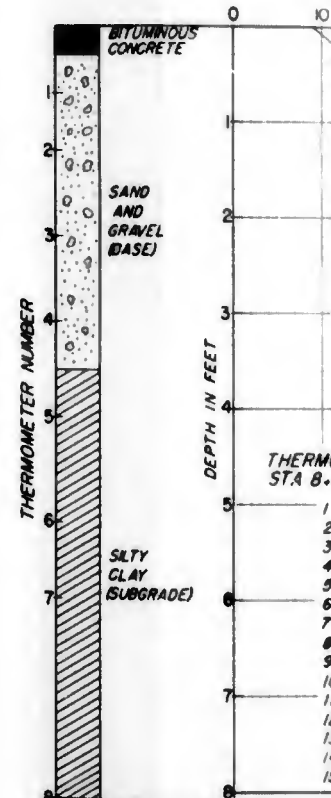
SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST, 1947



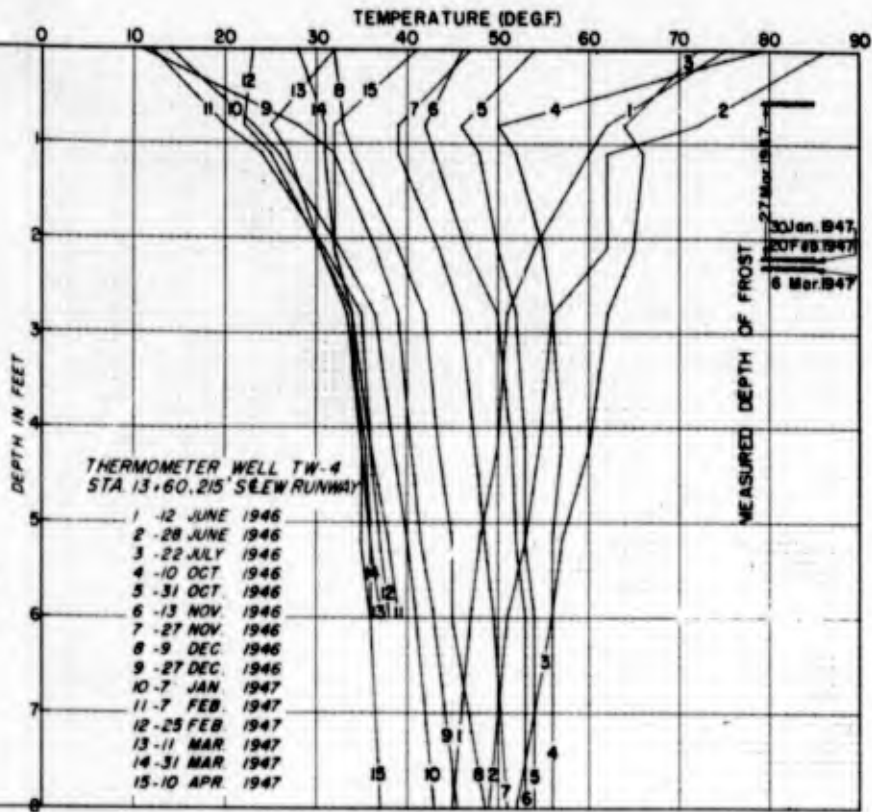
**TEST AREA F**



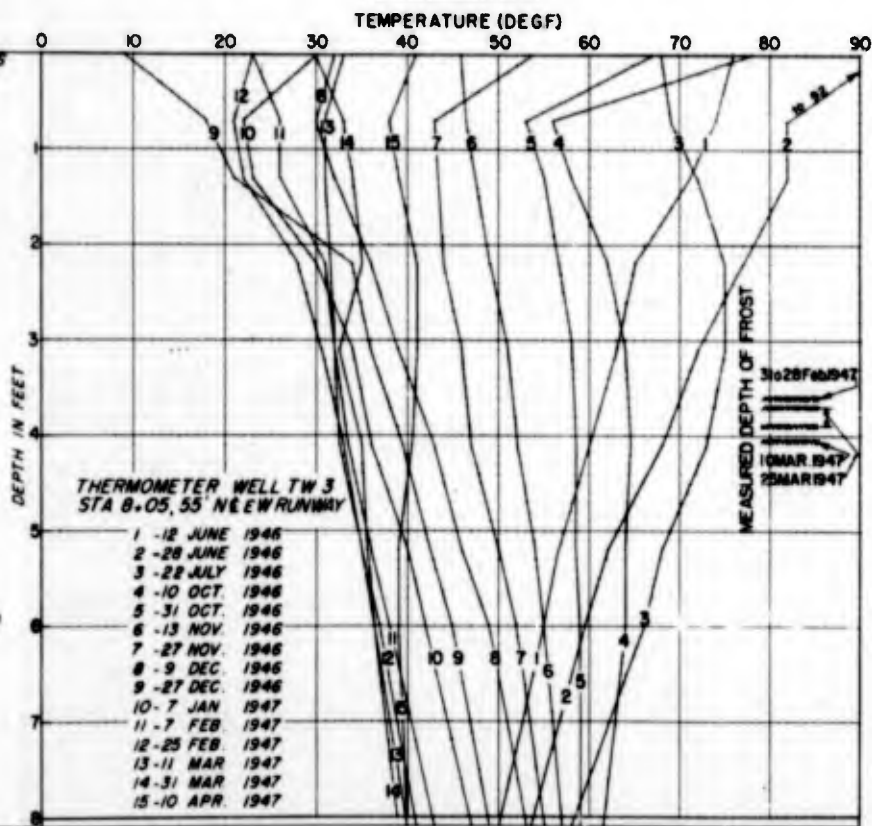
**TEST AREA E**



A



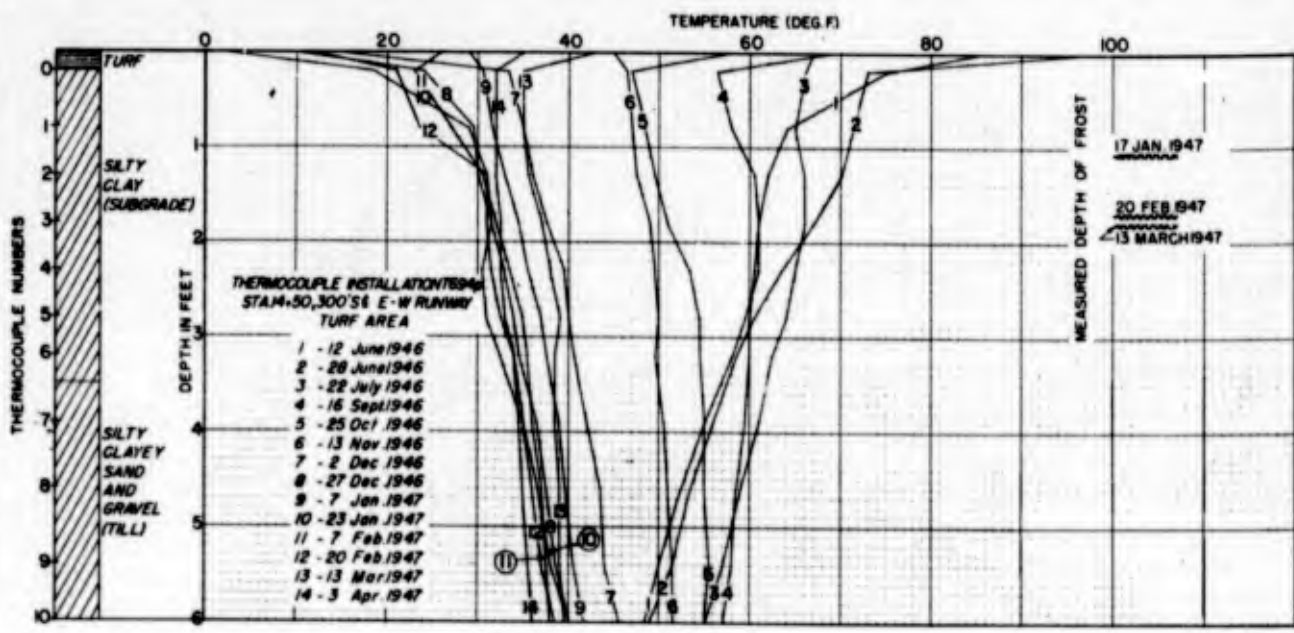
TURF AREA



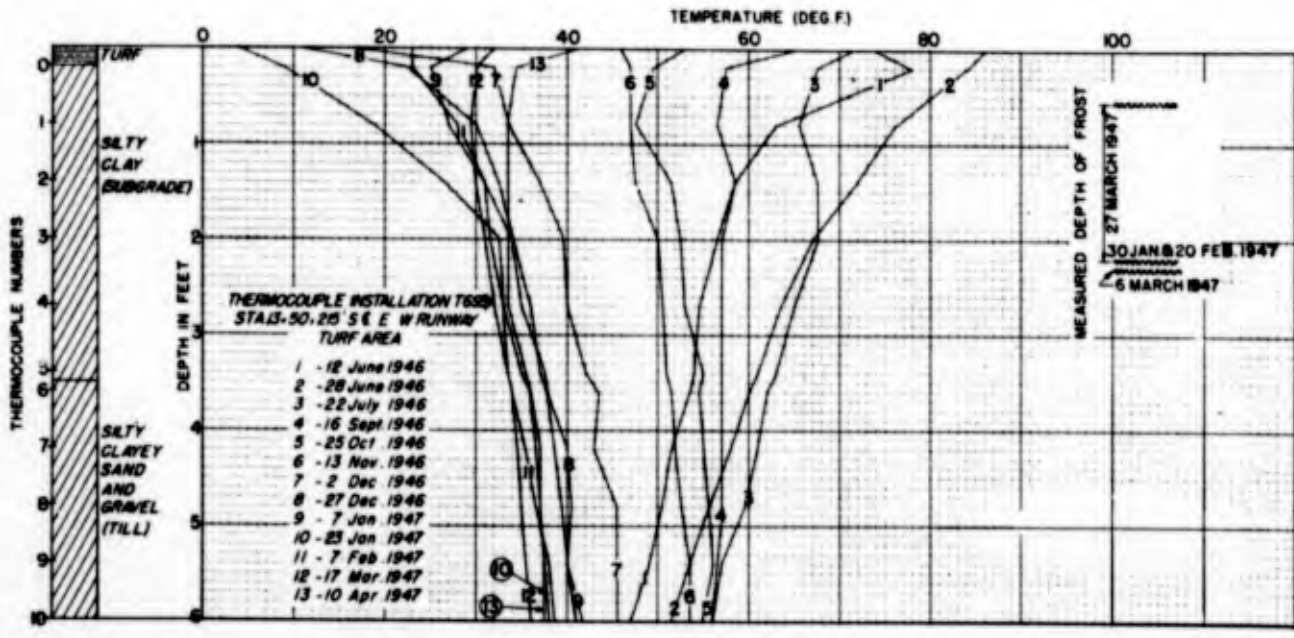
TEST AREA D

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
TYPICAL SUBSURFACE  
TEMPERATURES  
FROM  
THERMOMETER WELLS

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST, 1947

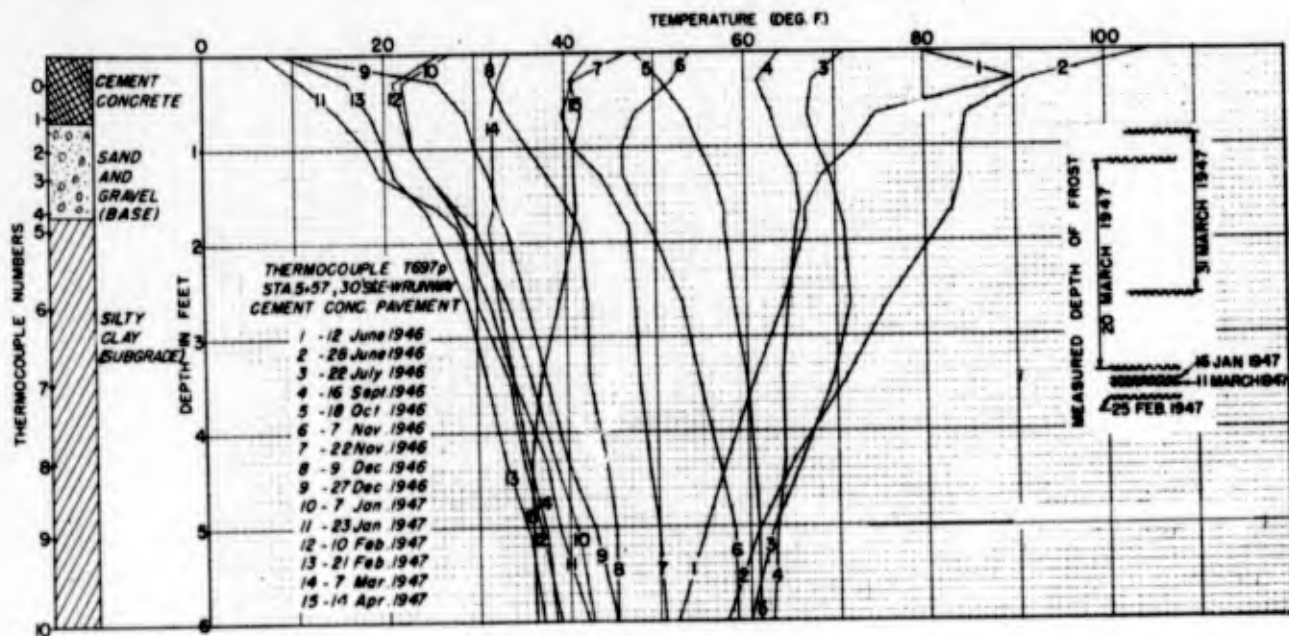


**TURF AREA**  
FIG. 1



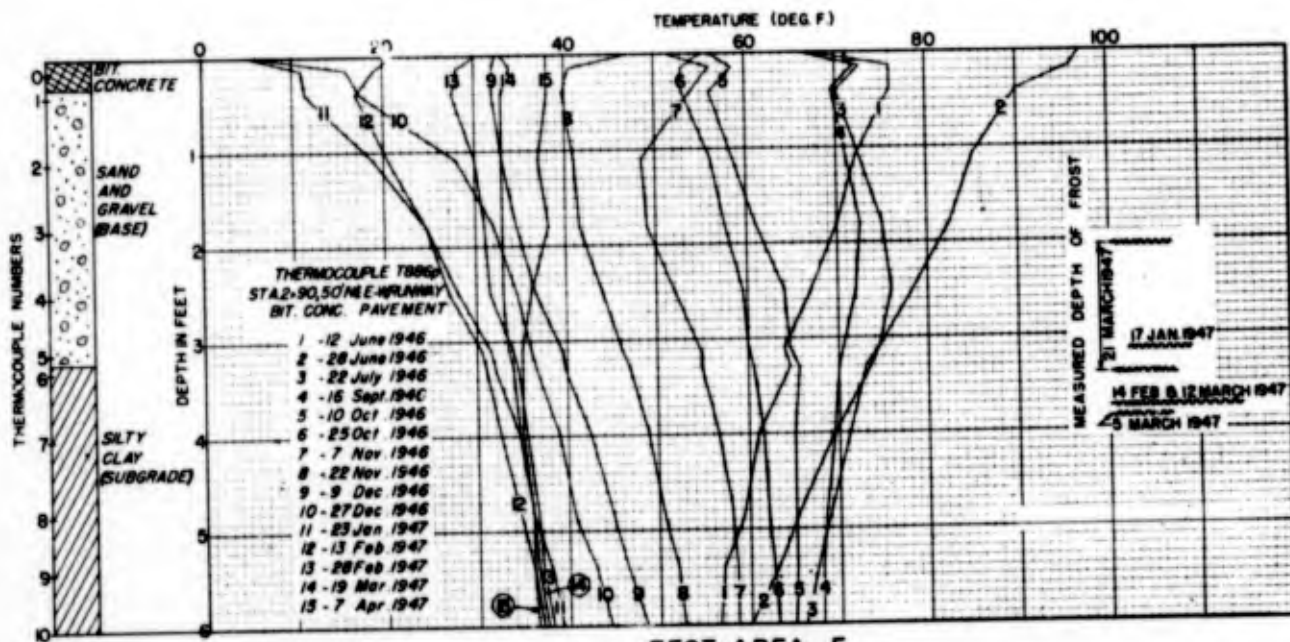
**TURF AREA**  
FIG. 3

A



**TEST AREA F**

FIG. 2



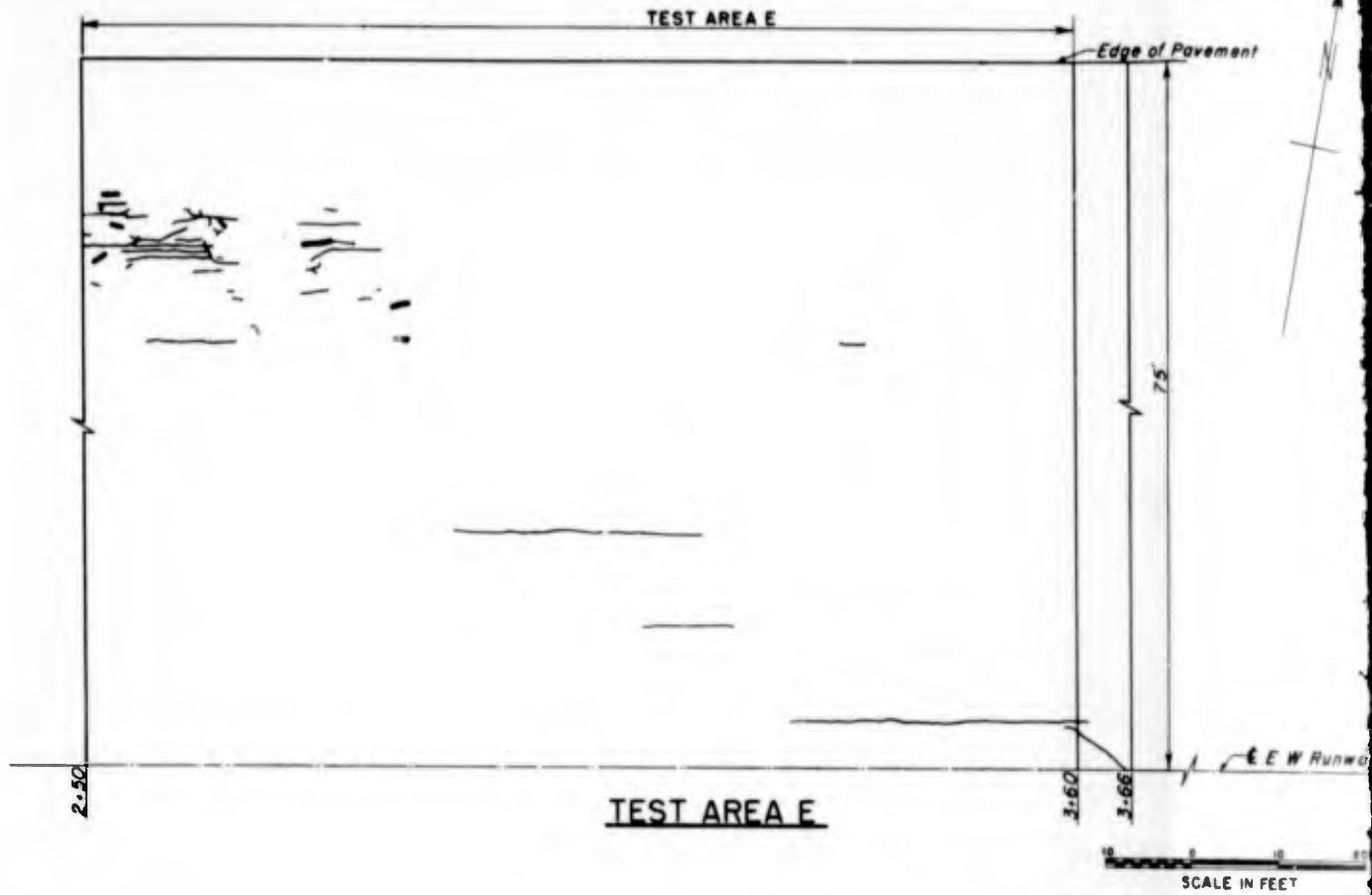
**TEST AREA E**

FIG. 4

FROST INVESTIGATION  
DOW FIELD, BANGOR, ME.  
TYPICAL SUBSURFACE  
TEMPERATURES  
FROM  
THERMOCOUPLES  
SOILS LABORATORY

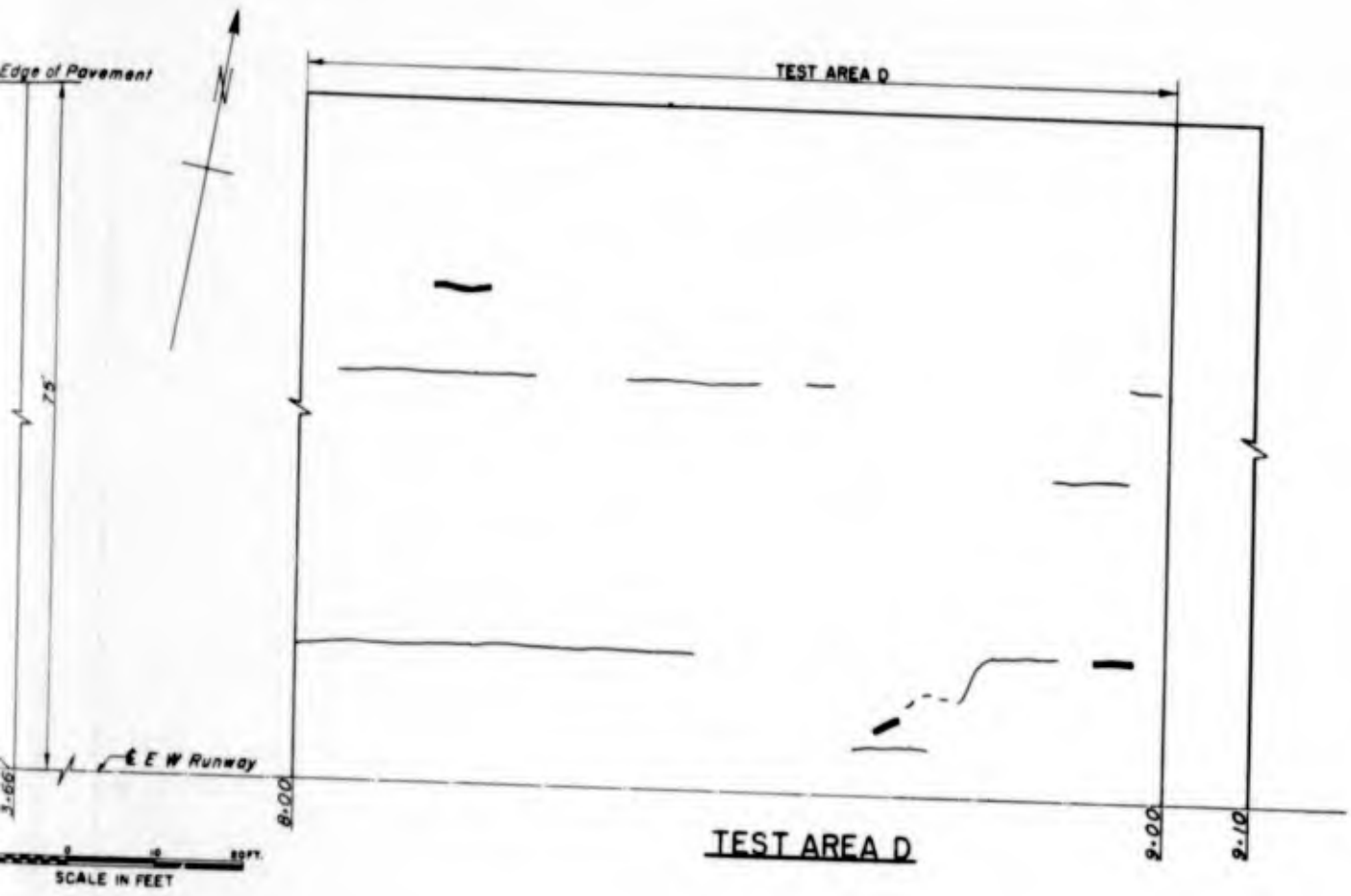
NEW ENGLAND DIVISION BOSTON, MASS. AUGUST 1947

PLATE 10



**LEGEND**

- SURVEY TAKEN NOV 11 1946
- - - SURVEY TAKEN APR 22 1947



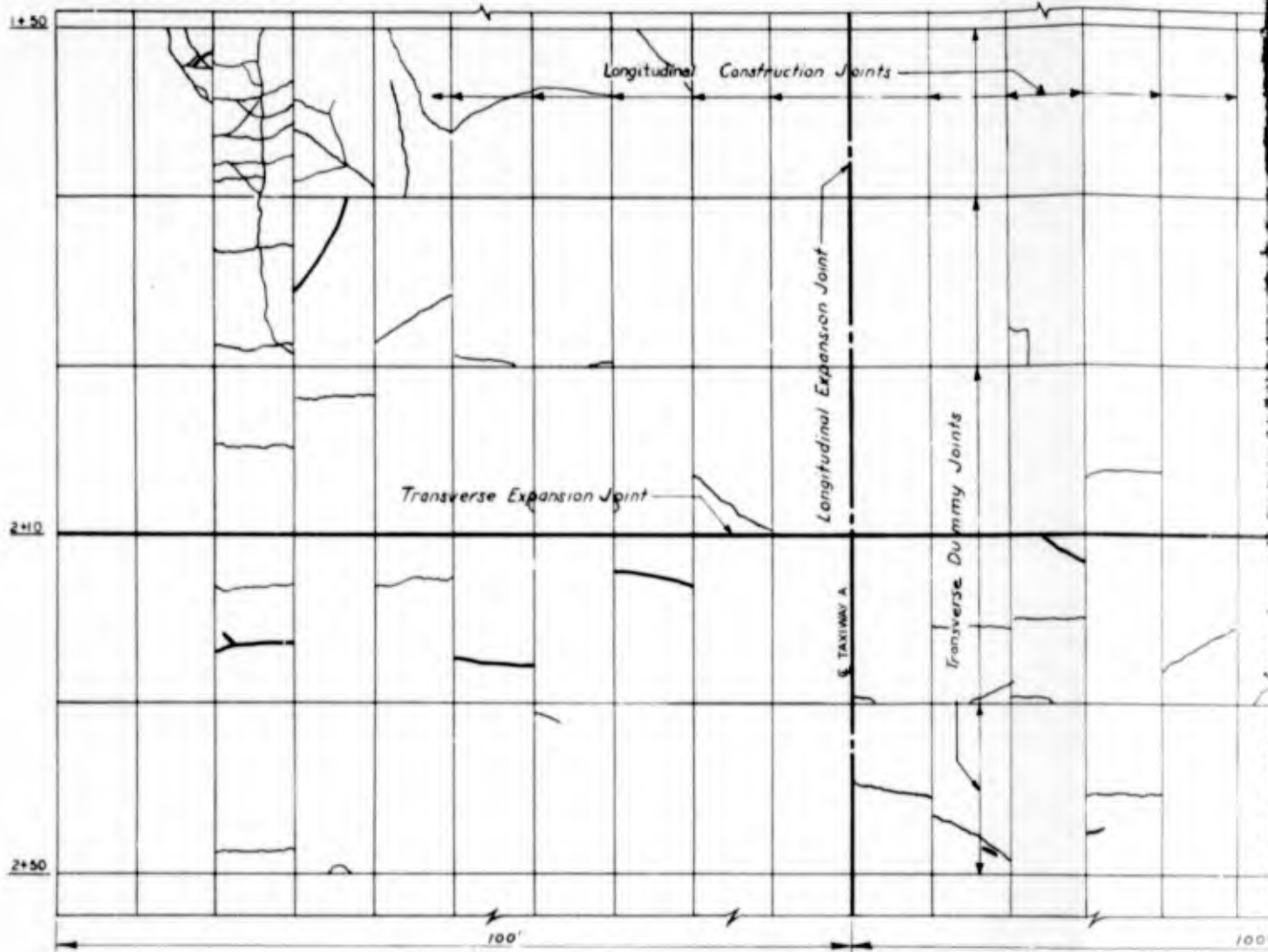
**LEGEND**

- SURVEY TAKEN NOV. 1 1946
- SURVEY TAKEN APR. 22 1947

FROST INVESTIGATION  
 DOW FIELD, BANGOR, ME.  
 CRACK SURVEY  
 TEST AREAS D AND E.

SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUGUST, 1947

B

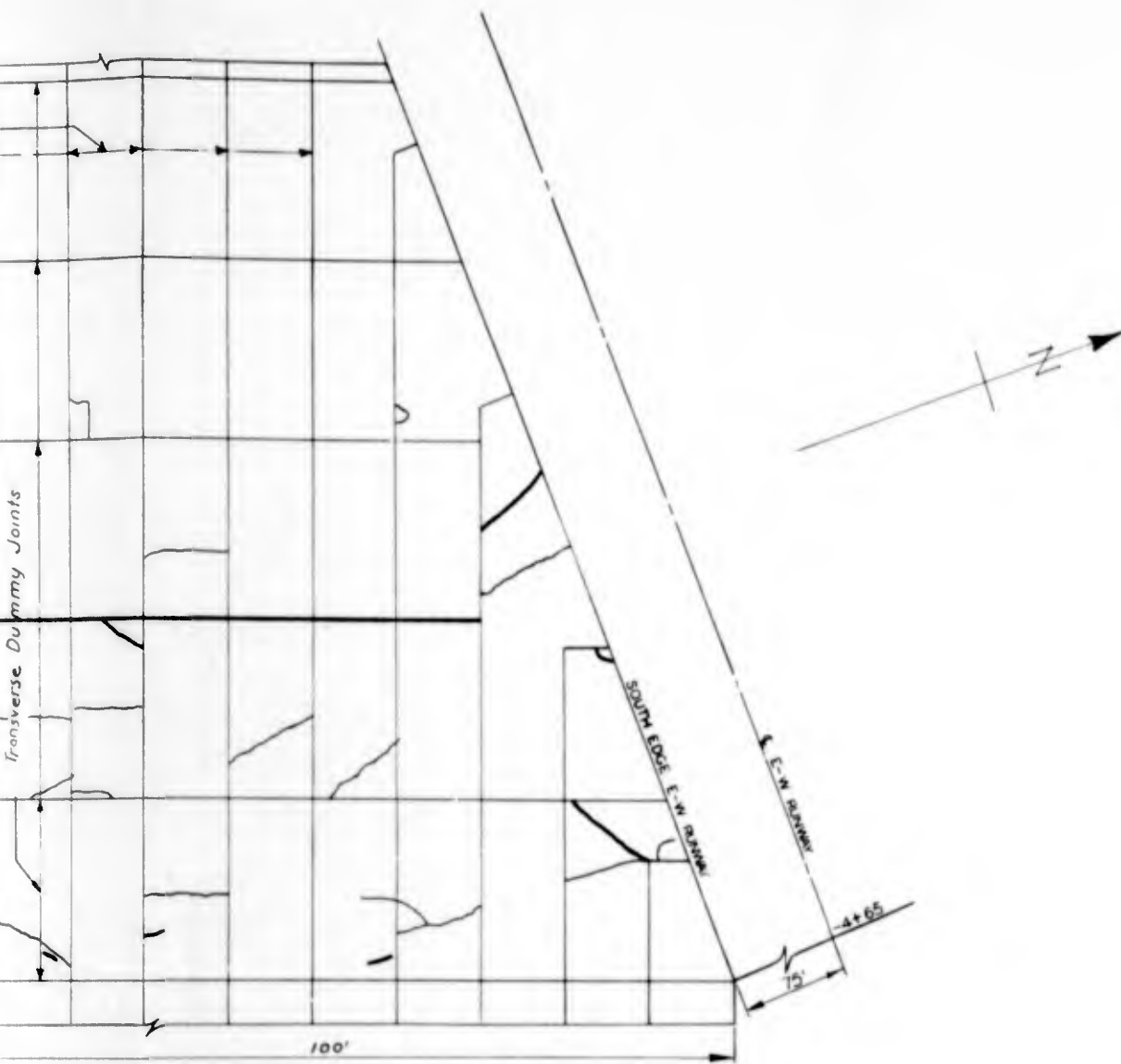


TEST AREA F



- LEGEND
- SURVEY TAKEN 1, NOV. 1946
  - SURVEY TAKEN 22 APR. 1947

A



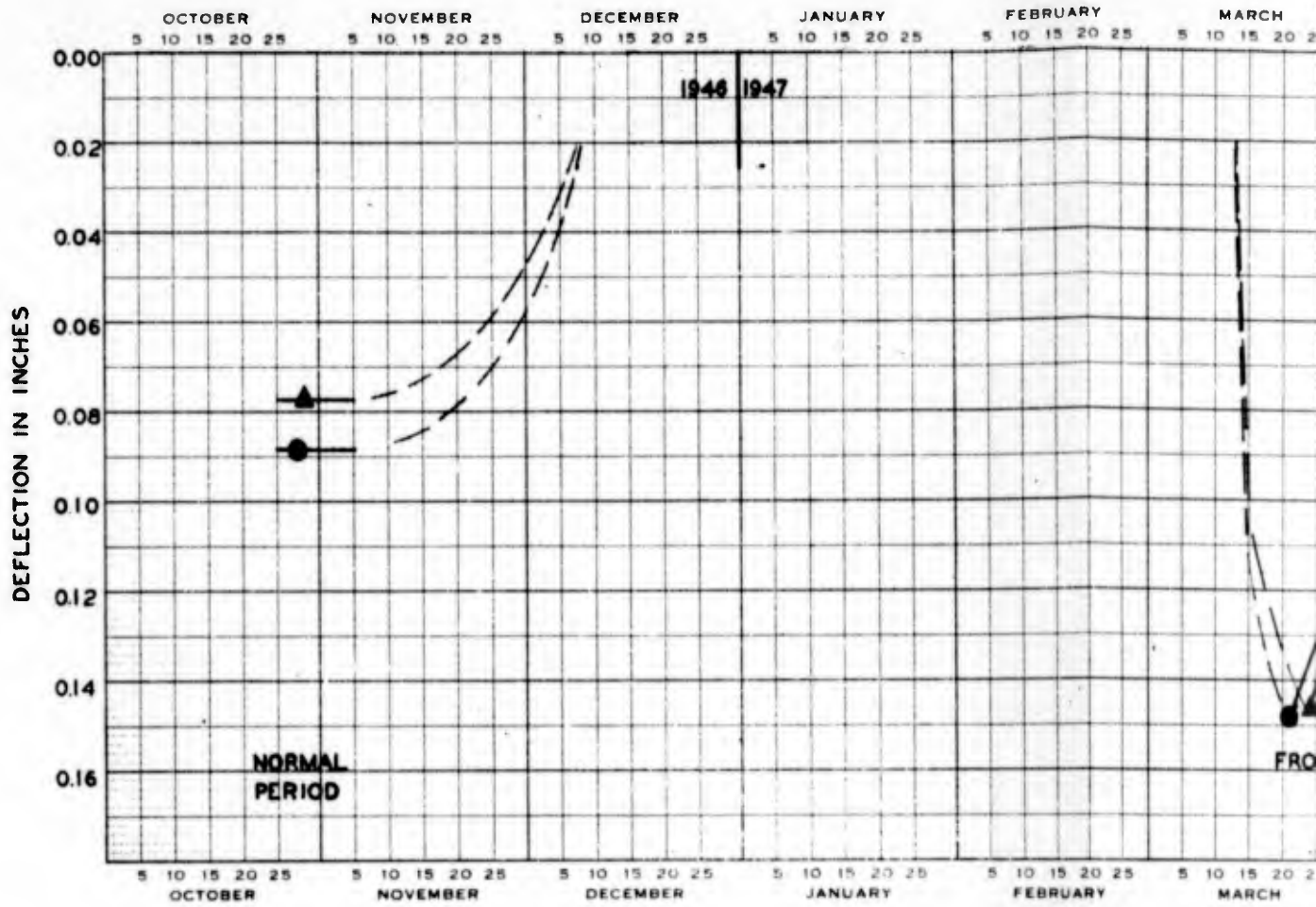
Transverse Dummy Joints

F  
60 FT.

946  
947

03

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.  
  
CRACK SURVEY  
TEST AREA F  
  
SOILS LABORATORY  
NEW ENGLAND DIVISION BOSTON, MASS. AUGUST, 1947



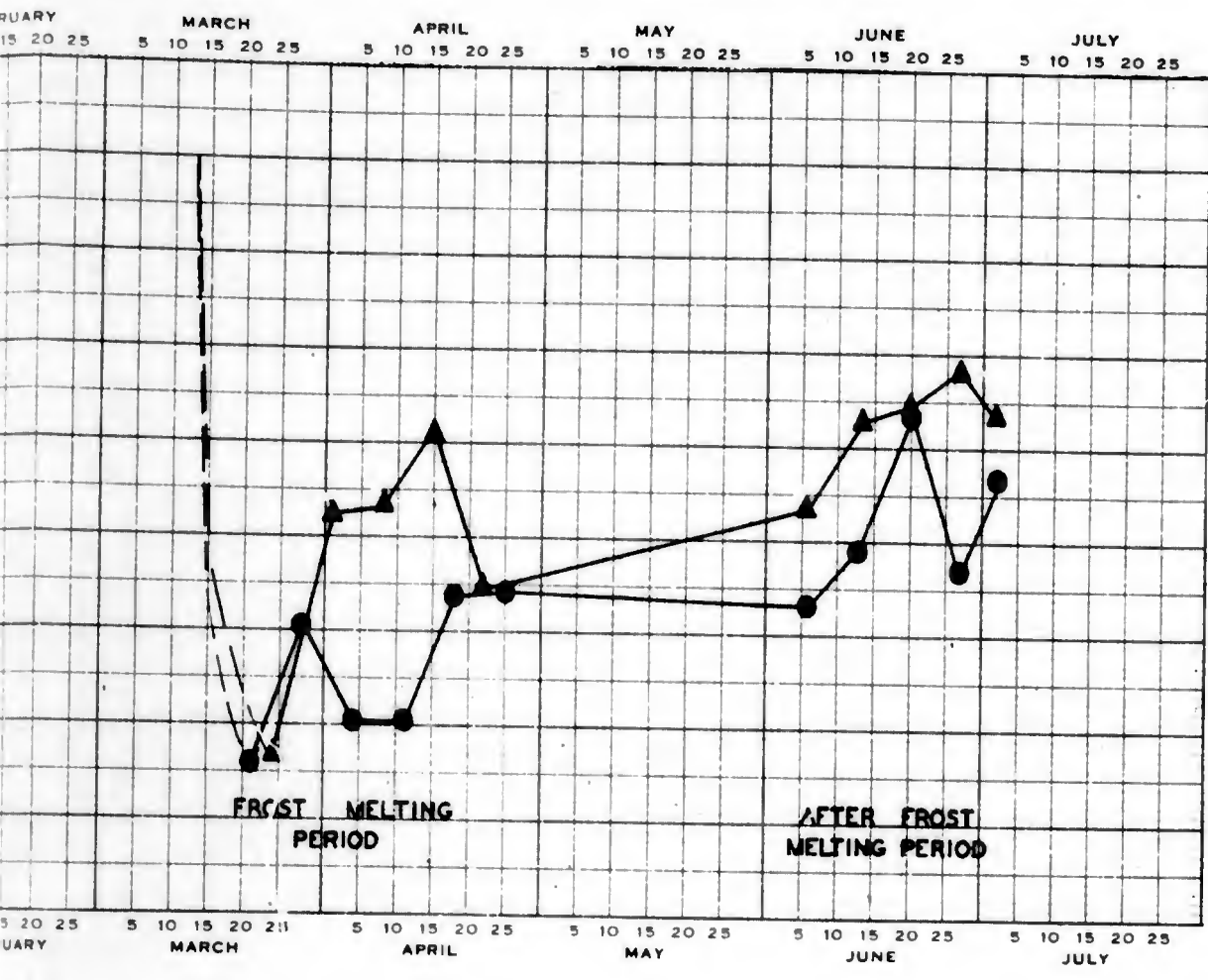
**LEGEND**

- ▲ — ▲ TEST AREA D
- — ● TEST AREA E

TESTS PERFORMED  
LOAD TO A 30" DIAM  
PAVEMENT SURFACE.

A

1

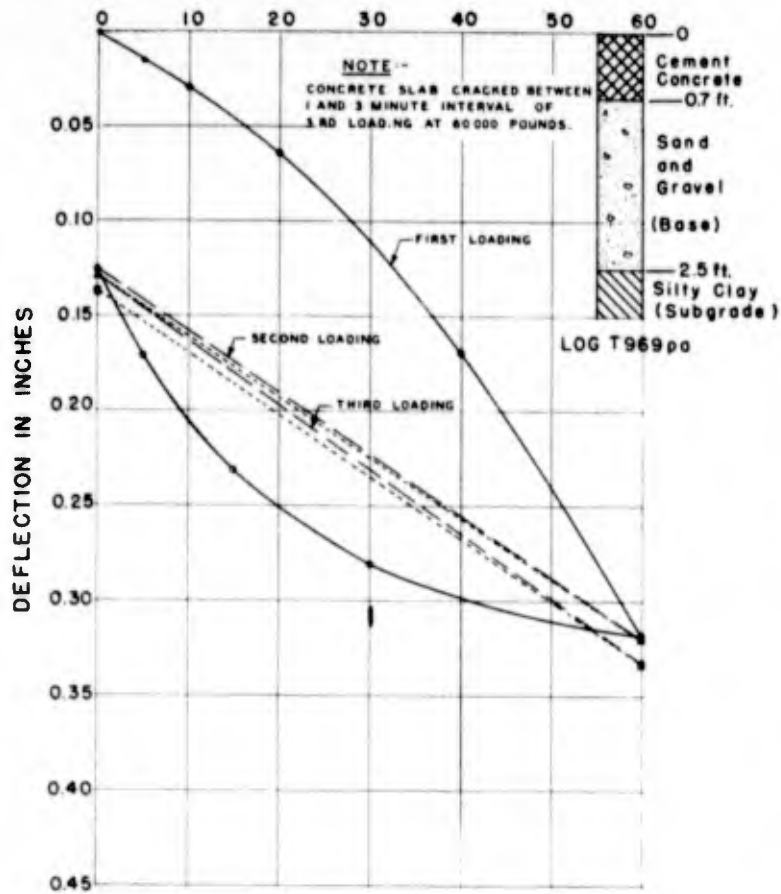


**NOTE**

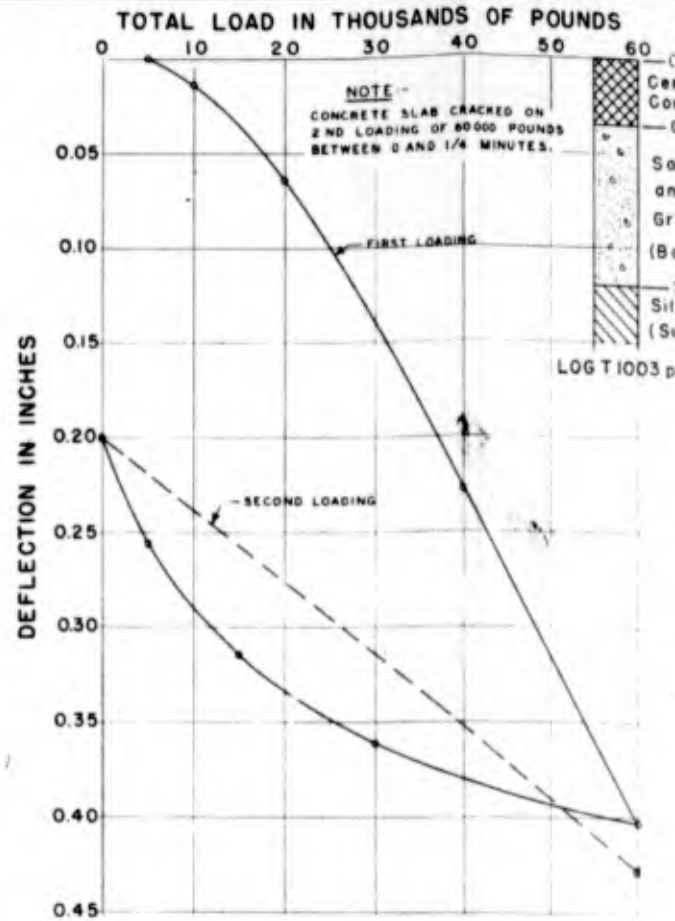
TESTS PERFORMED BY APPLYING A 20,000 POUND  
LOAD TO A 30" DIAMETER PLATE ON THE  
PAVEMENT SURFACE.



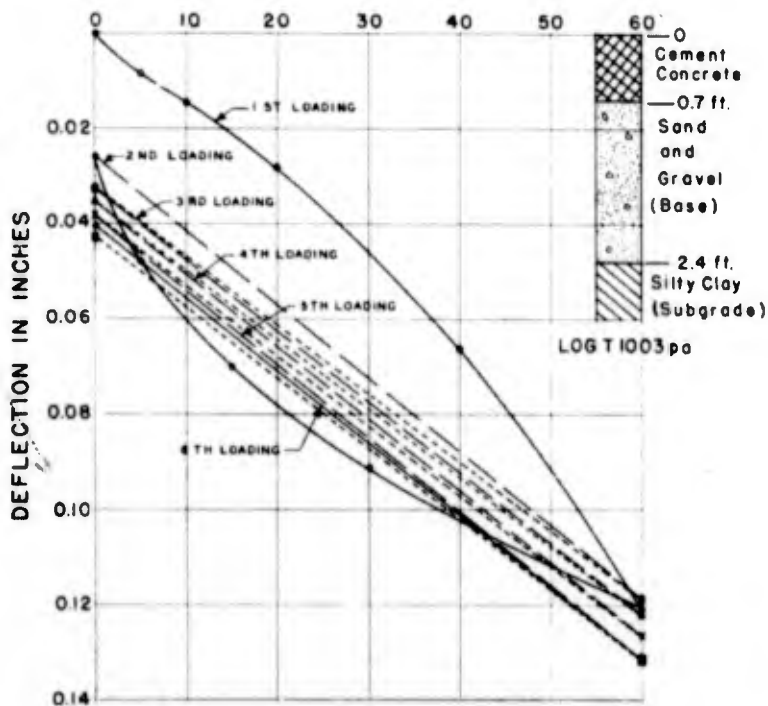
FROST INVESTIGATION  
DOW FIELD BANGOR ME.  
PLATE BEARING TESTS  
AVERAGE DEFLECTIONS  
TEST AREAS D AND E  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



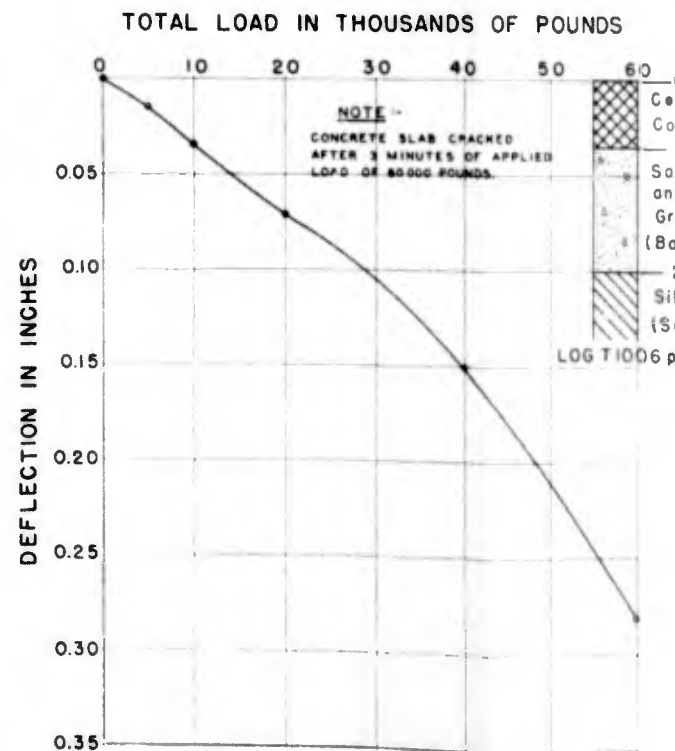
**PBT-108**



**PBT-152**

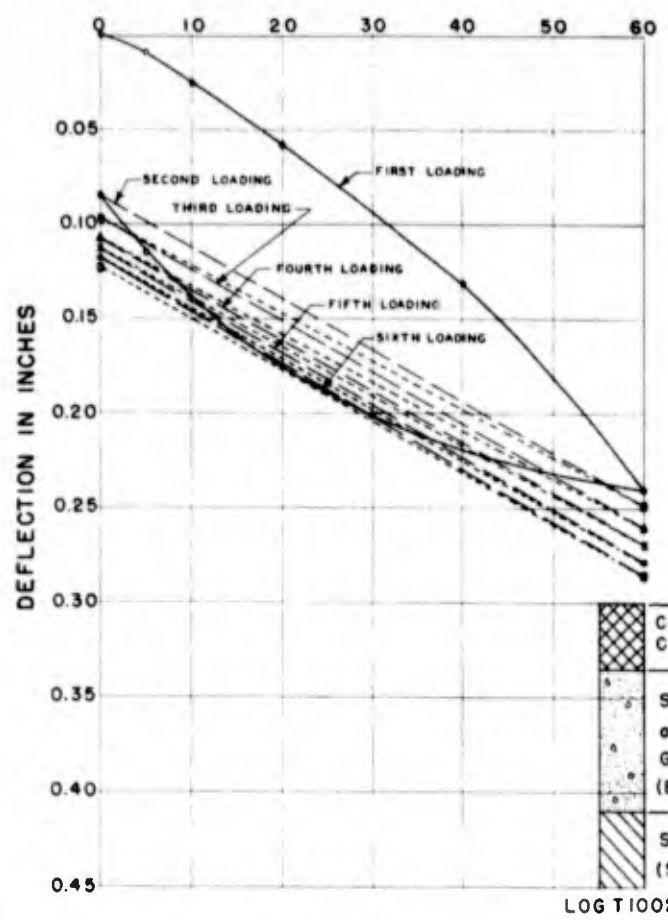
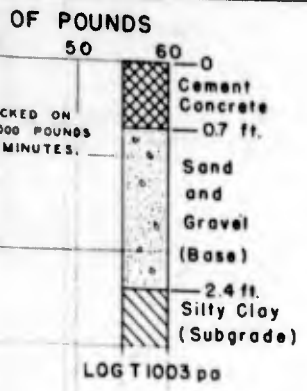


**PBT-171**



**PBT-172**

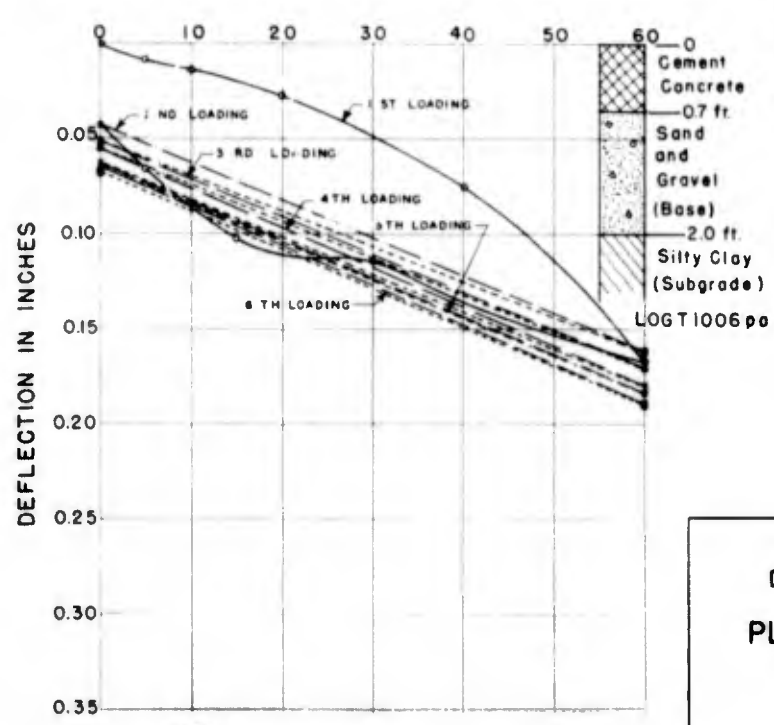
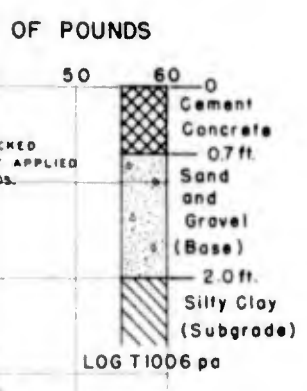
A



TEST NO.	LOCATION	STATION	OFFSET	DATE
108	TAXIWAY A	2 + 11	29' N C	23 OCT/46
152	TAXIWAY A	2 + 11	21' S C	9 APR/47
153	TAXIWAY A	2 + 09	51' N C	10 APR/47
171	TAXIWAY A	2 + 11	9' S C	4 JUNE/47
172	TAXIWAY A	2 + 11	39' S C	5 JUNE/47
193	TAXIWAY A	2 + 09	59' S C	24 JUNE

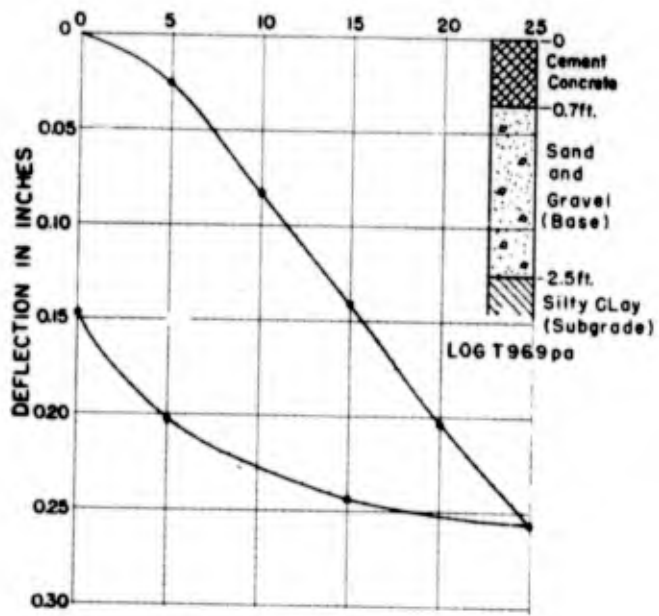
**PBT-153**

**NOTE:**  
Tests performed by applying loads, in increments, up to 60 000 pounds to a 24" diameter plate on the pavement surface, releasing the load and then reapplying.

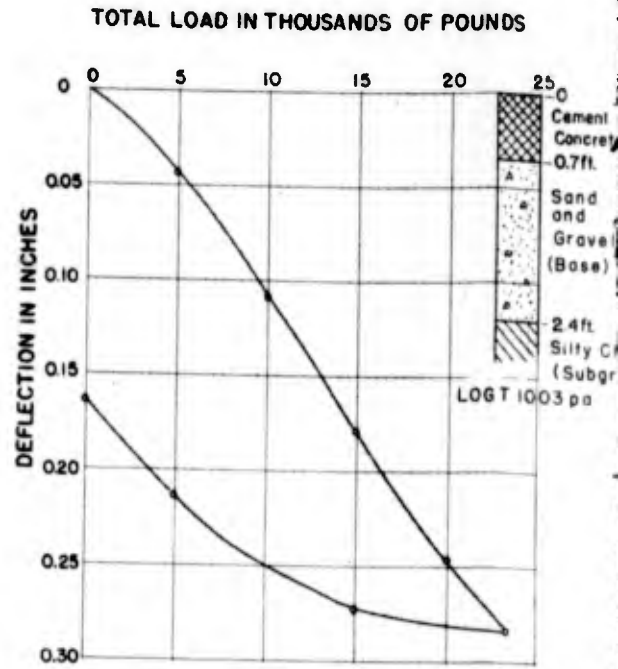


**PBT-193**

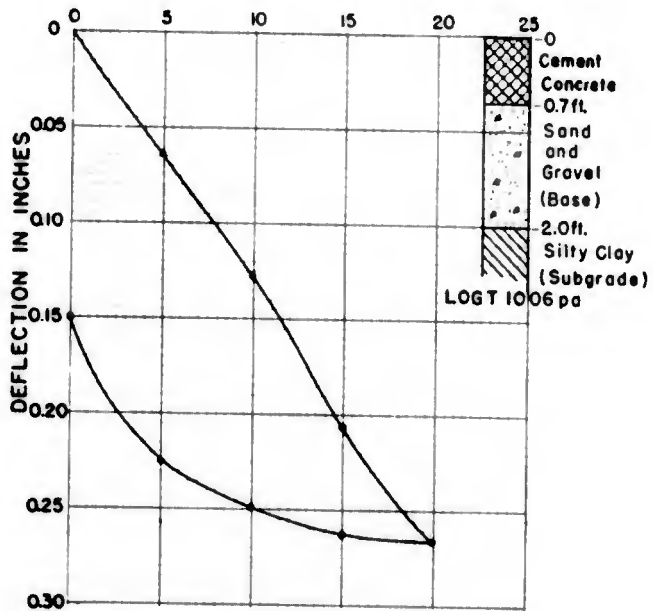
FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
**PLATE BEARING TESTS**  
RUPTURE  
TEST AREA F  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947



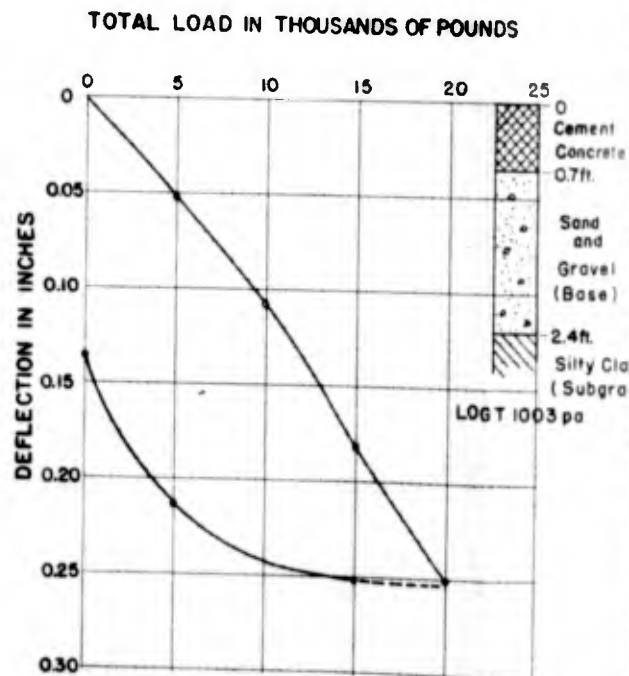
PBT-109



PBT-154



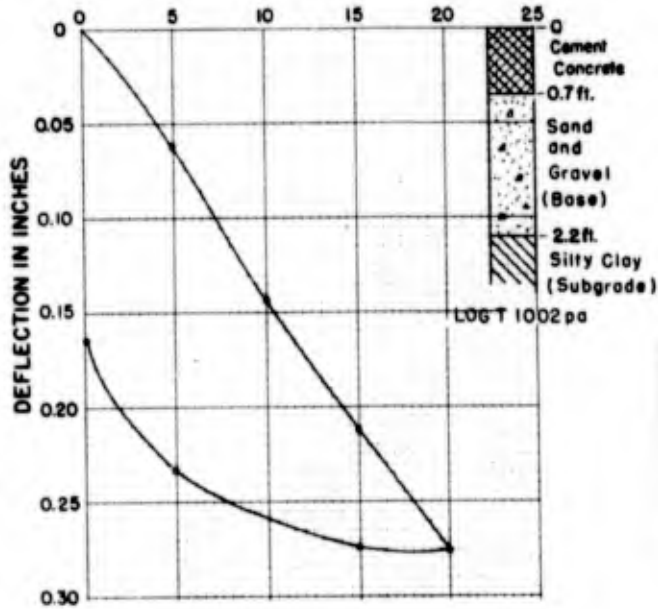
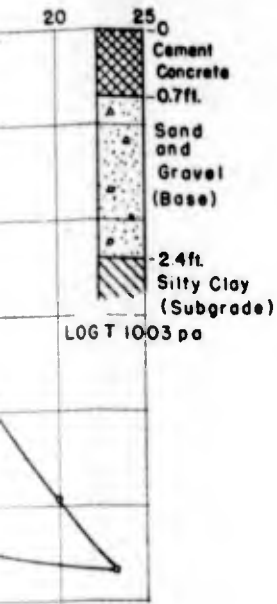
PBT-173



PBT-180

A

OF POUNDS



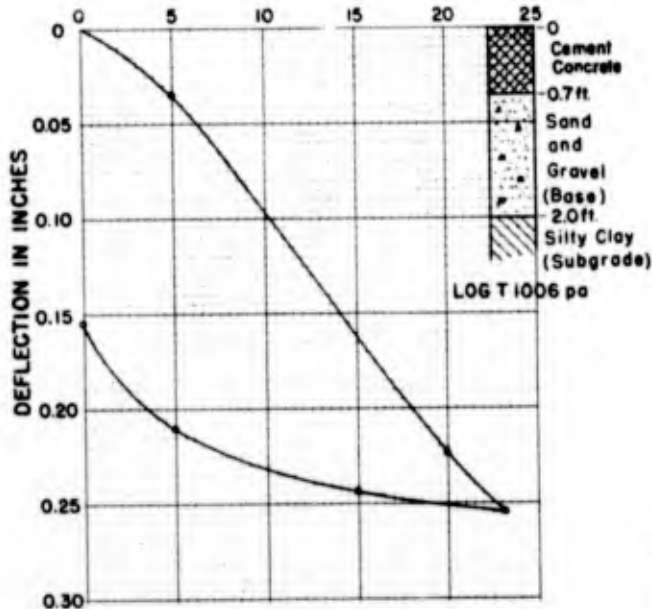
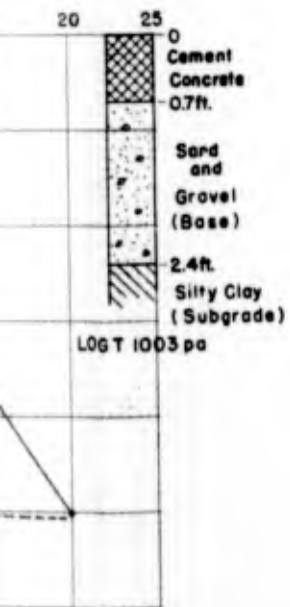
TEST NO.	LOCATION	STATION	OFFSET	DATE
109	TAXIWAY A	2 + 14	28' N. E.	25 OCT 46
154	TAXIWAY A	2 + 11	19' S. E.	11 APR /47
158	TAXIWAY A	2 + 09	49' N. E.	14 APR /47
173	TAXIWAY A	2 + 09	41' S. E.	5 JUNE /47
180	TAXIWAY A	2 + 09	12' S. E.	10 JUNE
194	TAXIWAY A	2 + 12	62' S. E.	26 JUNE

PBT-158

NOTE:-

Tests performed by applying load to a 30" diameter plate on the sand and gravel base (pavement removed)

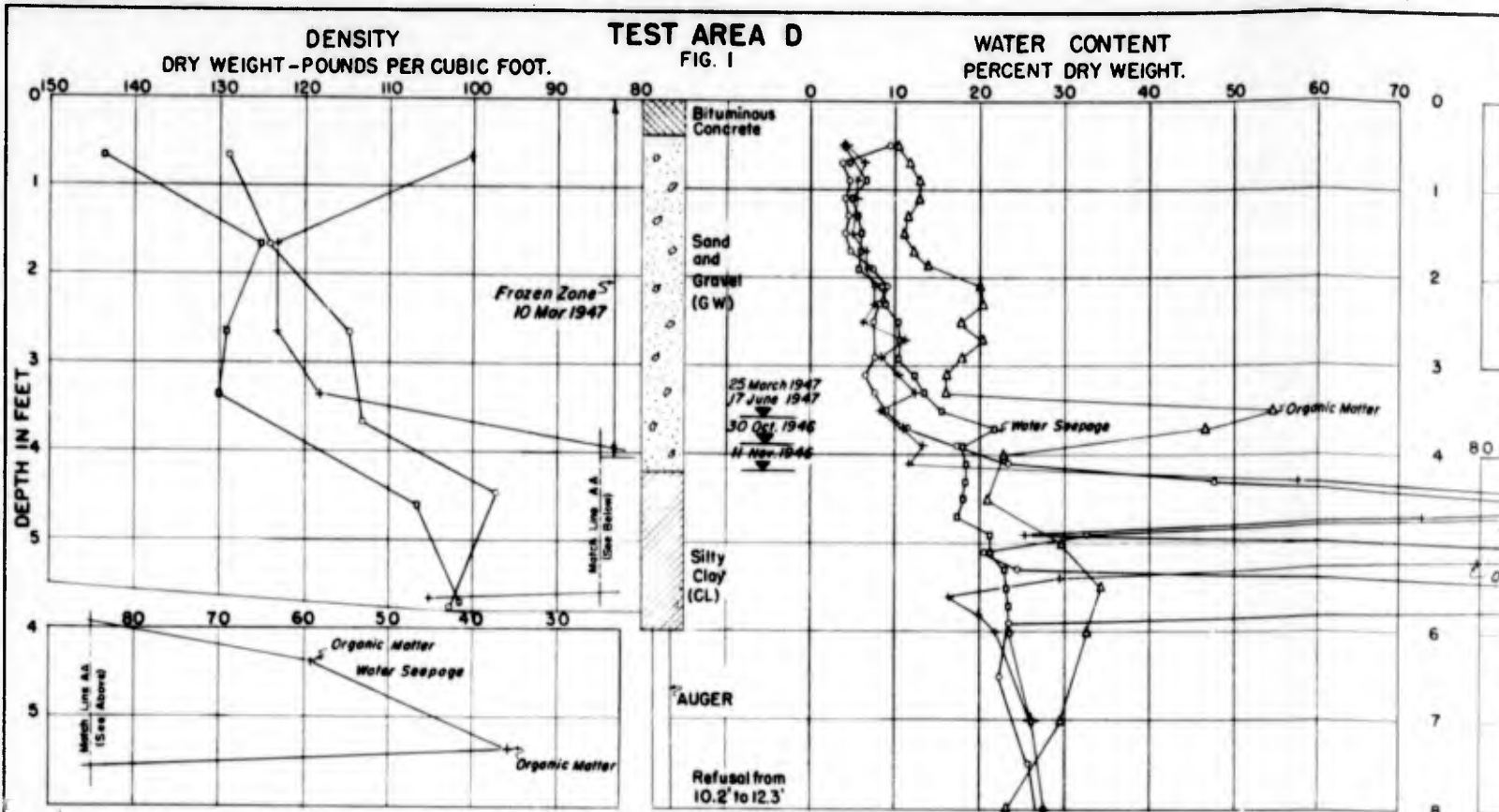
S OF POUNDS



PBT-194



FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
  
**PLATE BEARING TESTS**  
**SUBGRADE MODULUS**  
**TEST AREA F**  
  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947  
 PLATE 15

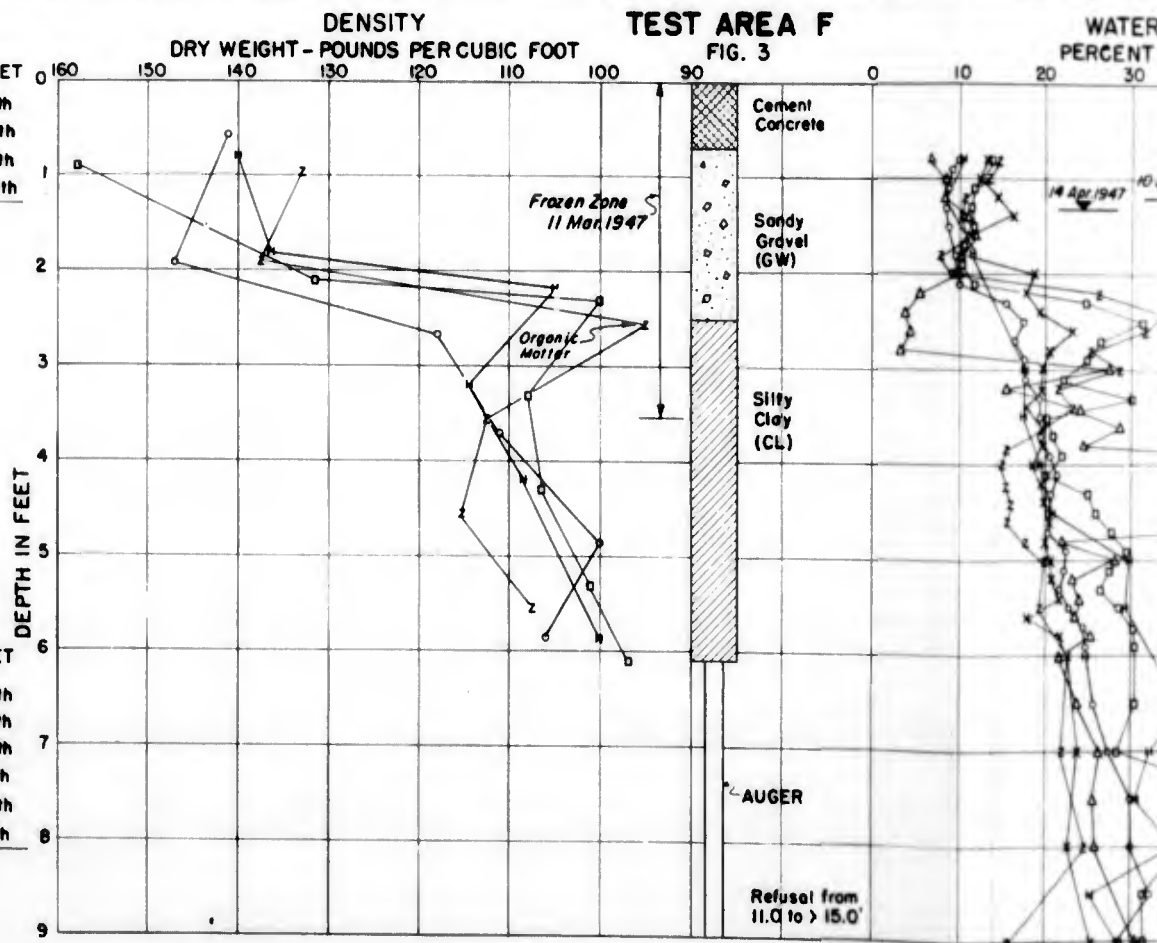


**TEST AREA D**

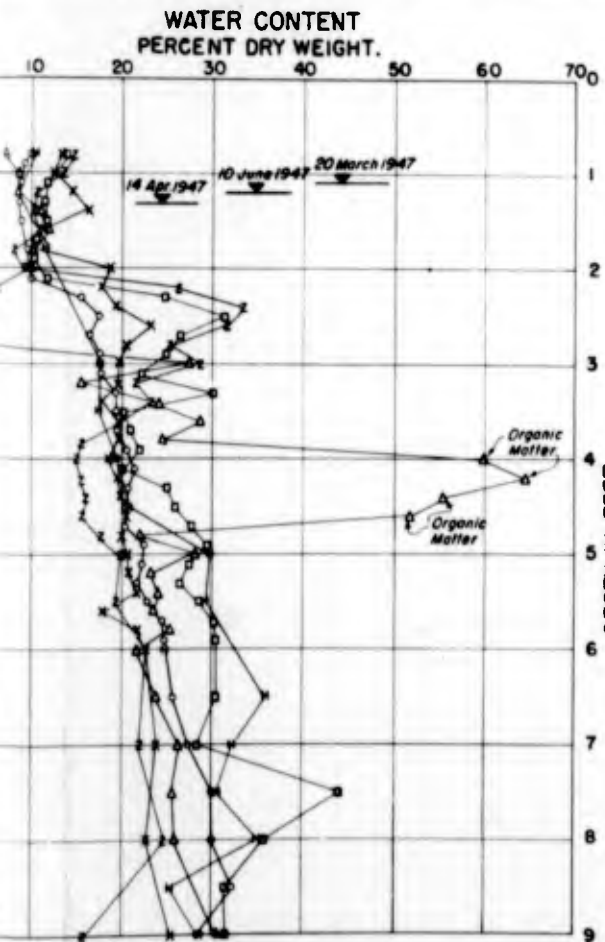
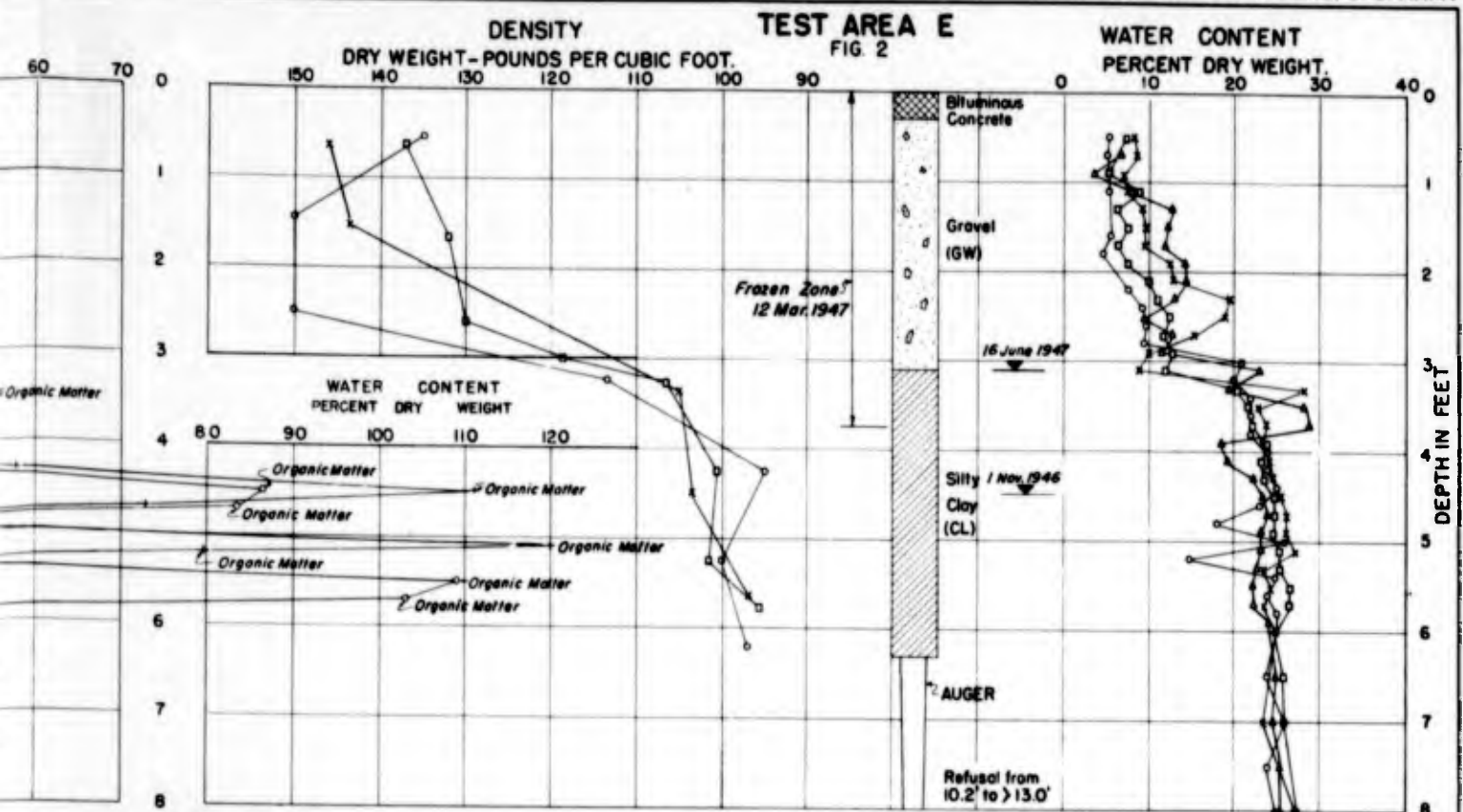
SYMBOL	TEST PIT	DATE	STA.	± OFFSET
○	T 970 pe	30 Oct. 1946	8+30	47' North
△	T 993 pe	10 Mar. 1947	9+25	27' North
□	T 999 pe	25 Mar. 1947	8+25	47' North
+	T1005 pe	17 Jun. 1947	8+40	48' North

**TEST AREA F**

SYMBOL	TEST PIT	DATE	STA.	± OFFSET
○	T 969 pe	28 Oct. 1946	2+13	28' North
△	T 994 pe	11 Mar. 1947	1+71	22' North
x	T 997 pe	20 Mar. 1947	1+49	71' South
○	T1002 pe	14 Apr. 1947	2+09	49' North
z	T1003 pe	10-11 Jun. 1947	2+09	12' South
+	T1006 pe	26 Jun. 1947	2+12	62' South



*A*



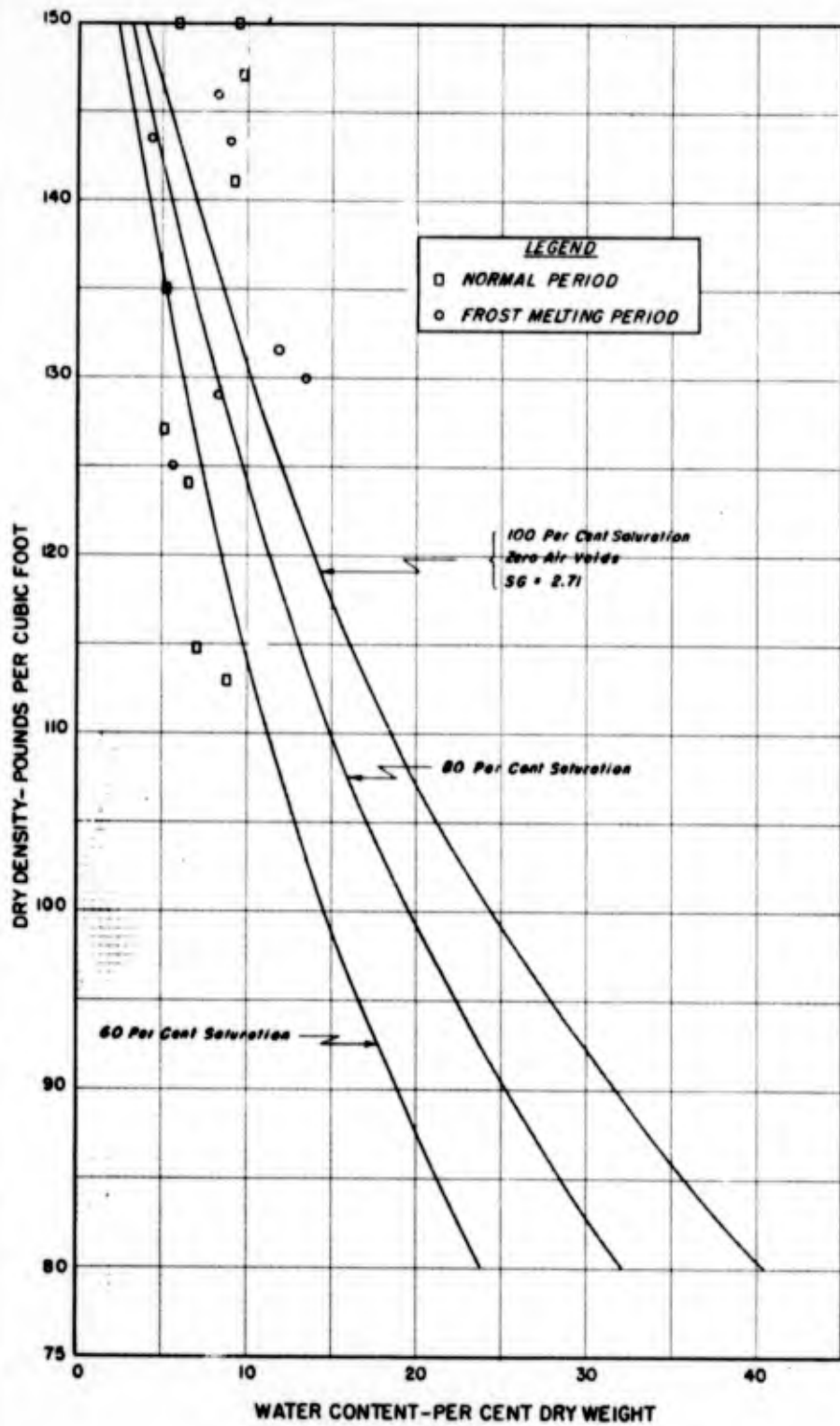
**TEST AREA E**

SYMBOL	TEST PIT	DATE	STA.	± OFFSET
○	T 968 pa	9 Oct. 1946	2+40	28' North
△	T 995 pa	12 Mar. 1947	2+80	26' North
□	T 998 pa	21 Mar. 1947	2+55	35' North
*	T1004 pa	17 Jun. 1947	2+50	27' North
∇	WATER TABLE			

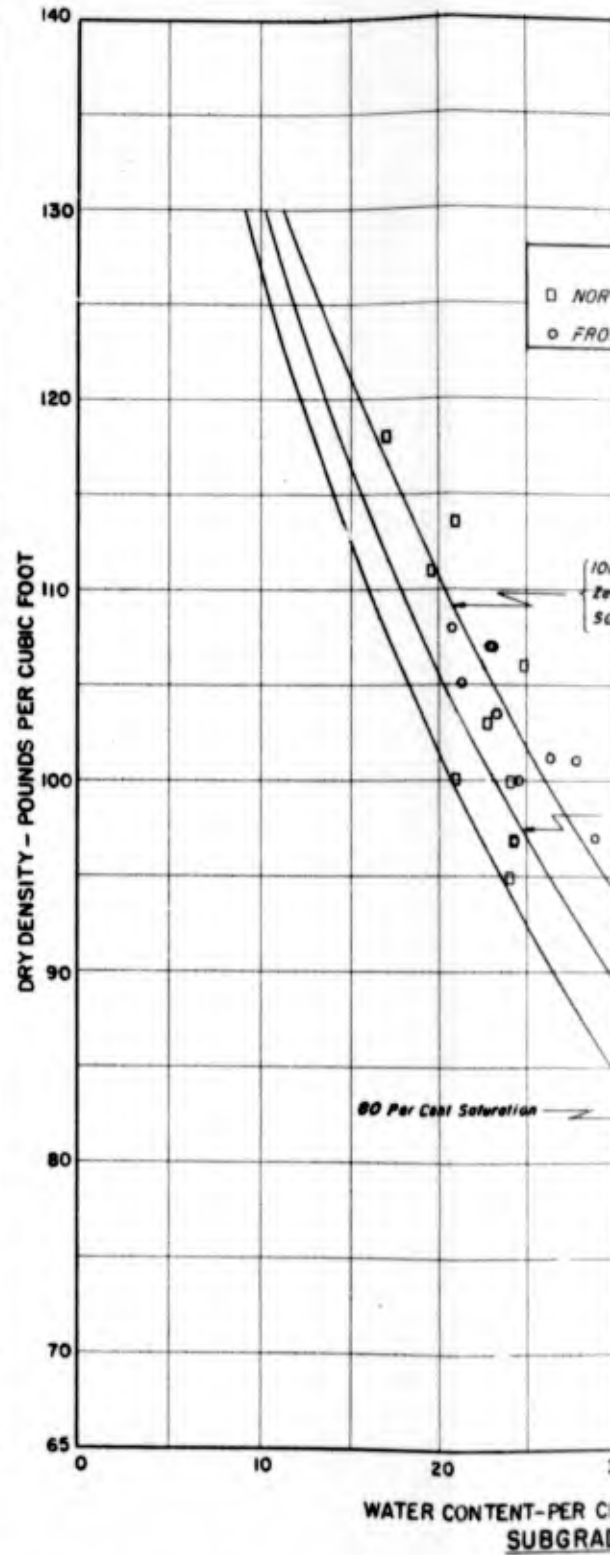
FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE.

WATER CONTENT-DENSITY  
SOIL PROFILES  
TEST AREAS D, E AND F

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



BASE  
FIG. 1

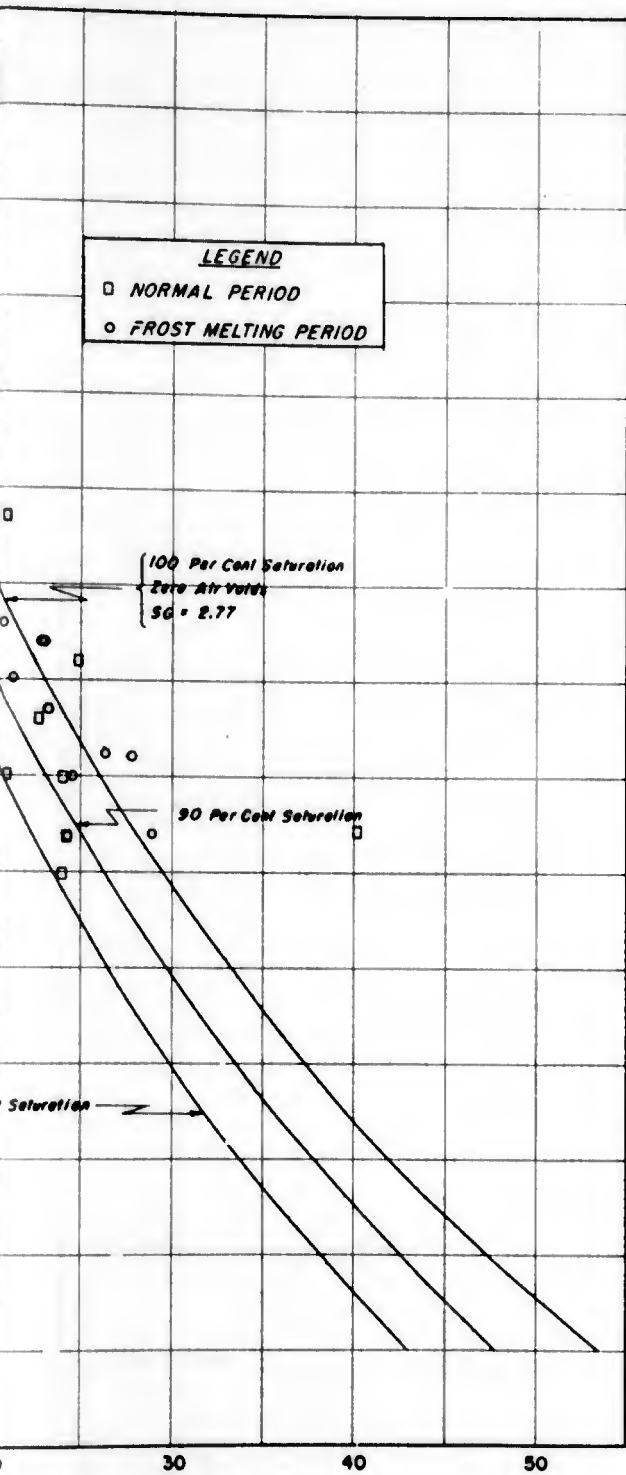


SUBGRADE  
FIG. 2

WATER CONTENT VS DENSITY

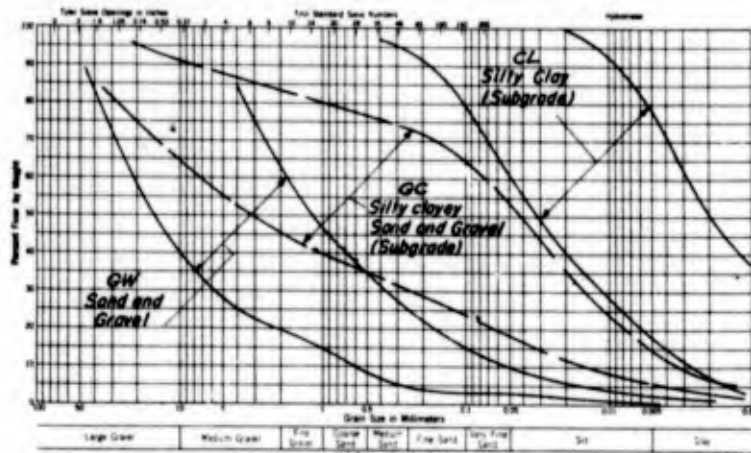
A

1



CONTENT-PER CENT DRY WEIGHT  
SUBGRADE

FIG. 2



GRADATION OF BASE AND SUBGRADE MATERIALS

FIG. 3

TEST AREA	TYPE	CLASSIFICATION	ATTERBERG LIMITS			SPEC. GRAVITY	
			LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	> 1/4	< 1/4
D, E, F	Base	Well graded Sand and Gravel (GW)	Avg. 33	20	13	2.67	2.74
			RANGE 29-38	19-22	11-17	2.60-2.77	—
D, E, F and Turf	Subgrade	Silty Clay (CL)	Avg. 33	20	13	—	2.74
			RANGE 29-38	19-22	11-17	—	2.71-2.78
Turf	Subgrade	Silty clayey Sand and Gravel (GC)	Avg. 20	15	4	2.60	2.79
			RANGE 19-21	15-17	2-6	—	—

FIG. 4

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE

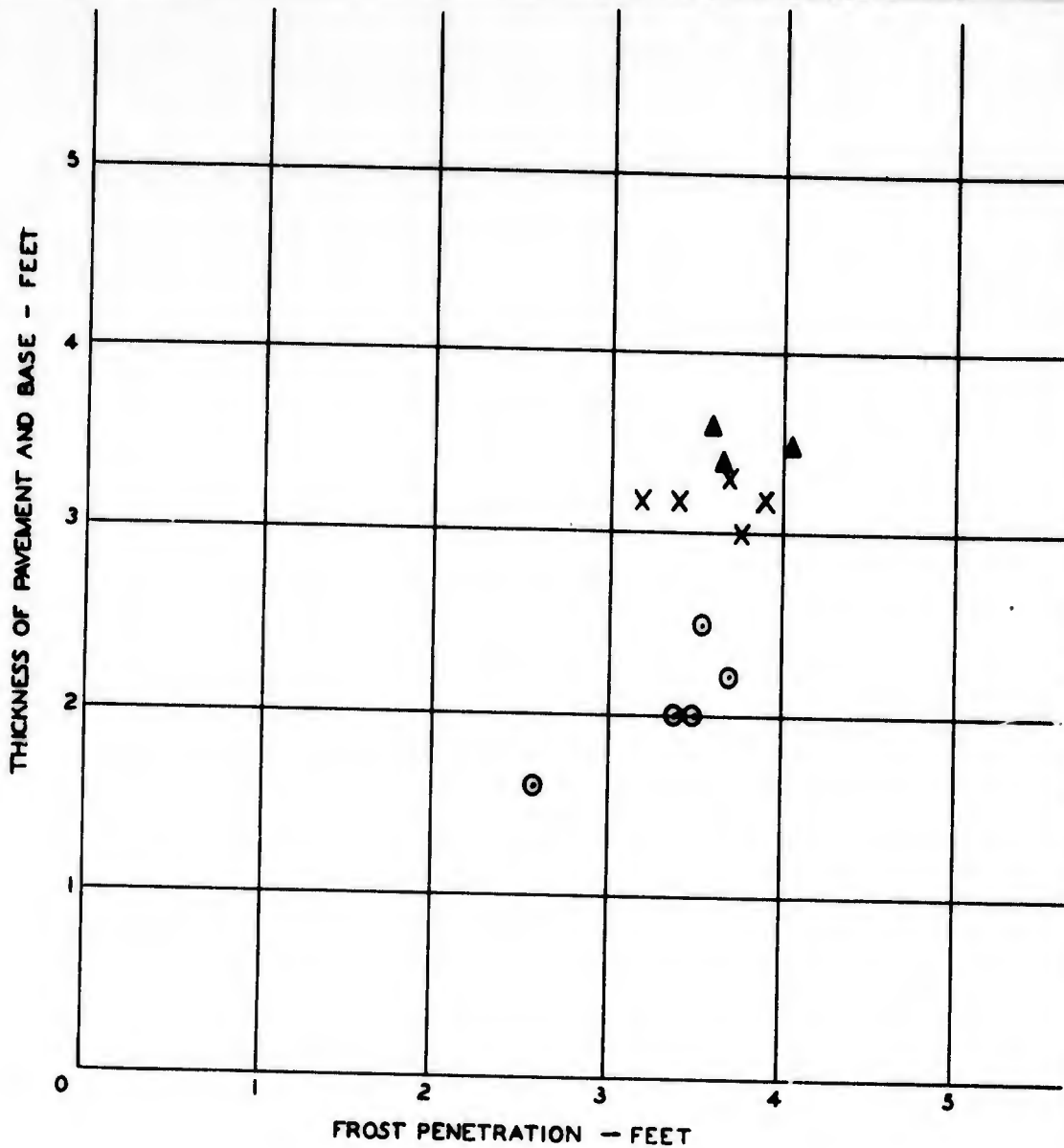
SOIL DATA SUMMARY  
TEST AREAS D, E AND F

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

PLATE 17

B

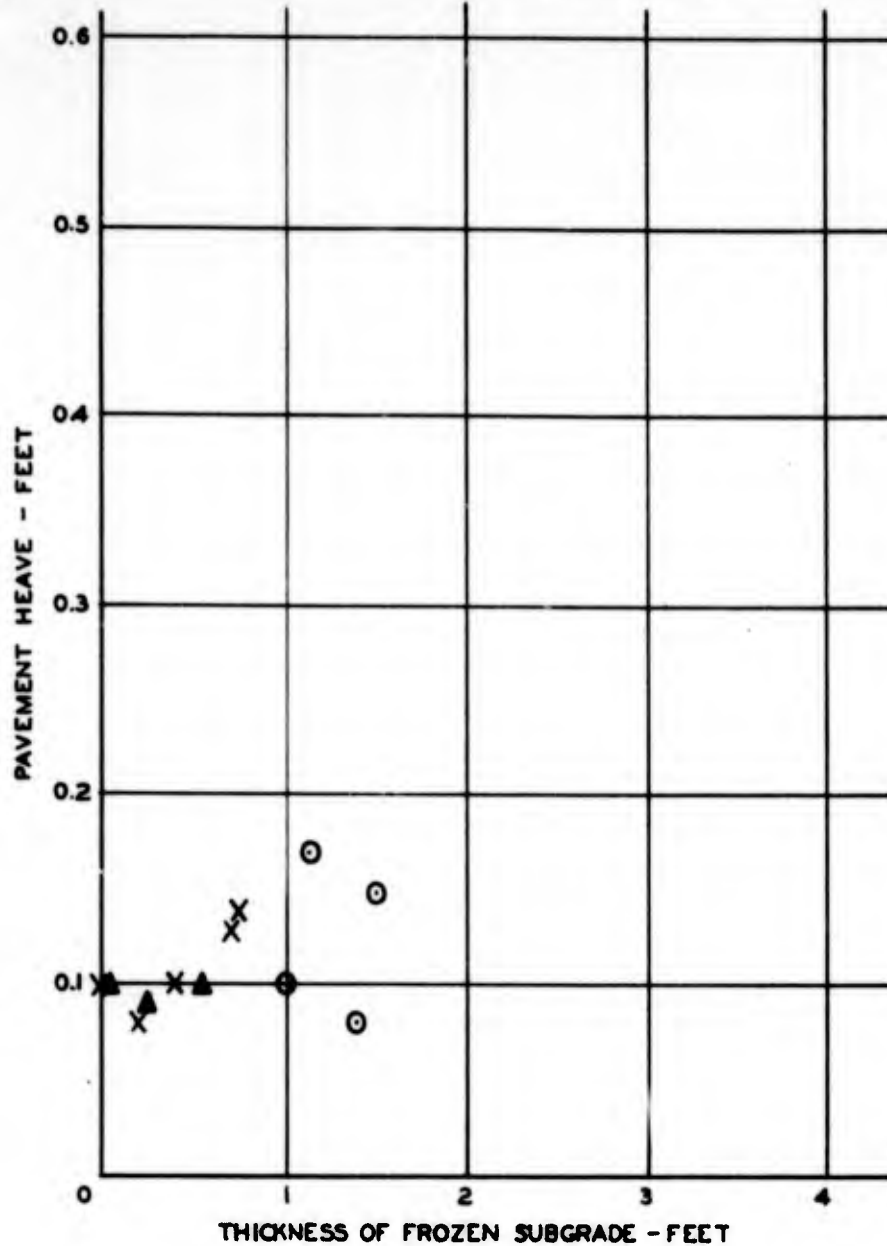
1



**LEGEND**

- ▲ TEST AREA D: BITUMINOUS CONCRETE PAVEMENT, GRAVEL BASE, SILTY CLAY SUBGRADE.
- X TEST AREA E: BITUMINOUS CONCRETE PAVEMENT, GRAVEL BASE, SILTY CLAY SUBGRADE.
- ⊙ TEST AREA F: CEMENT CONCRETE PAVEMENT, GRAVEL BASE, SILTY CLAY SUBGRADE.

**FROST INVESTIGATION**  
**DOW FIELD, BANGOR, ME.**  
**FROST PENETRATION VS.**  
**THICKNESS OF PAVEMENT**  
**AND BASE**  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



**LEGEND**

- ▲ TEST AREA D: BITUMINOUS CONCRETE PAVEMENT, GRAVEL BASE, SILTY CLAY SUBGRADE.
- X TEST AREA E: BITUMINOUS CONCRETE PAVEMENT, GRAVEL BASE, SILTY CLAY SUBGRADE.
- ⊙ TEST AREA F: CEMENT CONCRETE PAVEMENT, GRAVEL BASE, SILTY CLAY SUBGRADE.

**FROST INVESTIGATION**  
**DOW FIELD BANGOR, ME.**  
**PAVEMENT HEAVE RELATED TO**  
**THICKNESS OF FROZEN SUBGRADE**  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

NEW ENGLAND DIVISION  
CORPS OF ENGINEERS  
DEPARTMENT OF THE ARMY  
BOSTON, MASSACHUSETTS

APPENDIX 1

PART 2

REPORT ON  
TEST SECTION  
DOW FIELD, BAUGOR, MAINE

FROST INVESTIGATION

1946 - 1947

TABLE OF CONTENTS

<u>PARAGRAPH NO.</u>	<u>TITLE</u>	<u>PAGE NO.</u>
I - INTRODUCTION		
1-01	Authorization	1
1-02	Purpose	1
1-03	Scope	1
1-04	Definitions	2
II - DESCRIPTION OF TEST SECTION		
2-01	General	2
2-02	Pavements	3
2-03	Non-Frost Susceptible Materials	4
2-04	Frost Susceptible Materials	5
2-05	Insulation	6
2-06	Source of Water	8
2-07	Ground Water Observation Wells	8
2-08	Thermocouples	9
2-09	Temperature Measuring Equipment	9
2-10	Instrument Room	10
2-11	Thermograph	10
2-12	Bench Marks	10
III - OBSERVATIONS AND MEASUREMENTS		
3-01	General	11
3-02	Subsurface Temperature Measurements	11
3-03	Air Temperature	12
3-04	Surface Temperature	12
3-05	Weather Conditions	12
3-06	Water Table	13
3-07	Pavement Heave	13
IV - ANALYSIS OF RESULTS		
4-01	Weather	14
4-02	Test Element Temperatures	14
4-03	Depth of Freezing Temperature	16
4-04	Pavement Heave and Settlement	18
V - CONCLUSIONS AND RECOMMENDATIONS		
5-01	General Conclusions	19
5-02	Recommendations	21

LIST OF TABLES

<u>TABLE NO.</u>	<u>TITLE</u>
1	Summary of Data
2	Temperature Record of Test Element A
3	Temperature Record of Test Element B
4	Temperature Record of Test Element C
5	Temperature Record of Test Element D
6	Temperature Record of Test Element E
7	Temperature Record of Test Element F
8	Temperature Record of Test Element G
9	Temperature Record of Test Element H
10	Temperature Record of Test Element J
11	Temperature Record of Test Element K
12	Temperature Record of Test Element L
13	Temperature Record of Test Element M
14	Temperature Record of Test Element N
15	Temperature Record of Test Element P
16	Temperature Record of Test Embankment R
17	Temperature Record of Test Embankment S

LIST OF PLATES

<u>PLATE NO.</u>	<u>TITLE</u>
1	Test Section
2	Details of Test Section
3	Density and Water Content in Test Elements with Location of Thermocouples. Soil Classification Data
4	Density and Water Content in Test Elements with Location of Thermocouples
5	Typical Subsurface Temperatures
6	Maximum and Minimum Daily Temperatures
7	Freezing Index
8	Freezing Temperature and Pavement Heave Vs. Time. Elements A, B, C, D
9	Freezing Temperature and Pavement Heave Vs. Time. Elements E, F, G, H
10	Freezing Temperature and Pavement Heave Vs. Time. Elements J, K, L, M
11	Freezing Temperature and Pavement Heave Vs. Time. Elements N, P. Embankment R, S
12	Temperatures at Two Hour Intervals on 4 April, 1947
13	Temperatures at Two Hour Intervals on 12 April, 1947
14	Comparative Temperature Gradients in Elements and Embankment
15	Depth of Freezing Temperature Penetration
16	Details of Construction
17	General View of Test Elements During Construction
18	Subgrade Material in Elements
19	Test Elements Showing Pavement Settlement
20	Water Supply Tank

LIST OF PLATES (CONT'D)

<u>PLATE NO.</u>	<u>TITLE</u>
21	Thermocouples and Thermocouple Leads
22	Thermocouple Leads to Instrument Room
23	Thermocouple Switching Panel and Temperature Indicating Scale

## FROST INVESTIGATION

1946 - 1947

### REPORT ON TEST SECTION DOW FIELD, BANGOR, MAINE

#### I. INTRODUCTION

1-01. Authorization. The frost investigation program was continued by authorization contained in two letters from the Chief of Engineers to the Division Engineer, New England Division, dated 25 July 1946 and 12 August 1946, Subject: "Funds for Investigational Program for Fiscal Year 1947". The Frost Effects Laboratory, established at the New England Division by direction of the Chief of Engineers, as stated in Circular Letter No. 3221, dated 11 August 1944, was continued in its function. Addendum No. 1 to the original instructions and outline dated August 1946 from the Chief of Engineers, covers the details of the Test Section constructed at Dow Field, Bangor, Maine.

1-02. Purpose. A test section was constructed and observed (a) to determine the rate of frost penetration into non-frost susceptible base materials with rigid and flexible pavements and (b) to study the effect of density, degree of saturation and water supply on frost action in frost susceptible soils for a period of several years.

1-03. Scope. This report contains the construction details and results of observations made in a test section containing 14 combinations of pavement, base, and subgrade materials exposed to freezing temperature during the first year of observations. The test section includes 14 portland cement concrete cylinders each eight feet high and five feet inside diameter, containing specimen material of either cinders, sand and gravel,

crushed rock or silty clay referred to hereinafter as elements. The flexible type pavement was simulated by a four-inch cover of bituminous concrete placed over the specimen material, and the rigid pavement by a six-inch cover of portland cement concrete. The effect of shallow ground water was obtained in four of the elements by connections to a controlled water supply. The rate of frost penetration in each test element was determined by temperatures recorded by thermocouple installations. Observations were made of degree of saturation, water content, and density at time of placing, and pavement heave and subsidence during freezing and frost melting periods. Observations of the water content and density were made after the frost melting period in the four elements in which the subgrade was placed at a low density.

1-04. Definitions. The description of the tests and analysis of results involve a specialized use of certain terms and words. These words and terms are defined for use in the glossary in Part 1 of this report.

## II. DESCRIPTION OF TEST SECTION

2-01. General. An area, "Reclamation Yard", located at the southerly end of Dow Field, was made available for the construction of a test section. The work was performed by hired labor during the period from August to October 1946. The test section consisted of 14 elements, A to H inclusive, J to N inclusive and P, five feet in diameter and eight feet in depth. Each element was enclosed in a reinforced cement concrete pipe of standard tongue and groove construction eight feet long and 5 feet 10 inches outside diameter set upright in a reinforced cement concrete base of 12-inch thickness placed one foot below the original ground surface. The elements were placed in two rows 7.75 feet from center to center. The embankment

surrounding the elements was constructed of sand and gravel to a height approximately five feet below the top of the elements. Sawdust was placed on the gravel fill to six inches below the finished grade and a blanket of sand and gravel was placed to bring the embankment up to the top of the elements. Details of the test section are shown on Plates 1 and 2. Photographs taken during construction are shown on Plates 16 and 17. The sawdust was used for insulation to minimize heat transfer between elements and adjoining fill. Additional insulation was provided along the top of the pipe, as shown in Figure 4, Plate 2, to reduce heat transfer down through the concrete pipe.

The top of the test section, 60.5 feet in length by 21.75 feet in width, was sloped for surface drainage. The side slopes were two feet horizontal to one foot vertical.

2-02. Pavements. To simulate the effect of airfield pavements, the test elements were capped with portland cement concrete or bituminous concrete. Three elements B, D, and F had six inches of portland cement concrete pavements. The remaining 11 elements were designed for two inches of bituminous concrete pavement. Replacement of bituminous concrete at the end of the year indicated that the pavement averaged four inches thick. The pavements are similar in quality to those used in airfield construction. The cement concrete was a ready mixed, 1:2:4 proportion, with six bags of cement per cubic yard and with aggregate sizes shown by grain size curve in Figure 8, Plate 3. Compression test results on six molded 12-inch cylindrical samples from the portland cement concrete batches were as follows:

7 day strength = 1,894 pounds per square inch  
14 day strength = 2,770 pounds per square inch  
28 day strength = 3,646 pounds per square inch

The bituminous concrete contained five per cent of 85 to 100 penetration asphalt cement. The gradation of the aggregate in the mix is shown by the grain size curve in Figure 8, Plate 3. The pavement was sealed with an application of RC-2 at a rate of 0.25 gallon per square yard. Clean well-graded cover sand was applied to the seal coat at a rate of 20 pounds per square yard.

2-03. Non-Frost Susceptible Base Materials.

a. Cinders (Elements A and B). The behavior of cinders as a base course and insulating material when subject to freezing was investigated in elements A and B. The cinders used were retained on a 1/4-inch screen to remove excessive fines and were hand tamped into the portland cement concrete cylinders to avoid excessive crushing of the particles. The dry densities obtained ranged from 53 to 68 pounds per cubic foot with the water contents between one and two per cent as shown in Figures 1 and 2 on Plate 3. Four inches of bituminous concrete and six inches of cement concrete were placed directly on the cinders in elements A and B respectively.

b. Sand and Gravel (Elements C and D). Sand and gravel was compacted in elements C and D at dry densities ranging from 127 to 131 pounds per cubic foot and at water contents ranging from six to eight per cent as shown in Figures 3 and 4 on Plate 3. The grain size gradation is shown by curve 2 of Figure 7 on Plate 3. The material is well graded, and of GW classification. Four inches of bituminous concrete and six inches of cement concrete were placed directly on the sand and gravel in elements C and D respectively.

c. Crushed Rock (Elements E and F). Crushed rock was placed in elements E and F at dry densities ranging from 107 to 112 pounds per

cubic foot and one per cent water content as shown in Figures 5 and 6 on Plate 3. The grain size gradation is shown by curve 1 of Figure 7 on Plate 3. The original placing of material in element E did not result in the desired 110 pounds per cubic foot density. The material was removed and, in the second attempt, each foot layer was compacted to take a pre-weighed quantity necessary for the required density. The crushed rock was placed by dumping from a high-body dump truck and compacted with a power tamper. Four inches of bituminous concrete and six inches of cement concrete were placed directly on the crushed rock in elements E and F respectively.

2-04. Frost Susceptible Materials (Elements G,H,J,K,L,M,N and P). A frost susceptible silty clay (CL) representative of the existing top five feet of the subgrade soil in place under the airfield pavement at Dow Field was placed as a subgrade at controlled densities and water contents in eight elements. The grain size gradation curve is shown on Figure 7 on Plate 3. Four of the elements, G, H, J, and K, had a controlled water surface seven feet below the pavement and four elements, L, M, N, and P, were not in contact with a water surface to simulate a water table at infinity. The silty clay was placed dense at a high water content, loose at a high water content, dense at a low water content, and loose at a low water content in elements G, H, J, and K, respectively. These conditions were duplicated in elements L, M, N, and P, respectively. Table of element variables is shown on Plate 2. The silty clay was difficult to handle but the densities and water contents at which it was placed were approximately those desired. Plate 18 shows the material placed in element M at 28 per cent water content after the silty clay had been run through a mixer to bring the water content

up ten per cent and element P with the material placed at 22 per cent water content. During the frost melting period the pavement in those elements, H, K, M, and P, in which the subgrade was placed in a loose condition settled so that the pavement and base had to be removed, the subgrade brought up to grade by the addition of silty clay and new base and pavement placed. The condition of pavement in elements H and M after settlement and prior to reconstruction is shown on Plate 19. At the time of reconstruction density and water content determinations were made by driving a 2.75-inch diameter thin-walled, seamless steel tubing into the subgrade. These density and water content values showed considerable variation from those determined during the construction of the test elements. All values of density and water content determinations are shown on Plates 3 and 4.

The silty clay subgrade was covered with a six-inch layer of sand and gravel which was treated with RT-5 sprayed at the rate of one gallon per square yard. A four-inch layer of bituminous concrete pavement was placed over the sand and gravel.

2-05. Insulation.

a. The top edges and top 14 inches of the sides of each concrete cylinder were insulated with sawdust as shown in Figure 4, Plate 2. It was originally planned to use cork board and granulated cork for the insulating material. Failure to get delivery of the material necessitated the use of readily available sawdust. The sawdust was held in place by a permanent plywood form. After the sawdust was placed in the form, a plywood cover was nailed on. For water-proofing against surface seepage the cover was treated with double-ply 15-lb. felt thoroughly coated on all

surfaces with three coats of roofing pitch. The felt overlapped the pavement surface by two inches and extended three inches outside the perimeter of the plywood form, as shown by Plate 19.

b. The insulating fill between cylinders and the bulk of the embankment consisted of sawdust as shown in section in Figure 3, Plate 1. Because of the scarcity of cinders in this vicinity, it was necessary to use sawdust. The sawdust was hauled by truck and shovelled into place by hand. Where possible, the trucks were driven over successive layers of the material in an effort to obtain as great an initial settlement as possible. Attempts to compact the sawdust by hand in the constricted areas did not appear to be successful. Sawdust insulation was also used in back-filling the trench excavated for the water supply lines.

c. The use of sawdust introduced a heating effect not originally anticipated. The decomposition of the sawdust used in the embankment generated sufficient heat to raise its temperature to over 100 degrees Fahrenheit. This condition was observed at the start of measuring temperatures in the test section. Two corrective measures were attempted. On November 14 the surface of the test section was soaked with water. This resulted in reducing the temperature of the sawdust from approximately 100 degrees to 50 degrees Fahrenheit. Soaking was continued until the beginning of freezing weather on 28 November. The cooling effect of the water was only temporary as subsequent temperature readings again indicated a rise in the sawdust temperature. A second corrective measure was attempted from the 3rd to the 10th of December 1946. A total of 120 auger holes on two foot centers surrounding the test elements were dug in order to reduce the volume of sawdust in the embankment. The holes, nine inches in diameter, were dug through

the sawdust to gravel and backfilled with gravel, as the gravel was intended to serve as a ventilation tube for releasing the heat within the sawdust. Temperatures decreased upon completion of this work, but it is possible that colder weather had a greater influence than the replacement of a small portion of sawdust.

2-06. Source of Water. Elements G, H, J, and K, were connected at the base to a controlled water supply as shown in Figure 5 on Plate 2. A two-layer filter 12-inches thick consisting of sand with gradation of grain sizes shown by curves 5 and 6 in Figure 7 of Plate 3, designed to prevent the washing out of the fines contained in the silty clay was placed between the subgrade and the base of the element. A reservoir was installed in the instrument room by excavating a pit of 2 x 4 foot area to a depth of five feet. The excavation was lined with cement concrete taken from the same batches used for the test element bases. A galvanized metal supply tank with ball and cock valve to control the water level was installed in the pit as shown on Plate 20. The water level was maintained at the top surface of the filter material. Copper tubing was laid from the tank to the cylinders as shown in Figure 5, Plate 2.

2-07. Ground Water Observation Wells. Observation wells for measuring the actual depth to the controlled source of water was installed in test elements G, H, J, and K. The observation wells consisted of 3/4-inch pipe perforated at the lower end and capped at the top with a coupling and plug. A short iron rod was welded to the coupling to facilitate removal of the plug. Figure 5 of Plate 2 shows the installation detail. Observation wells also were installed in the north and south edge of the test section embankment. The north and south wells were used to detect a possible rise of the natural

ground water capable of seeping into the cylinders. This precaution was made since the controlled supply of water from the reservoir was intended to serve as the only source of ground water.

2-08. Thermocouples. The temperature of the pavement, base, and sub-grade materials in each test element was measured by thermocouples set in the positions shown on Plates 3 and 4. The thermocouple details are the same as used in the previous investigations and are described in Paragraph 3-03 b, Part 1 of this report. Nine thermocouples were installed in each of the 14 test elements. A vertical board in the center of the empty cylinder, as shown in Figure 1, Plate 21, was used to hold the thermocouple at the desired position. As the material was filled over a thermocouple, it was detached from the board and the lower part of the board was sawed off and removed. Precaution against the wire snapping because of frost action was made by allowing sufficient slack and covering the cables with a heavy coating of grease. The outlet sleeve of the cylinders shown in Figure 3, Plate 2 was made watertight by sealing with battery compound. The entire thermocouple line leading to the entrance of the instrument room was buried in a trench backfilled with cinders and gravel to a depth of one foot above the top bank of ducts. Figure 2, Plate 21 and Figure 1, Plate 22 show several thermocouple cables in position before backfilling.

Thermocouples R and S in Figure 1, Plate 1 were installed at two locations in the embankment outside the test elements. These installations each consist of seven units spaced in the gravel and sawdust fill as shown in Figure 5, Plate 1. Temperatures within the embankment were observed for comparison with those obtained within the test elements.

2-09. Temperature Measuring Equipment. The temperatures of the

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2-09. Temperature Measuring Equipment. The temperatures of the

thermocouples were measured during the period 11 October to 23 December 1946 on a Leeds and Northrup direct reading portable type potentiometer by connecting each of the thermocouple leads with the instrument separately. On 23 December 1946 a Leeds and Northrup Micromax Temperature Indicator was installed. Each of the thermocouple leads was connected permanently to the instrument and the temperature at any thermocouple was obtained by switching the proper switch. The switch panels and the temperature indicating scale are shown on Plate 23.

2-10. Instrument Room. A section of Building T162 in the Reclamation Yard at Dow Field was partitioned off for use as an instrument room to contain the temperature measuring instruments and water supply controls. The interior walls were constructed of 1/2-inch insulation board and the exterior wall was sheathed with matched boards with the space between the studs packed with sawdust. Two 3-Kilowatt electric heaters, with a thermostatic control, were installed to maintain a constant room temperature.

2-11. Thermograph. A thermograph was installed in a shelter located 25 feet north of the test section as shown in Figure 2, Plate 1 to obtain continuous records of air temperature.

2-12. Bench Marks. Two bench marks were established for reference points to measure changes in elevation of the element pavements throughout the freezing and frost melting periods. One bench mark consisted of a bolt set in the concrete foundation of the northwest corner of the nearest warehouse building in the Reclamation Area. The second bench mark consisted of a 1-1/2-inch pipe set inside a 2-1/2-inch pipe casing. The casing was approximately five feet long to protect the bench mark pipe through the frost zone and the bench mark pipe was set firmly in the clay subgrade. This bench

mark was located approximately 40 feet south of the test elements.

### III. OBSERVATIONS AND MEASUREMENTS

3-01. General. Observations of conditions pertinent to frost action studies such as rate of frost penetration, subsurface temperatures, ice lens formation, pavement heave, and changes in density and water content were proposed for the investigations. No suitable means for measuring rate of frost penetration, ice lens formation, and changes in density and water content were developed consequently only weather conditions, subsurface temperature, and pavement heave measurements were made.

3-02. Subsurface Temperature Measurements. Subsurface temperature measurements were made at intervals ranging from two to nine days, commencing 11 October 1946 and ending 26 December 1946. Two sets of readings were made daily, except Sunday, beginning 27 December 1946. The first set of readings was made between 7 A.M. and 10 A.M.; the second was made between 1:30 P.M. and 4:30 P.M. The morning readings were made to measure the effect of the more constant, colder night temperature. Typical subsurface temperature gradients for the elements are shown on Plate 5. The afternoon readings were made to determine the time lag between the varying air temperature and the soil temperature within the elements.

To further investigate the time effect of air temperature fluctuations, measurements were made at two-hour intervals on the following days:

- 4 April 1947; 5 A.M. to 7 P.M., (Clear)
- 5 April 1947; 5 A.M. to 1 P. M., (Clear until 11 A.M.)
- 12 April 1947; 5 A.M. to 3 P.M., (Cloudy until 1:30 P.M.)
- 15 April 1947; 5 A.M. to 7 P.M., (Clear)
- 21 April 1947; 5 A.M. to 1 P.M., (Cloudy)
- 26 April 1947; 5:30 and 7:30 A.M., (Cloudy until 7:30 A.M.)

The results of all thermocouple temperature measurements are tabulated in Tables 2 to 17. All temperatures are shown in degrees Fahrenheit.

Prior to the installation on 23 December 1946 of the Micromax temperature measuring equipment, the hand operation of the potentiometer required two hours to obtain a set of temperature readings. The automatic equipment required 15 minutes. For this reason, a greater range in air temperature occurred during the time required to obtain the sets of temperature readings made from 11 October to 23 December 1946.

3-03. Air Temperature. Continuous records of air temperature were obtained from the thermograph. The minimum and maximum daily temperatures from the thermograph records shown on Plate 6 were used to calculate the 1946-1947 freezing index plotted on Plate 7. The air temperatures at the time of reading the thermocouples were obtained from the thermograph recordings.

3-04. Surface Temperature. The temperature at the surface of each element was measured by a mercury thermometer. While reading the thermocouples for a given test element, the thermometer was placed on the pavement surface of the test section and shielded from the sun by a wooden board. These readings are tabulated for comparison with other temperature readings in Tables 2 to 17 inclusive.

3-05. Weather Conditions. The direction and intensity of the wind as indicated by the Beaufort scale is tabulated with the temperature data in Tables 2 to 17. Cloud and sun conditions prevailing during the time of temperature measurements also are shown. The test section was kept clear of snow cover to eliminate consideration of its insulation effect during this investigation.

3-06. Water Table. The observation wells in elements G, H, J, and K were examined each time temperature measurements were made. The measured depth from surface of element to water varied from 7.1 to 7.3 feet.

The north and south observation wells were dry except on four separate occasions during the latter part of November and December when the water table appeared in the wells at depths ranging from 7.6 to 7.9 feet.

3-07. Pavement Heave. The heave of the pavement on each of the test elements was determined by level surveys as an indication of the frost action which occurred. The original elevation of five points on each test cylinder pavement was referenced to a bench mark not subject to frost action. The five level points on top of each test element consisted of the center of pavement and the quarter points along the pavement circumference. Changes in elevation were measured to the nearest hundredth foot on the following dates:

19 Nov. 1946	7 Feb. 1947
31 Dec. 1946	11 Feb. 1947
27 Jan. 1947	17 Feb. 1947
31 Jan. 1947	10 Mar. 1947
4 Feb. 1947	13 Mar. 1947
17 Mar. 1947	8 Apr. 1947
27 Mar. 1947	16 Apr. 1947
1 Apr. 1947	22 Apr. 1947

Changes in elevation of the pavement at the center of the elements are plotted on Plates 8 to 11 for comparison with the penetration of the 32°F. temperature.

#### IV. ANALYSIS OF RESULTS

4-01. Weather. The winter during this investigation was milder than usual for Bangor, Maine. The 1946-1947 freezing index shown on Plate 7 was 965 as compared with a 13-year normal of 1275. Rainfall and snowfall are not pertinent to this study because of controlled ground water conditions and because the top of the test section was maintained clear of snow. The direction and intensity of the wind may have an effect on the rate of drying the pavement surfaces, but no measurable influence is evident from the pavement temperature data.

4-02. Test Element Temperatures. At the time of reading, morning and afternoon, the pavement surface temperatures were usually warmer than the air temperatures. The bituminous concrete surface was warmer than the cement concrete during a majority of the observations. The continuous air temperatures recorded on the thermograph show that the daily maximum and minimum air temperatures usually occurred at the time of measuring the afternoon and morning test element temperatures. The hourly change in air temperature is reflected in the elements to a depth of approximately one foot. Below this depth the temperature gradient in all the test elements was approximately the same. The warming effect of the sawdust embankment surrounding each test element may have limited the depth to which the daily fluctuations of air temperature were transferred within the test elements.

The effect of fluctuations in air temperature measured at two-hour intervals during clear and cloudy days is shown in Plates 12 and 13. The same data is tabulated in Tables 2 to 17, but the plotted data are arranged to facilitate a comparison of the temperature changes of the various materials as a function of air temperature changes. The clear day selected

for analysis is 4 April 1947 when temperature measurements were made every two hours from 5 A.M. to 7 P.M. The cloudy day selected for analysis is 12 April 1947 when an unusually warm spell occurred. Temperature measurements on this day were made from 5 A.M. to 3 P.M. at 1:30 P.M. on 12 April the weather cleared and the sun appeared at 2 P.M. However, the rain until 11 A.M. and cloudy weather until 2 P.M. offered a good contrast with the readings of the clear day. The thermograph records of continuous air temperature are reproduced in Figure 1 of Plates 12 and 13 for consideration of air temperature conditions for three days prior to the time of making the two-hour interval readings. The curves in Figure 2, Plates 12 and 13 indicate the surface temperature reaction of each test element. The surface temperature of all elements was warmer than the air during a clear day. The rain on 12 April during the 5 A.M., 7 A.M., and 9 A.M. readings kept the surface temperature of all test elements approximately equal to the air temperature. However, the surface temperature of all test elements became warmer than the air after the rain ended despite continued cloudiness.

Figures 3, 4, and 5 on Plates 12 and 13 show the temperature changes within the elements and embankment during the same two-hour intervals. The thermal characteristics of the material is indicated by comparing the temperature versus time curves. During the daylight hours the surface temperature is higher than the air temperature and reaches its peak one to three hours ahead of the air temperature. Approximately two hours were required for changes in surface temperature to reach the midpoint of either four inches of bituminous concrete or six inches of cement concrete. However, consideration must be given to the magnitude and rate of change in air temperature. For the test period on 4 April there was a 20 degree Fahrenheit drop in air

temperature during the 12 hours prior to the measurements, as shown on Plate 12. For the test period on 12 April the air temperature was more constant and dropped nine degrees Fahrenheit prior to the measurements, as shown on Plate 13. The peaks of temperature changes in relation to time are thus more pronounced for the 4 April measurements. The results on Plates 12 and 13 show a consistently lower temperature on top of the base course for the elements capped with cement concrete. During a clear day the base course surface beneath the cement concrete pavement is from 4 to 20 degrees Fahrenheit colder than the base course surface beneath the bituminous concrete. Although there is no distinction between the various materials for temperatures measured below approximately one foot, consideration must be given to the effect of the sawdust embankment. It is believed that the insulation value of the sawdust embankment, in addition to its heat producing characteristics had a greater effect through the side walls of the test element than the air temperature acting vertically through the element surface.

The continued effect of the decomposition of the sawdust insulation is indicated by the temperature gradients of the four elements adjacent to the thermocouple installation (S) located in the center of the test embankment. Typical temperature gradients are shown on Plate 14. The temperature lag in the sawdust is shown and a comparison of the temperature measurements in the test embankment and those in the test areas as presented in Part 1 of this Appendix indicates that temperatures were consistently higher in the test elements than in the runway test areas. The average depth of freezing temperature penetration was 17 inches in the test elements and 47 inches in the runway test areas.

4-03. Depth of Freezing Temperature. The frozen zones of the materials

in each test element is best analyzed by comparing the depth of freezing temperature versus time. The graphs on Plates 8 through 11 show the freezing temperature zone determined from thermocouple readings made in the morning about one hour after daybreak. The boundary of the frozen zone is considered to be the depth of penetration of the 32-degree Fahrenheit temperature. The plotted depth of the 32-degree temperature was interpolated by assuming a straight line temperature gradient between the temperature of any two adjacent thermocouples which bracket 32 degrees Fahrenheit.

An additional summary of the depth of the 32-degree Fahrenheit penetration is shown on Plate 15. The maximum depth during the test period is shown in Figure 1 by a bar graph representative of each test element. The mean depth of the 32-degree temperature for the month of January is correspondingly shown in Figure 2.

In the elements containing the non-frost susceptible base materials the maximum depth of freezing temperature penetration was consistently greater under the portland cement concrete than under the bituminous concrete. The freezing temperature penetration under the portland cement concrete pavement was greatest in the crushed rock and least in the sand and gravel. Under the bituminous concrete pavement there was very little difference between the three types of base materials with the penetration in the crushed rock slightly greater than in the sand and gravel and into the cinders slightly less than in the sand and gravel. The actual depths of freezing temperature penetration is shown below.

<u>Material</u>	<u>Depth of Freezing Temperature Penetration</u>	
	<u>Bituminous Concrete</u>	<u>Cement Concrete</u>
Cinders	19 inches	26 inches
Crushed Rock	22 inches	30 inches
Sand and Gravel	20 inches	23 inches

Based upon the depth of freezing temperature penetration these tests do not indicate the insulating value of cinders compared with the other materials tested.

In the elements containing the frost susceptible subgrade materials, the frost penetration was least in the elements with ground water available and highest in the elements without ground water with the exception of elements K and M as shown in the following table:

<u>ELEMENT</u>	<u>DENSITY</u>	<u>WATER CONTENT</u>	<u>DEGREE OF SATURATION</u>	<u>WATER TABLE</u>	<u>FREEZING TEMPERATURE PENETRATION (inches)</u>
G	dense	high	high	yes	12
H	loose	high	high	yes	14
J	dense	low	low	yes	16
K	loose	low	low	yes	18
L	dense	high	high	no	22
M	loose	high	high	no	17
N	dense	low	low	no	21
P	loose	low	low	no	19

A similar study of the thermocouple readings obtained during the afternoon show the same bottom depth of the frozen zone. The distinction between the morning and afternoon readings is the greater number of periods during the afternoon when the temperature near the surface was above 32 degrees Fahrenheit. These values measured during the afternoon appear as thawing periods.

4-04. Pavement Heave and Settlement. The only evidence of frost action available in this investigation is indicated by the amount of pavement heave. The pavement heave, and in some cases the pavement settlement, are shown related to time and depth of freezing temperature on Plates 8 to 11.

Pavement heave occurred in elements containing the frost susceptible silty clay. The heave and settlement in the elements limited to base course material was of a negligible amount being not greater than

one-quarter of an inch.

The four elements G, H, J, and K, containing a source of water can be compared for frost action with the four elements L, M, N, and P, which were sealed off from a source of water and are considered to have water table at infinite depth. The elements exposed to a source of water developed the most heave although element H showed a consistent settlement. The elements with water table at infinite depth, heaved and settled to a lesser degree depending on the original degree of compaction. The appearance of the paved surface of elements H and M during settlement are shown on Plate 19.

Elements H, K, M, and P, developed settlement mainly after the freezing period. The original dry density at which the silty clay was placed in these cylinders was fairly loose ranging from 90 to 98 pounds per cubic foot. Elements G, J, L, and N heaved and returned nearly to their original elevation. The original dry density at which the silty clay was placed in elements which heaved was more dense, ranging from 101 to 107 pounds per cubic foot. It is apparent that a poorly compacted frost-susceptible subgrade will settle during the frost melting period.

#### V. CONCLUSIONS AND RECOMMENDATIONS

5-01. General Conclusions. Based upon the conditions encountered the following conclusions are presented.

a. The freezing temperature penetration was greater under the rigid pavement than under the flexible pavement for all types of non-frost susceptible materials tested.

b. The deepest depth of freezing temperature penetration was in the crushed rock with portland cement concrete pavement.

c. The deepest depth of freezing temperature penetration in the elements with bituminous concrete pavement was in the element with crushed rock.

d. The tests do not indicate the insulating value of cinders compared with other materials tested.

e. In the elements containing frost susceptible materials the elements with ground water available had less depth of freezing temperature penetration but greater heave than those without ground water.

f. The elements with loosely compacted subgrade developed heave during the freezing period and settlement below the original grade during the frost melting period.

g. The elements with loosely compacted subgrade at high water content had less depth of freezing temperature penetration than those with a more dense subgrade with and without ground water available.

h. In the elements with ground water available those with subgrade at a high degree of saturation had less depth of freezing temperature penetration than those with the subgrade at a lower degree of saturation.

i. In the elements with no ground water available the greatest and the least depth of freezing temperature penetration was found in the two elements placed at a high degree of saturation. The depth of freezing temperature penetration in the two elements placed at a low degree of saturation was between the depths found in the elements with material placed at a high degree of saturation.

j. The hourly changes in air temperature penetrated to a depth of approximately one foot in the test elements. Below this depth the temperatures inside the test elements were stabilized and followed the general

seasonal changes of air temperature.

k. The surface temperature of either the bituminous concrete or cement concrete pavement was usually warmer than the air during a clear day.

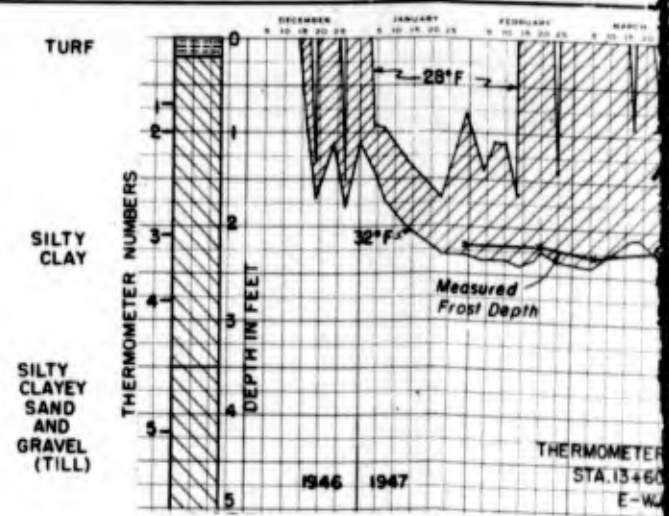
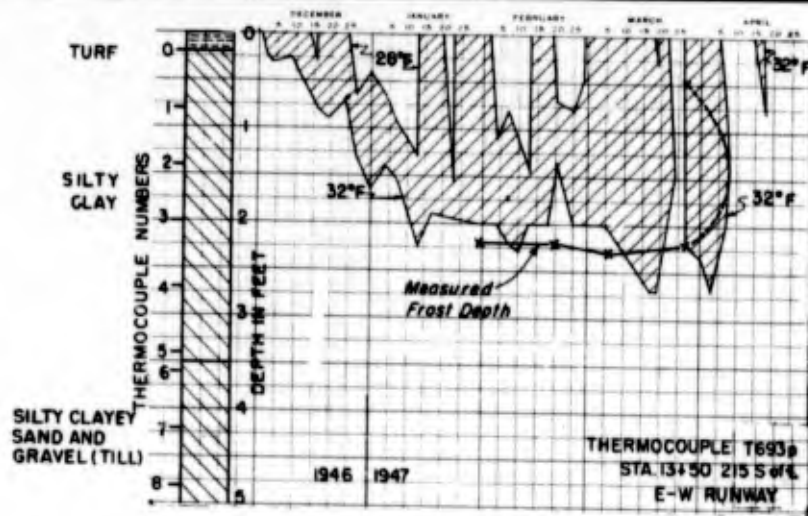
l. During a rainfall the surface temperatures of all test cylinders were about equal to the air temperature.

m. The bituminous concrete was usually warmer than the cement concrete especially during March and April.

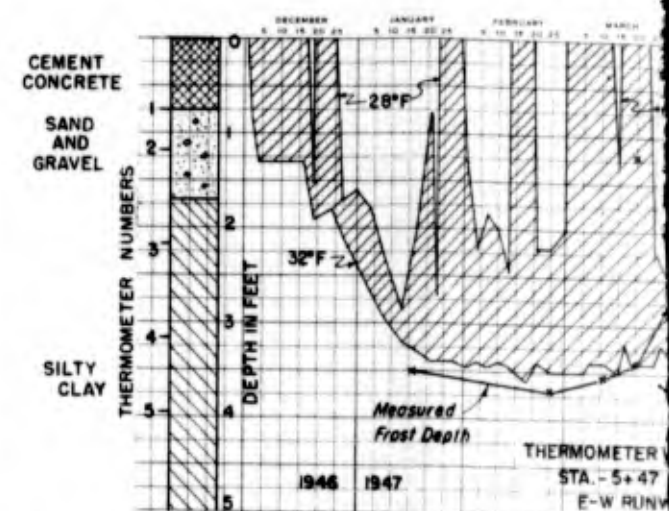
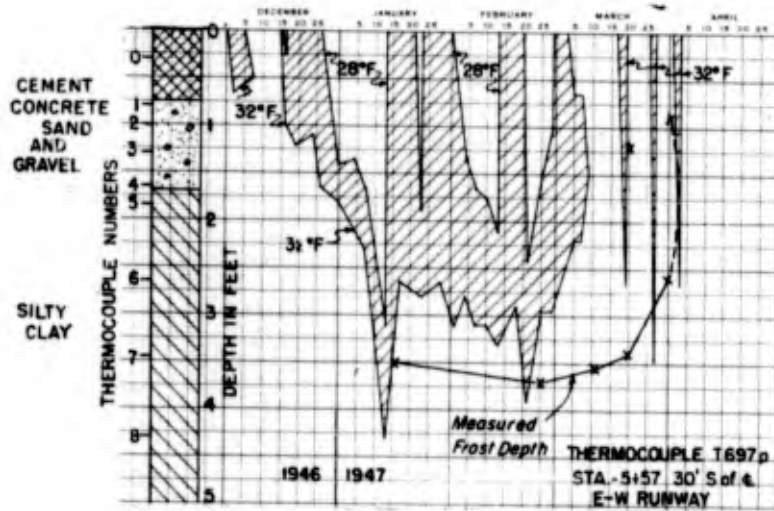
n. The time lag for changes of air temperature to penetrate four inches of bituminous concrete is about the same as that for six inches of cement concrete.

o. The bituminous concrete, including the top of base course material, had a wider range of daily temperature changes than that of daily temperature changes measured in cement concrete pavement.

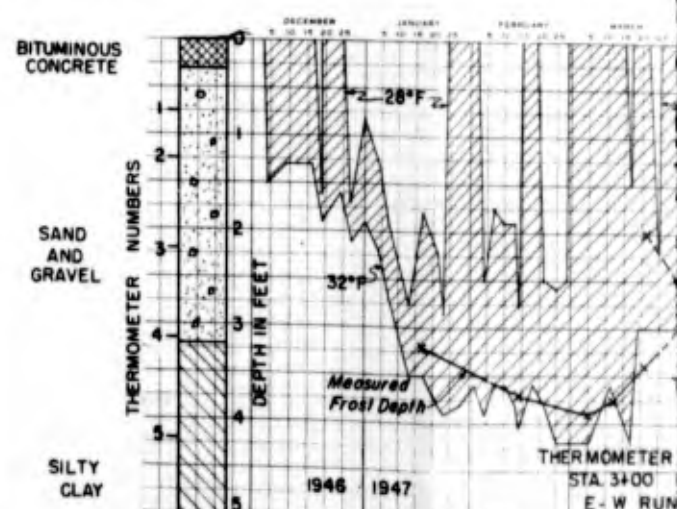
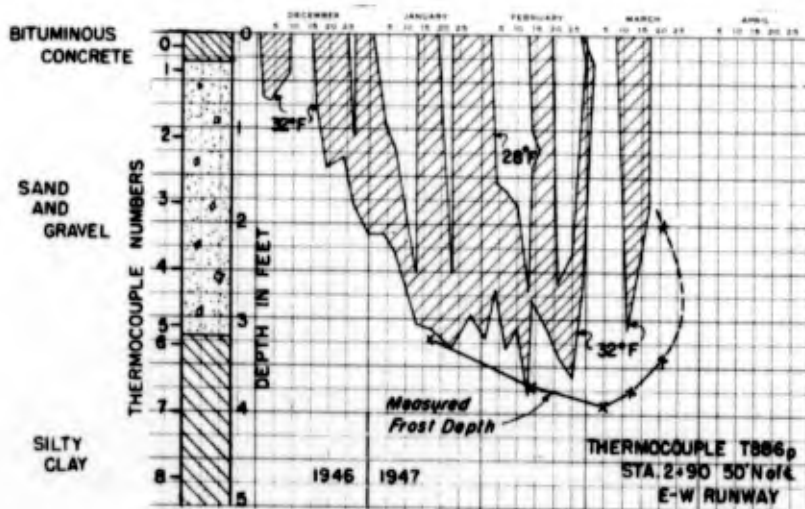
5-02. Recommendations. It is recommended that temperature and heave measurements be continued for another year after the replacement of the sawdust embankment with sand and gravel. Where settlement occurred it is necessary to remove the pavement and place additional material to bring the pavements to the same grade. Another season of observations, similar to those reported herein, will contribute a more thorough and better understanding of the frost behavior of the material investigated.



**TURF AREA**

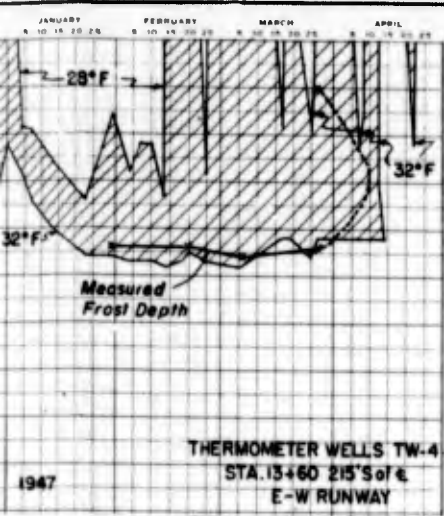


**TEST AREA F**



**TEST AREA E**

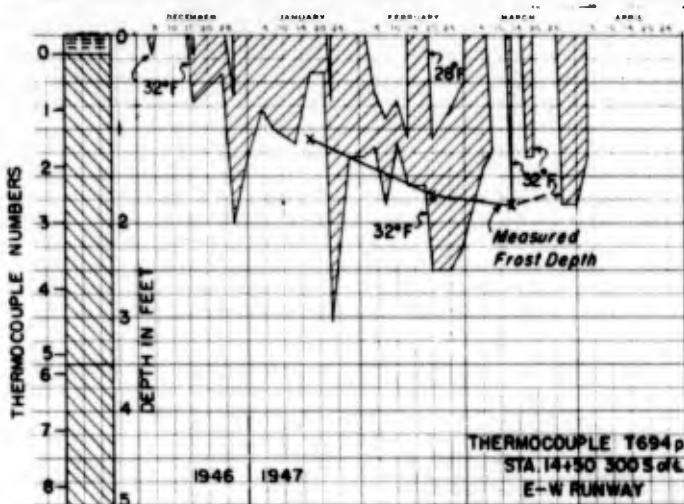
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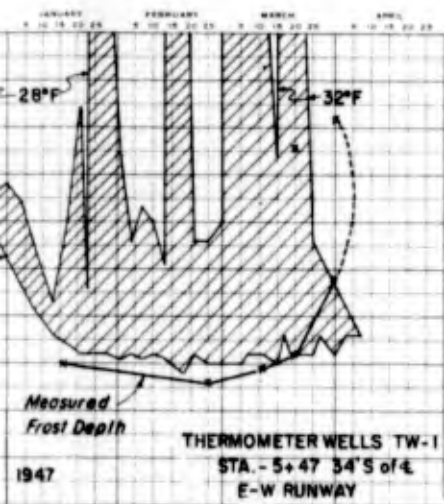
TURF

SILTY CLAY

SILTY CLAYEY SAND AND GRAVEL (TILL)



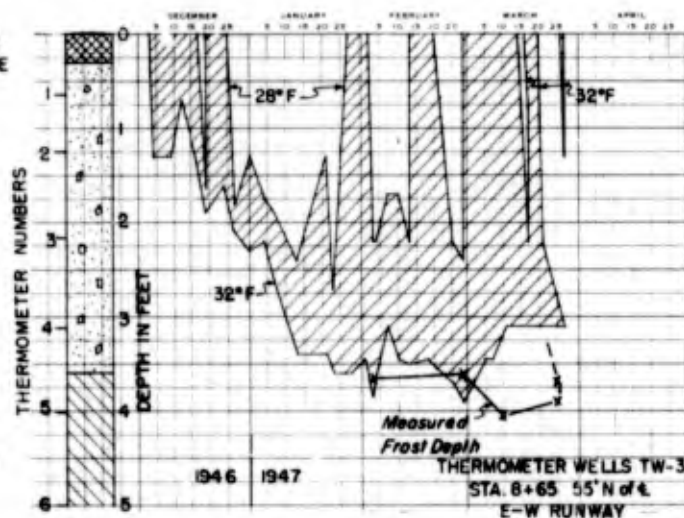
TURF AREA



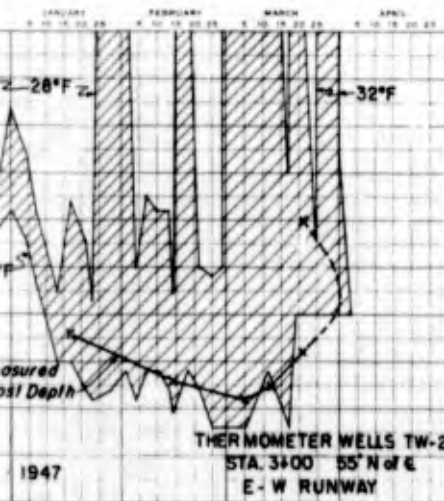
BITUMINOUS CONCRETE

SAND AND GRAVEL

SILTY CLAY



TEST AREA D



FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
SUBSURFACE TEMPERATURES  
AND  
FROST PENETRATION

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



## SUMMARY OF DATA

TEST ELEMENT	SURFACE		BASE			SUBGRADE			WATER CONTENT PER CENT DRY WT.		
	TYPE	THICKNESS (INCHES)	CLASSIFICATION	THICKNESS (INCHES)	PER CENT FINER THAN 0.075 mm	CLASSIFICATION	THICKNESS (INCHES)	PER CENT FINER THAN 0.075 mm	AS PLACED OCT. 1946	ON JUNE 1947	AS PLACED OCT. 1946
A	Bit. Conc.	4	Cinders	92	= (A)	-	-	-	1	-	58
B	P.C.C.	6	Cinders	90	= (A)	-	-	-	1	-	62
C	Bit. Conc.	4	Sand and Gravel (GW)	92	<2	-	-	-	7	-	128
D	P.C.C.	6	Sand and Gravel (GW)	90	<2	-	-	-	7	-	130
E	Bit. Conc.	4	Crushed Rock (B)	92	<1	-	-	-	1	-	110
F	P.C.C.	6	Crushed Rock (B)	90	<1	-	-	-	1	-	109
G	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Base -	-	116
H	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Subg. 18	-	102
J	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Base -	2	116
K	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Subg. 29	24	95
L	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Base -	-	123
M	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Subg. 16	-	104
N	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Base -	4	121
P	Bit. Conc.	4	Sand and Gravel (GW)	6	<2	Silty Clay (CL)	74	51	Subg. 19	23	92
EMBANKMENT LOCATION											
R	Sand and Gravel (GW)	6	-	-	-	Sawdust	60	-	Base -	-	120
S	Sand and Gravel (GW)	6	-	-	-	Sawdust	60	-	Subg. 17	-	104
									Base -	-	110
									Subg. 28	24	94
									Base 3	-	115
									Subg. 15	-	103
									Base 6	4	124
									Subg. 21	25	91

(A) Cinders retained on 1/4" sieve prior to placing.  
 (B) Crushed rock 3/8" to 1 1/2" diameter.

**NOTES:**

Freezing Index was 965.

Atterberg Limits of Subgrade Clay (CL).

	Average	Range
Liquid Limit	33	29-36
Plastic Limit	20	19-22
Plasticity Index	13	11-17

Specific Gravity of Subgrade Clay was 2.

A

# SUMMARY OF DATA

DEPTH INCHES	WATER CONTENT PER CENT DRY WT.		DENSITY PCF		DEGREE OF SATURATION			GROUND WATER DEPTH (INCHES)	FREEZING TEMPERATURE PENETRATION (INCHES)	MAXIMUM PAVEMENT HEAVE (INCHES)	MAXIMUM PAVEMENT SETTLEMENT (INCHES)
	AS PLACED OCT. 1946	ON JUNE 1947	AS PLACED OCT. 1946	ON JUNE 1947	PROPOSED	AS PLACED OCT. 1946	ON JUNE 1947				
1	-	-	58	-	-	-	-	Infinity	19	0.1	0.1
1	-	-	62	-	-	-	-	"	26	0.0	0.2
7	-	-	128	-	-	-	-	"	20	0.1	0.0
7	-	-	130	-	-	-	-	"	23	0.1	0.1
1	-	-	110	-	-	-	-	"	22	0.1	0.1
1	-	-	109	-	-	-	-	"	30	0.0	0.2
Base - Subg. 18	-	-	116 102	-	-	80 - 90	74	84	12	1.2	0.0
Base - Subg. 29	2 24	-	116 95	13 104	-	80 - 90	100	84	11	0.0	3.2
Base - Subg. 16	-	-	123 104	-	-	60 - 70	69	84	16	1.3	0.0
Base - Subg. 19	4 23	-	121 92	123 103	-	60 - 70	61	84	16	0.8	1.2
Base - Subg. 17	-	-	120 104	-	-	80 - 90	73	Infinity	22	1.0	0.0
Base - Subg. 28	-	24	110 94	123 100	-	80 - 90	94	"	17	0.1	2.3
Base 3 Subg. 15	-	-	119 103	-	-	60 - 70	63	"	21	0.6	0.0
Base 6 Subg. 21	4 25	-	124 91	134 100	-	60 - 70	66	"	19	0.5	1.2
-	-	-	-	-	-	-	-	-	12	-	-
-	-	-	-	-	-	-	-	-	10	-	-

Freezing Index was 965.

Atterberg Limits of Subgrade Clay (CL).

	Average	Range
Liquid Limit	35	29-56
Plastic Limit	20	19-22
Plasticity Index	13	11-17

Specific Gravity of Subgrade Clay was 2.74.

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE

**SUMMARY OF DATA**

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947

TABLE I

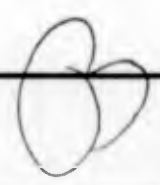


Table for October and November 1946. Columns include Thermo-couple No., Depth in feet, Type of material, and temperature readings for various times of day. Includes sub-sections for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for January 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and temperature readings for various times of day. Includes sub-sections for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for February 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and temperature readings for various times of day. Includes sub-sections for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for March 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and temperature readings for various times of day. Includes sub-sections for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for April 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and temperature readings for various times of day. Includes sub-sections for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

A













DATE AND TIME

DECEMBER 1946		JANUARY 1947																															
26	27	27	28	30	30	31	31	2	2	3	3	4	4	7	7	8	9	9	10	10	11	11	13	13	14	14	15	15	16	16	17	17	18
48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48	48
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

FEBRUARY 1947																																
1	3	3	4	4	5	5	6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20
35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

MARCH 1947																															
6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	17	17	18	18	19	19	20	20	21	21	22	22	24	24	25	26
44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

APRIL 1947																															
4	4	5	5	5	7	7	8	8	9	9	10	10	11	11	12	12	12	12	12	12	12	14	14	15	15	15	15	15	15	15	15
44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44	44
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

**NOTE:**  
 Air temperature obtained from thermograph record.  
 Surface temperature obtained from mercury thermometer laid on the surface of the pavement.

26	26	26	28	28
44	44	44	44	44
Clear	Clear	Clear	Clear	Clear

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
**TEMPERATURE RECORD**  
 OF  
 TEST ELEMENT D  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947

OB

TABLE 5

2











DATE AND TIME

DECEMBER 1946											JANUARY 1947																																				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31																	
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

FEBRUARY 1947																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

MARCH 1947																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

APRIL 1947																														
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

25	26	27	28	29	30	31
15	16	17	18	19	20	21
15	16	17	18	19	20	21
15	16	17	18	19	20	21

**NOTES:**  
 Air temperature obtained from thermograph record.  
 Surface temperature obtained from mercury thermometer laid on the surface of the pavement.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
**TEMPERATURE RECORD**  
 OF  
**TEST ELEMENT G**  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947

TABLE 8









DATE AND TIME

DECEMBER 1946							JANUARY 1947																								
26	27	28	30	31	31	1	2	2	3	3	4	4	7	7	8	9	9	10	10	11	11	13	13	14	15	15	16	16	17	17	18
26	27	28	30	31	31	1	2	2	3	3	4	4	7	7	8	9	9	10	10	11	11	13	13	14	15	15	16	16	17	17	18
59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59	59
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

FEBRUARY 1947																																
1	1	3	4	4	5	5	6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20
57	57	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	56	
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

MARCH 1947																																	
6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20	21	21	22	22	24	24	25	26
57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

APRIL 1947																																	
4	4	4	5	5	5	5	7	7	8	8	9	9	10	10	11	11	12	12	12	12	12	12	14	14	15	15	15	15	15	15	15	15	
57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear

NOTES:  
 Air temperatures obtained from thermograph record.  
 Surface temperatures obtained from mercury thermometer laid on the surface of the pavement.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 TEMPERATURE RECORD  
 OF  
 TEST ELEMENT J  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947



TABLE 10



DATE AND TIME

DECEMBER 1946										JANUARY 1947																								
24	26	27	28	30	30	31	31	2	2	3	3	4	4	7	7	8	9	9	10	10	11	11	13	13	14	14	15	15	16	16	17	17	18	
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24
24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24	24

FEBRUARY 1947																																		
31	1	1	3	3	4	4	5	5	6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20
31	1	1	3	3	4	4	5	5	6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20

MARCH 1947																																		
5	6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20	21	21	22	22	24	24	25	26
5	6	6	7	7	8	8	10	10	11	11	12	12	13	13	14	14	15	15	17	17	18	18	19	19	20	20	21	21	22	22	24	24	25	26

APRIL 1947																																
4	4	4	4	5	5	5	7	7	8	8	9	9	10	10	11	11	12	12	12	12	12	12	14	14	15	15	15	15	15	15	15	15
4	4	4	4	5	5	5	7	7	8	8	9	9	10	10	11	11	12	12	12	12	12	12	14	14	15	15	15	15	15	15	15	15

25	25	26	26	26	26	26
25	25	26	26	26	26	26

**NOTES:**  
 Air temperature obtained from thermograph record  
 Surface temperature obtained from mercury thermometer laid on the surface of the pavement.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
**TEMPERATURE RECORD  
 OF  
 TEST ELEMENT K**  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947



TABLE II



DATE AND TIME

Table for JANUARY 1947. Columns include dates from 26 to 18, with corresponding time slots (e.g., 0745, 0800, 0815) and weather observations (e.g., Clear, Cloudy, Rain, Snow).

Table for FEBRUARY 1947. Columns include dates from 1 to 20, with corresponding time slots and weather observations.

Table for MARCH 1947. Columns include dates from 6 to 26, with corresponding time slots and weather observations.

Table for APRIL 1947. Columns include dates from 4 to 15, with corresponding time slots and weather observations.

Small table with 5 columns and 10 rows, likely a summary or specific data points.

NOTES:

Air temperature obtained from thermograph record.
Surface temperature obtained from mercury thermometer laid on the surface of the pavement.

FROST INVESTIGATION
DOW FIELD, BANGOR, MAINE
TEMPERATURE RECORD
OF
TEST ELEMENT L
SOILS LABORATORY
NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947

B



DATE AND TIME

		JANUARY 1947																																																										
27	28	30	30	31	31	2	2	3	3	4	4	7	7	8	9	9	10	10	11	11	13	13	14	14	15	15	16	17	17	18																														
28	21	24	27	25	28	27	27	27	26	25	25	25	24	23	22	21	21	20	19	18	17	16	15	14	13	12	11	10	9	8																														
29	26	29	32	30	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																														
30	27	30	33	31	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																													
31	28	31	34	32	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																												
1	29	32	35	33	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																											
2	30	33	36	34	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																										
3	31	34	37	35	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																									
4	32	35	38	36	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																								
5	33	36	39	37	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																							
6	34	37	40	38	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																						
7	35	38	41	39	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																					
8	36	39	42	40	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																				
9	37	40	43	41	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																			
10	38	41	44	42	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																		
11	39	42	45	43	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																	
12	40	43	46	44	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7																
13	41	44	47	45	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7															
14	42	45	48	46	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7														
15	43	46	49	47	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7													
16	44	47	50	48	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7												
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19	47	50	53	51	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7									
20	48	51	54	52	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7								
21	49	52	55	53	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7							
22	50	53	56	54	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7						
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29	57	60	63	61	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38</																														

DATE AND TIME

Table for October and November 1946. Columns include Thermo-couple No., Depth in feet, Type of material, and dates from 11/11/46 to 12/30/46. Rows include 1-9 thermocouples and summary rows for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for January 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and dates from 1/18/47 to 1/31/47. Rows include 1-9 thermocouples and summary rows for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for February 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and dates from 2/21/47 to 2/28/47. Rows include 1-9 thermocouples and summary rows for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for March 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and dates from 3/26/47 to 3/31/47. Rows include 1-9 thermocouples and summary rows for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

Table for April 1947. Columns include Thermo-couple No., Depth in feet, Type of material, and dates from 4/16/47 to 4/28/47. Rows include 1-9 thermocouples and summary rows for Air Temperature, Surface Temperature, Weather, and Wind (Beaufort Scale).

A

DATE AND TIME

		JANUARY 1947																											
		2	2	3	3	4	4	7	7	8	9	9	10	10	11	11	13	13	14	14	15	15	16	16	17	17	18		
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31	31	31	31	30	30	27	27	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26			
Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear			
NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW			

		FEBRUARY 1947																															
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NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW		

		MARCH 1947																															
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NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW		

		APRIL 1947																														
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02	03	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	26	
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NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW	NW		

26	26	28	28
0735	1525	0745	1630
17	22	26	22
21	24	27	25
23	23	21	22
24	24	26	26
25	25	26	26
26	26	26	26
27	27	26	26
28	28	28	29
29	29	29	29
30	30	30	30
Clear	Clear	Clear	Clear
NW	NW	NW	NW

**NOTES:**  
 Air temperature obtained from thermograph record.  
 Surface temperature obtained from mercury thermometer laid on the surface of the pavement.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
**TEMPERATURE RECORD**  
 OF  
**TEST ELEMENT N**  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947

TABLE 14













DATE AND TIME

Table with columns for dates from December 24 to January 18, 1947. Rows contain numerical data and weather condition abbreviations.

Table with columns for dates from February 1 to February 20, 1947. Rows contain numerical data and weather condition abbreviations.

Table with columns for dates from March 5 to March 26, 1947. Rows contain numerical data and weather condition abbreviations.

Table with columns for dates from April 4 to April 15, 1947. Rows contain numerical data and weather condition abbreviations.

Small table with columns for dates from 25 to 30. Rows contain numerical data.

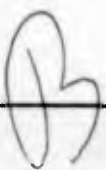
NOTES

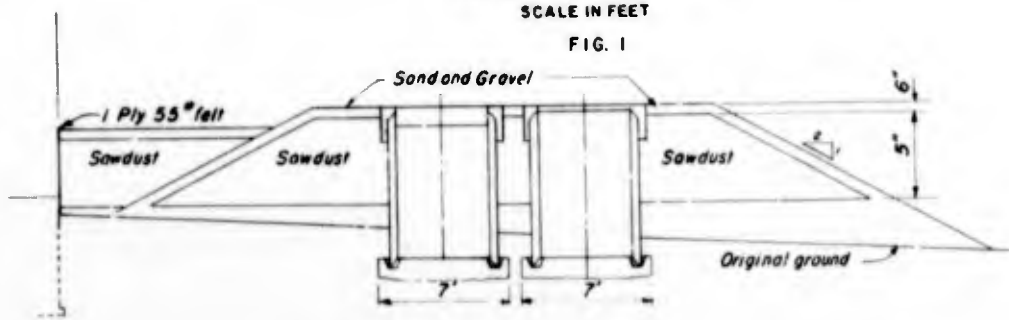
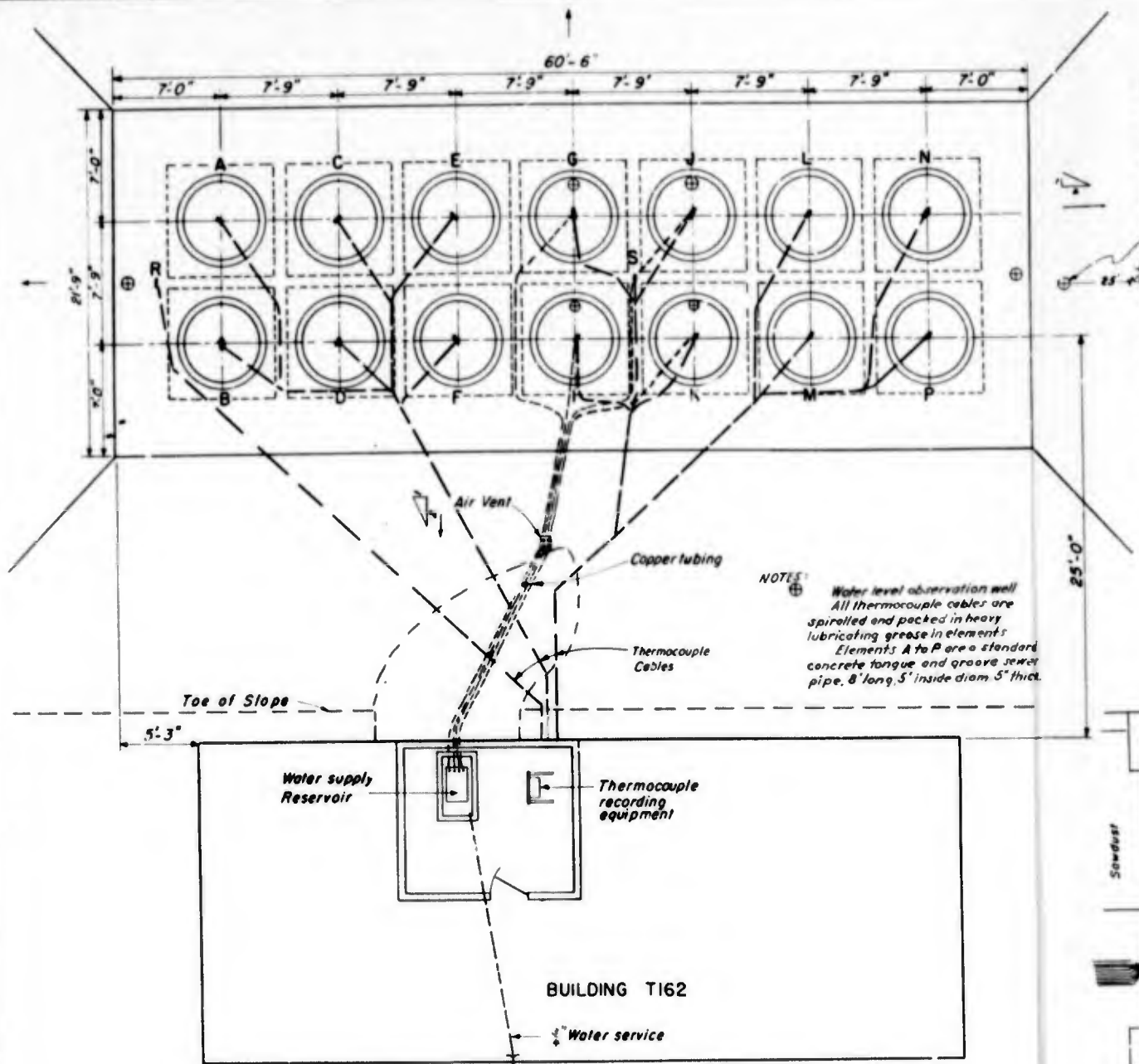
Air temperatures obtained from thermograph record. Surface temperature obtained from mercury thermometer laid on the surface of the embankment.

FROST INVESTIGATION DOW FIELD, BANGOR, MAINE TEMPERATURE RECORD OF EMBANKMENT S

SOILS LABORATORY NEW ENGLAND DIVISION BOSTON, MASS. AUG. 1947

TABLE 17





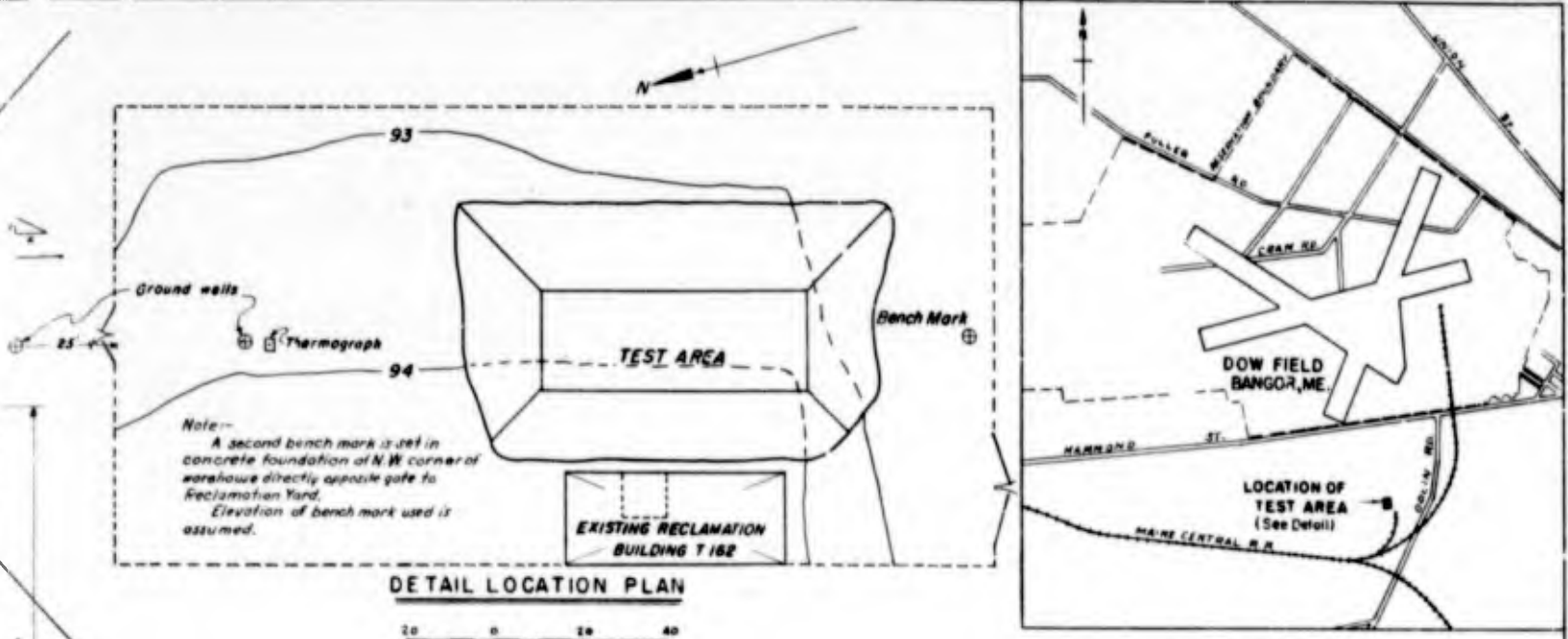
TYPICAL SECTION OF EMBANKMENT

SCALE IN FEET

FIG. 3



LOCATIO



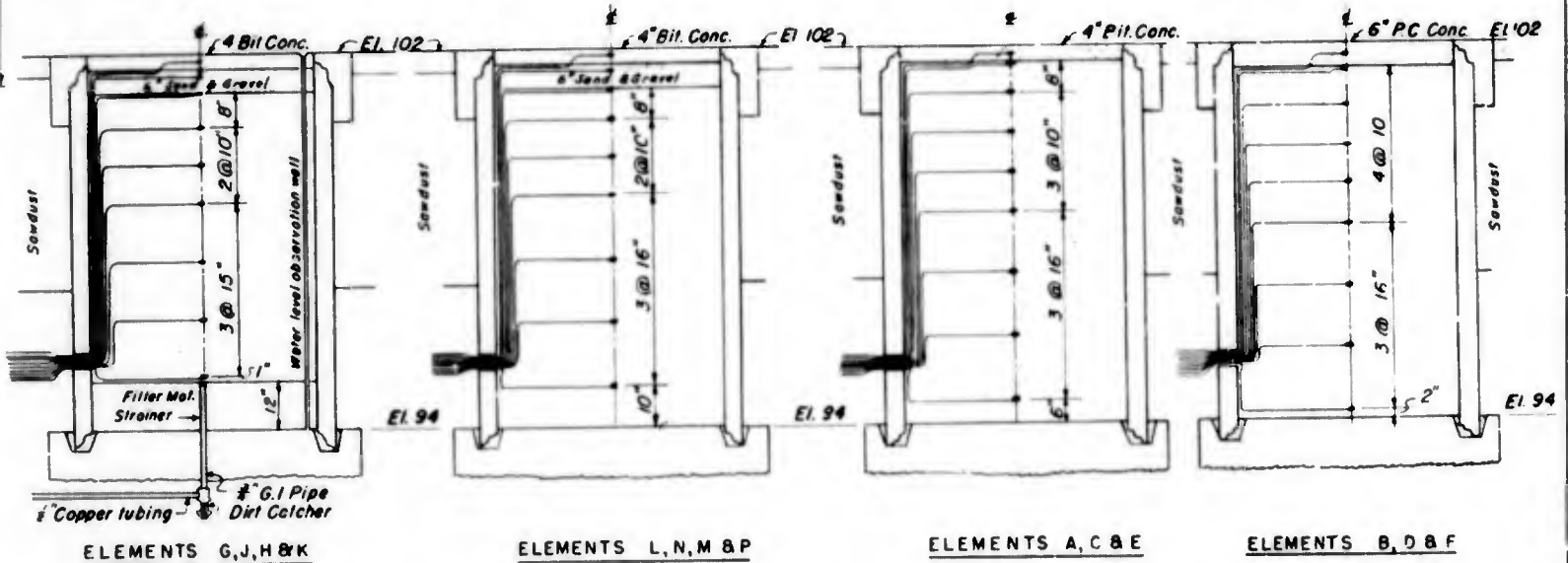
DETAIL LOCATION PLAN

SCALE IN FEET

FIG. 2

SITE PLAN

SCALE IN FEET



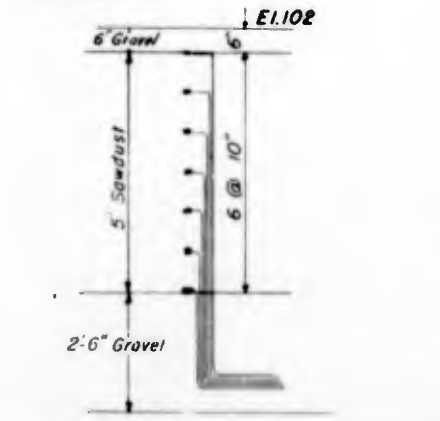
TYPICAL SECTIONS

SCALE IN FEET

FIG. 4

**NOTES:-**

For gradation of materials in test elements see PLATE 3  
 Densities and water contents shown PLATE 2.  
 Further test section details shown PLATE 2.



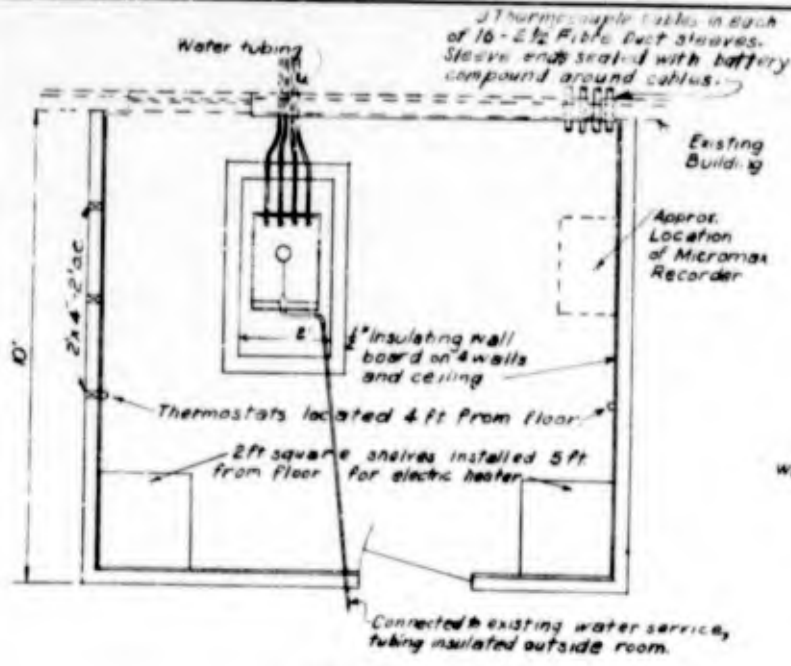
LOCATION OF THERMOCOUPLES AT R & S

FIG. 5

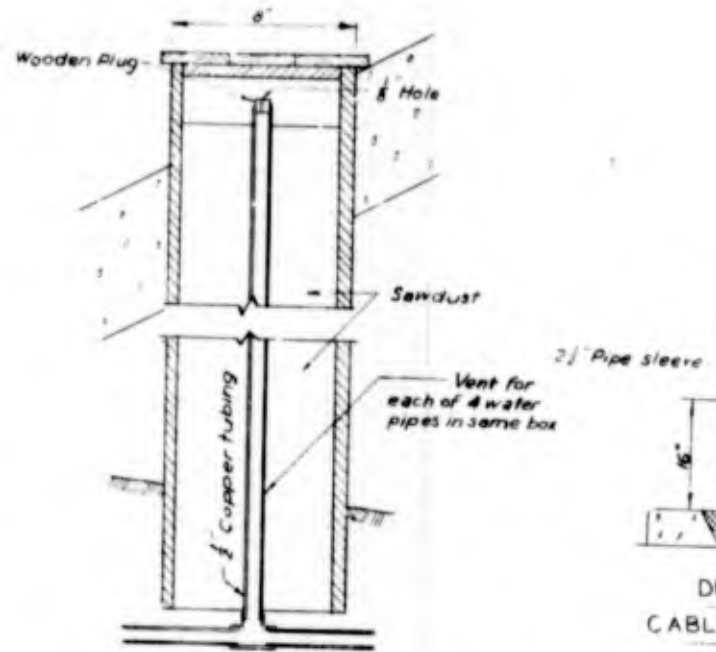
**FROST INVESTIGATION  
 DOW FIELD, BANGOR, ME.**

**TEST SECTION**

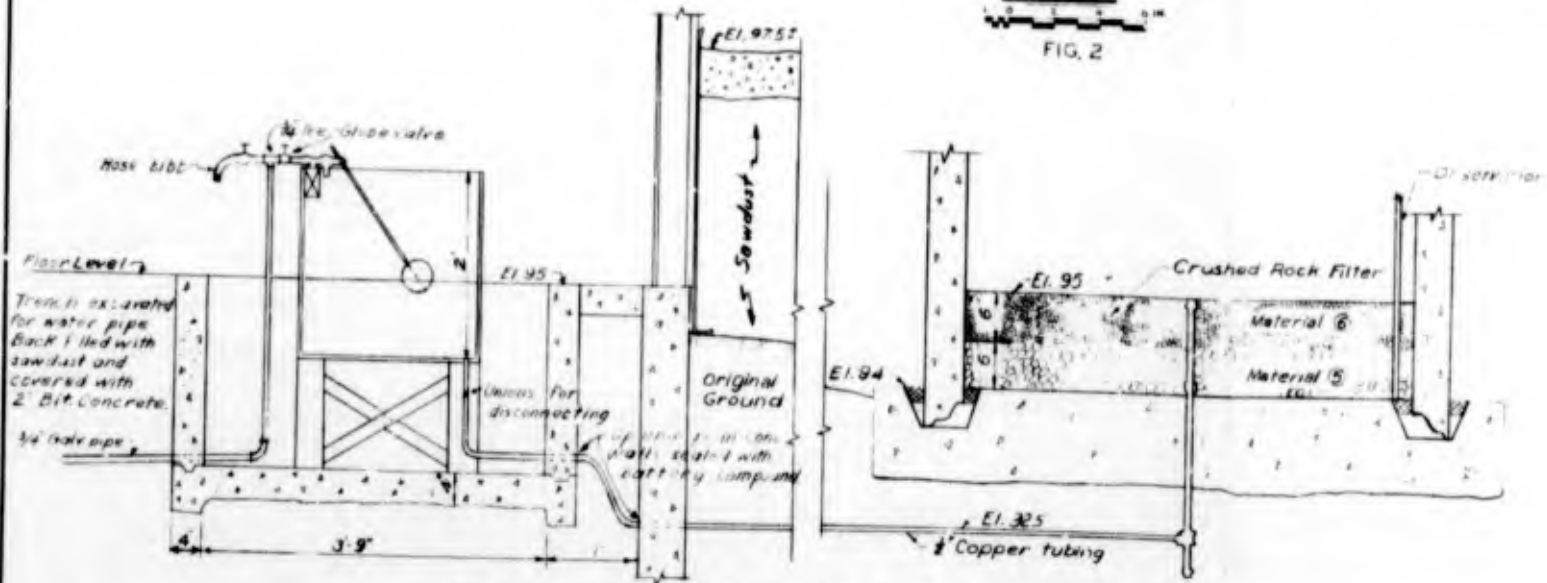
SCALED AS SHOWN  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS AUG 1947



ROOM PLAN  
FIG. 1



DETAIL OF  
AIR VENT  
FIG. 2

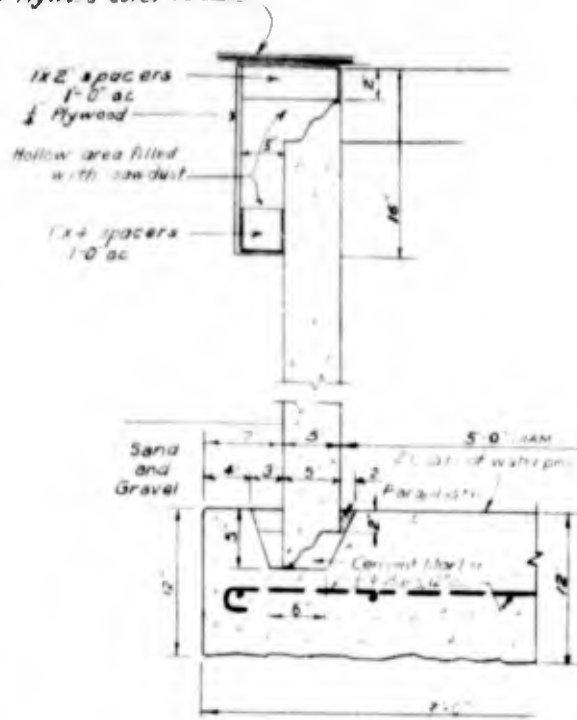


SECTION - WATER SUPPLY INSTALLATION  
TO ELEMENTS G, H, J & K

FIG. 5

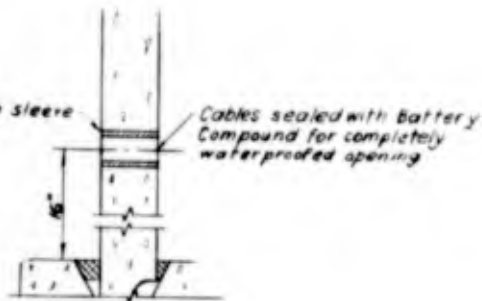
R

2 plies 15\* asphalt felt matted onto Plywood cover



DETAIL OF BASE & TOP

FIG. 4



DETAIL OF CABLE ENTRANCE TO ELEMENT

FIG. 3

Element	Specimen Material	Pavement	Density as Placed in PCF Dry Wt	Water Content for Required % Saturation	% Saturation at Start of Tests
A	Cinders	4 Bit Conc	53-60	1 to 2	
B	Cinders	6 PC Conc	60-64	1 to 3	
C	Sand & Gravel	4 Bit Conc	127-131	6 to 8	
D	Sand & Gravel	6 PC Conc	128-131	6 to 8	
E	Cr Rock	4 Bit Conc	110	4 to 6	
F	Cr Rock	6 PC Conc	107-112	4 to 6	
G	Silty Clay	4 Bit Conc	102-105	11 to 25	80-90
H	Silty Clay	4 Bit Conc	92-98	25 to 29	80-90
J	Silty Clay	4 Bit Conc	102-107	15 to 19	60-70
K	Silty Clay	4 Bit Conc	90-95	15 to 24	60-70
L	Silty Clay	4 Bit Conc	104-107	13 to 19	80-90
M	Silty Clay	4 Bit Conc	92-94	25 to 30	80-90
N	Silty Clay	4 Bit Conc	121-105	11 to 19	60-70
P	Silty Clay	4 Bit Conc	90-93	18 to 23	60-70

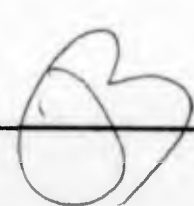
TABLE - ELEMENT VARIABLES

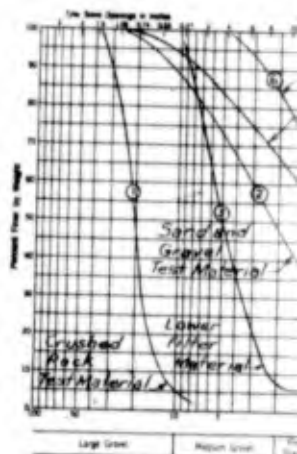
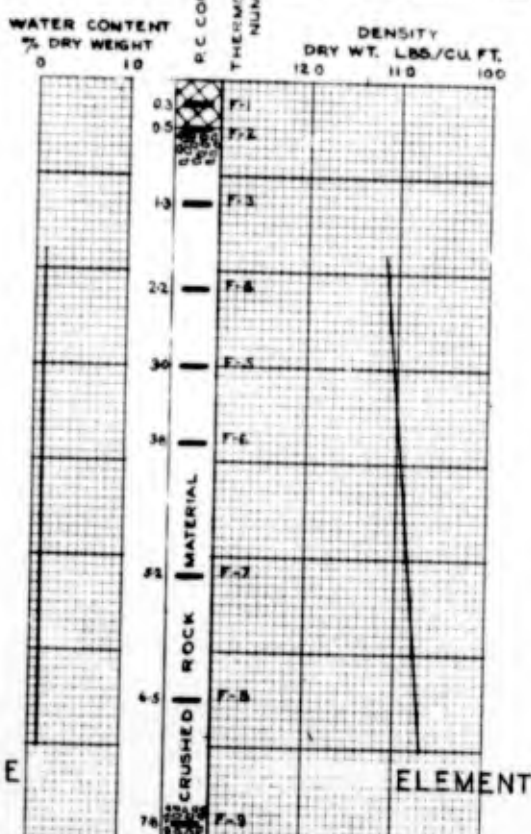
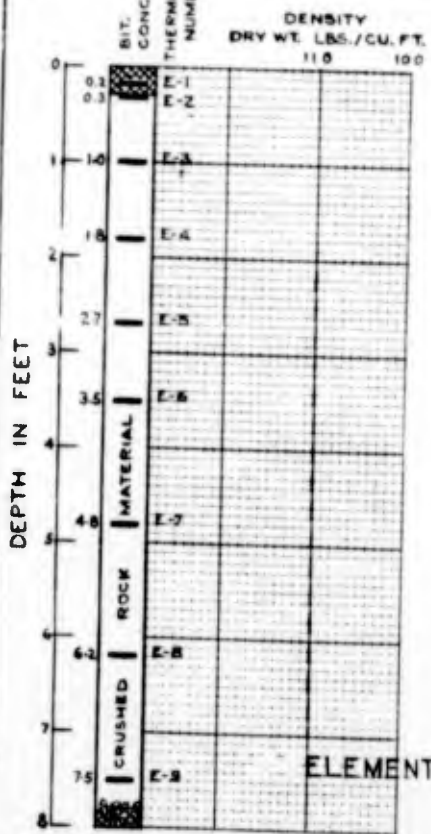
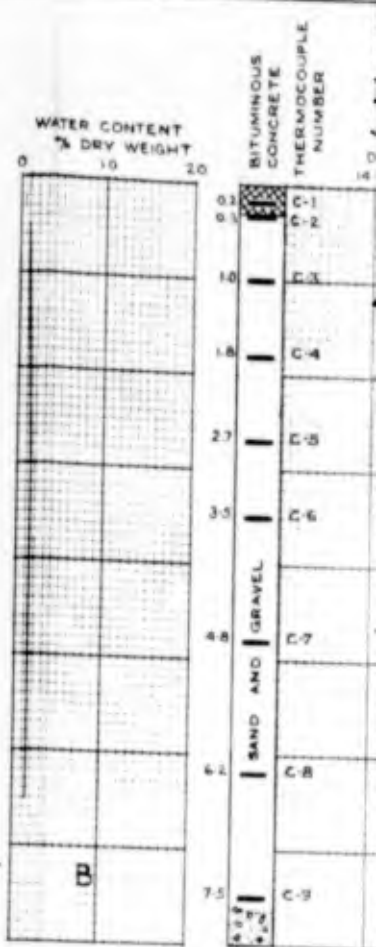
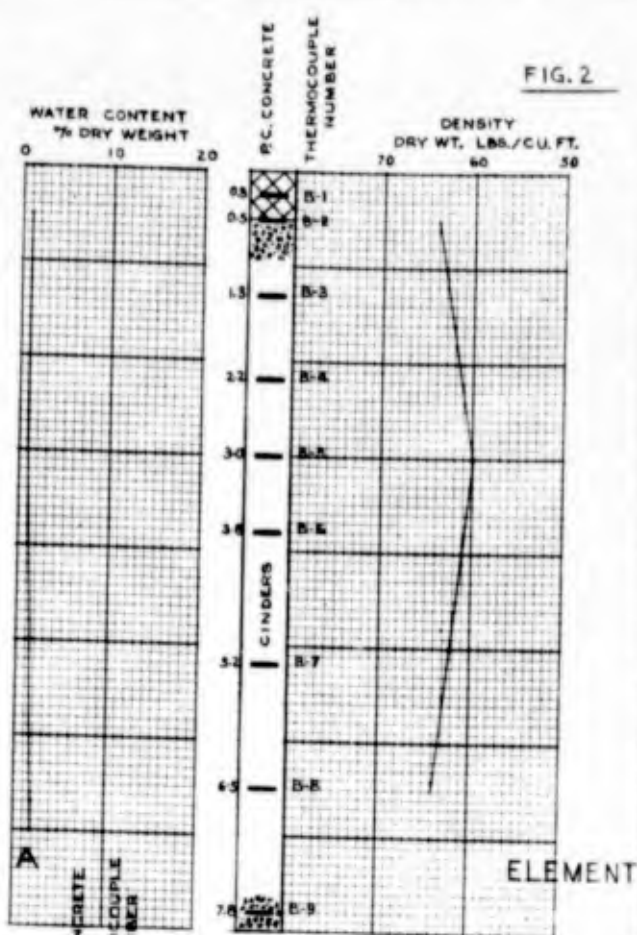
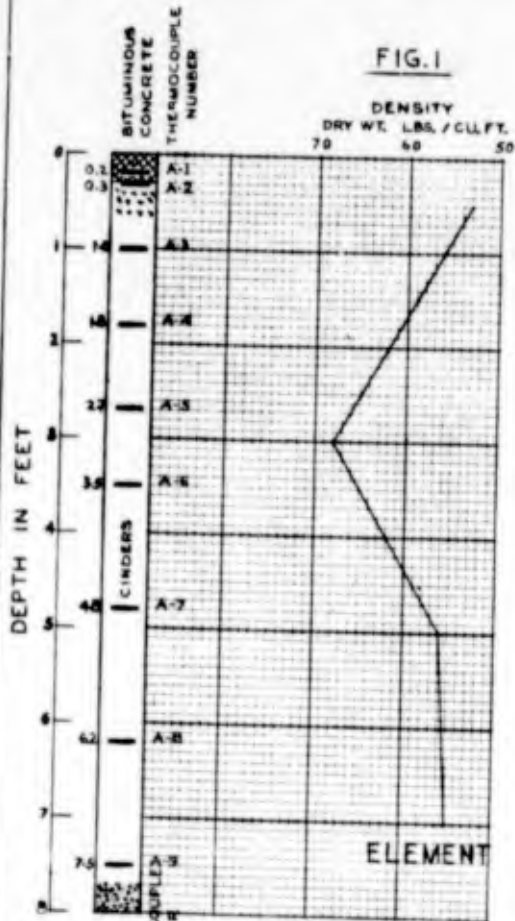
FROST INVESTIGATION  
DOW FIELD, BANGOR, ME.

DETAILS OF TEST SECTION

SCALES AS SHOWN  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947

Note  
For gradation of materials see Plate 3





A

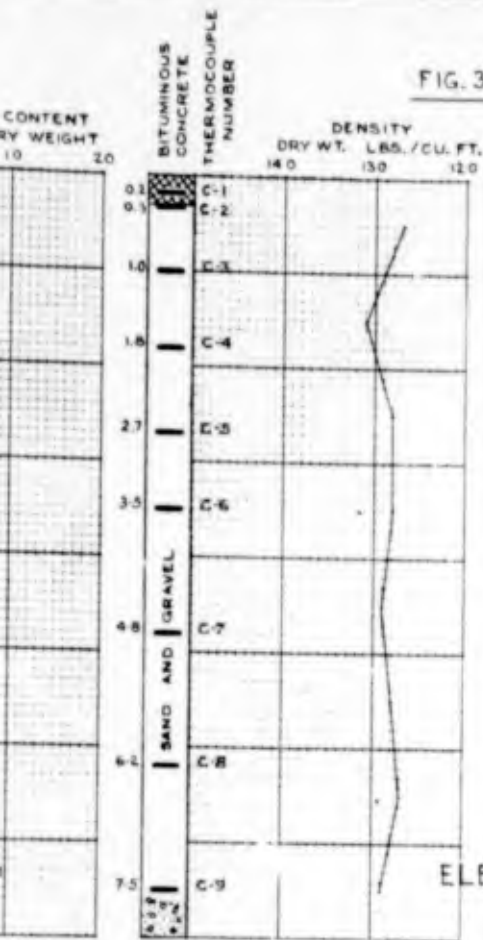


FIG. 3

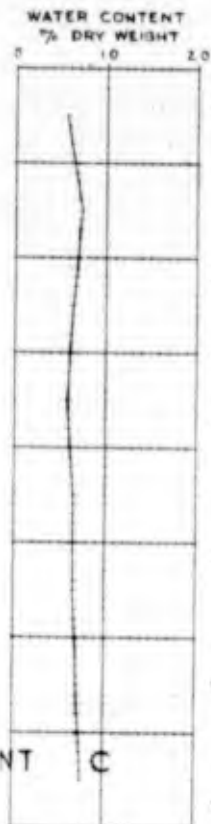
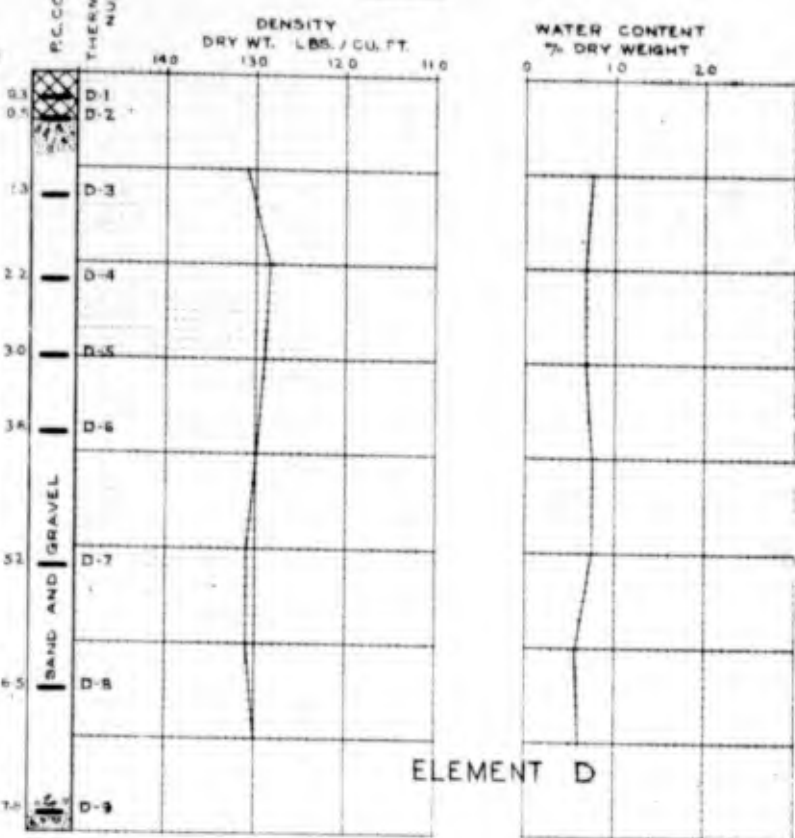


FIG. 4



ELEMENT C

ELEMENT D

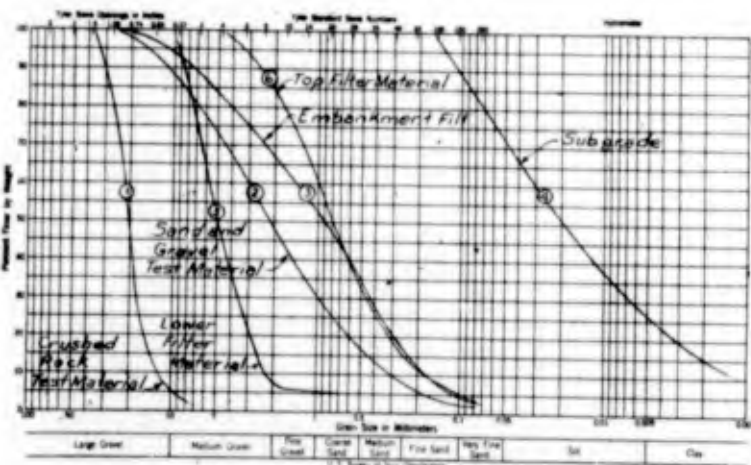


FIG 7

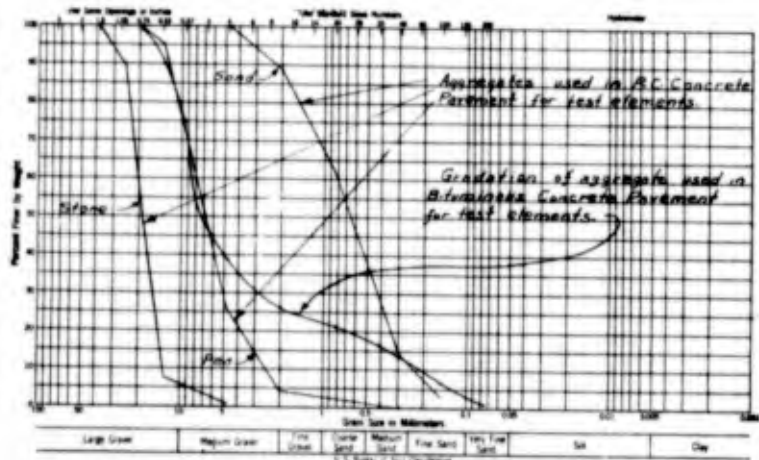


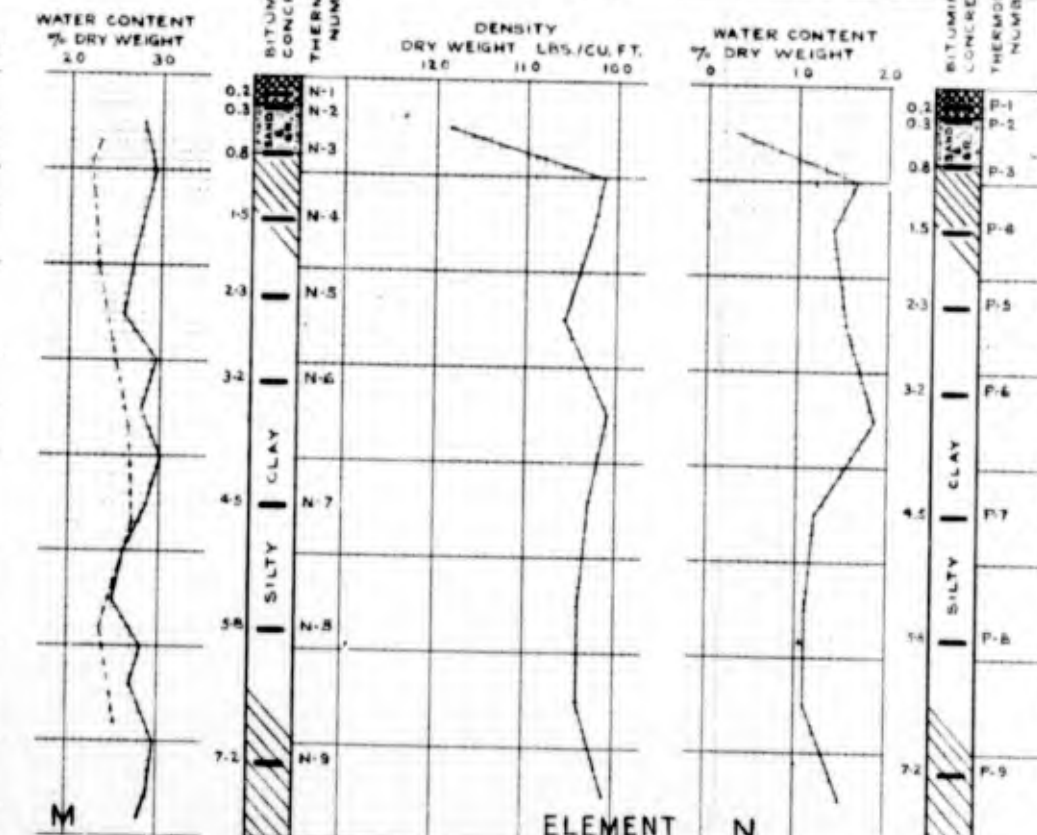
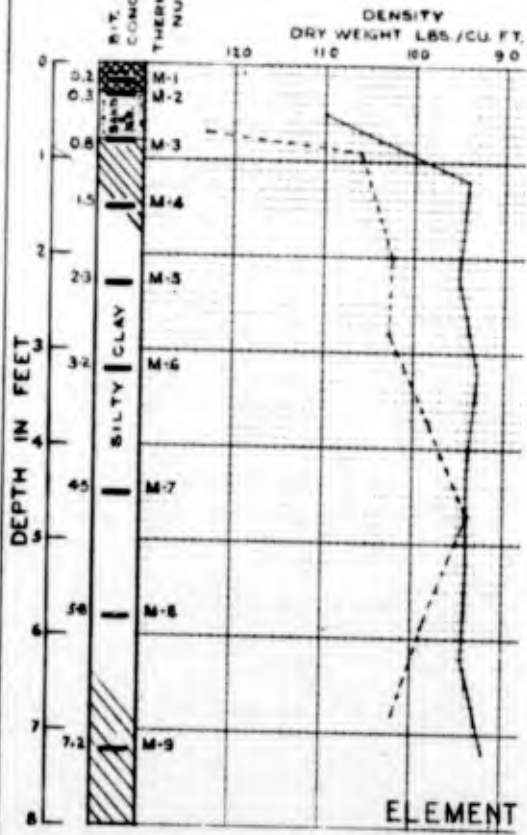
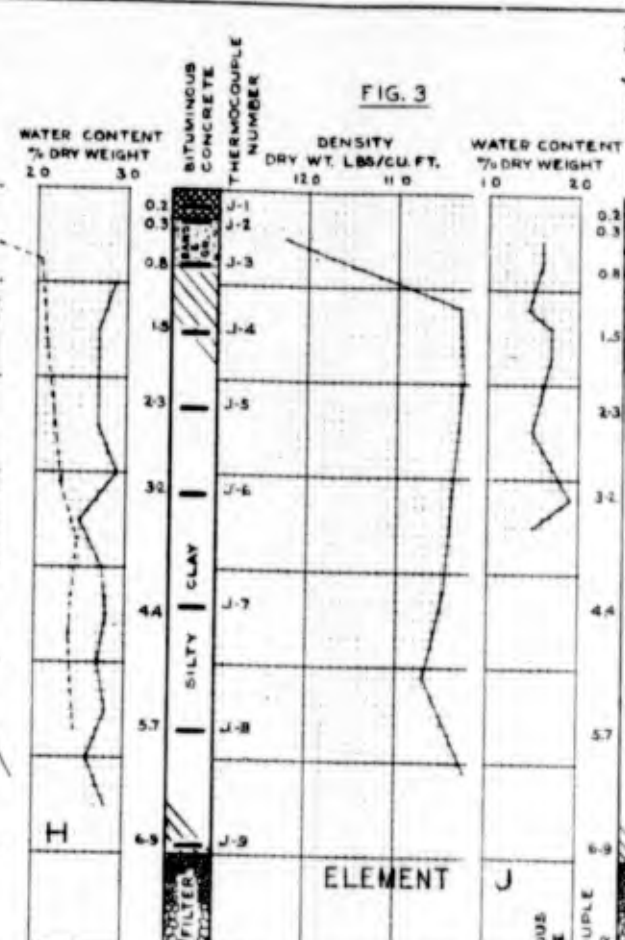
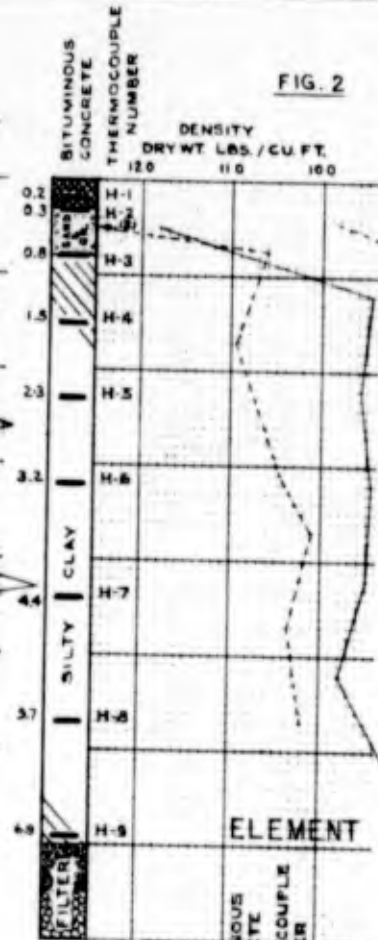
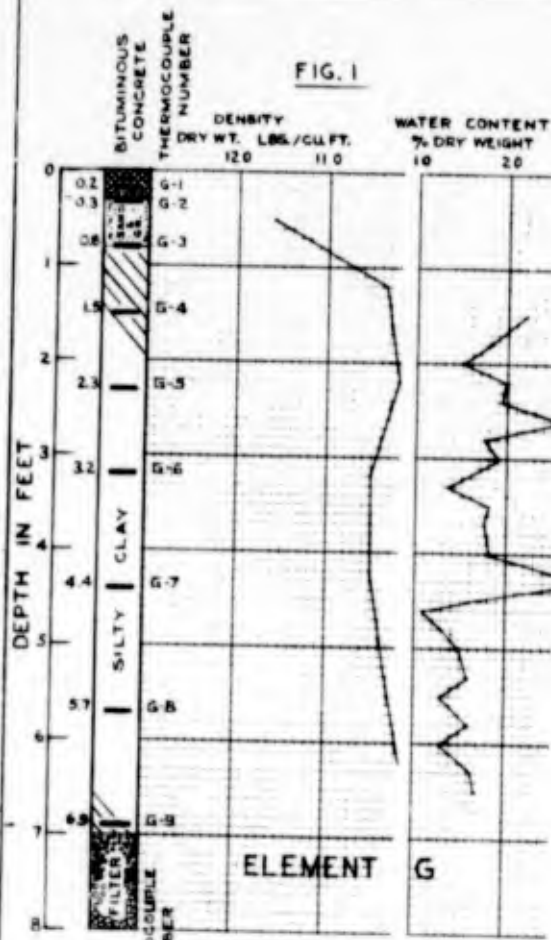
FIG 8

NOTE :-

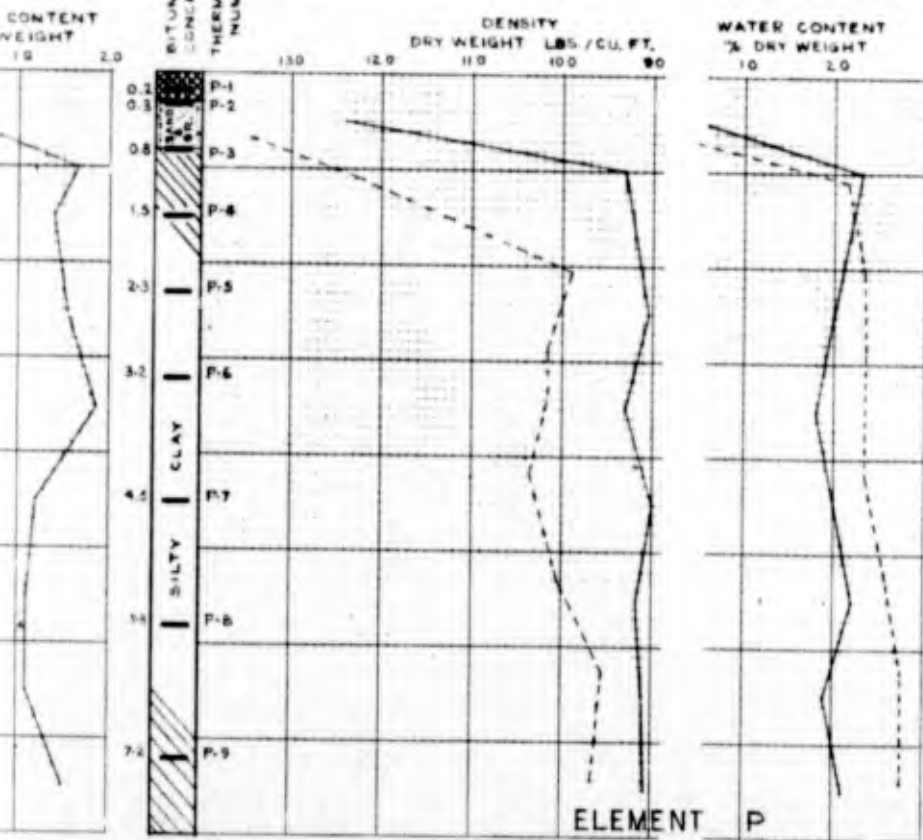
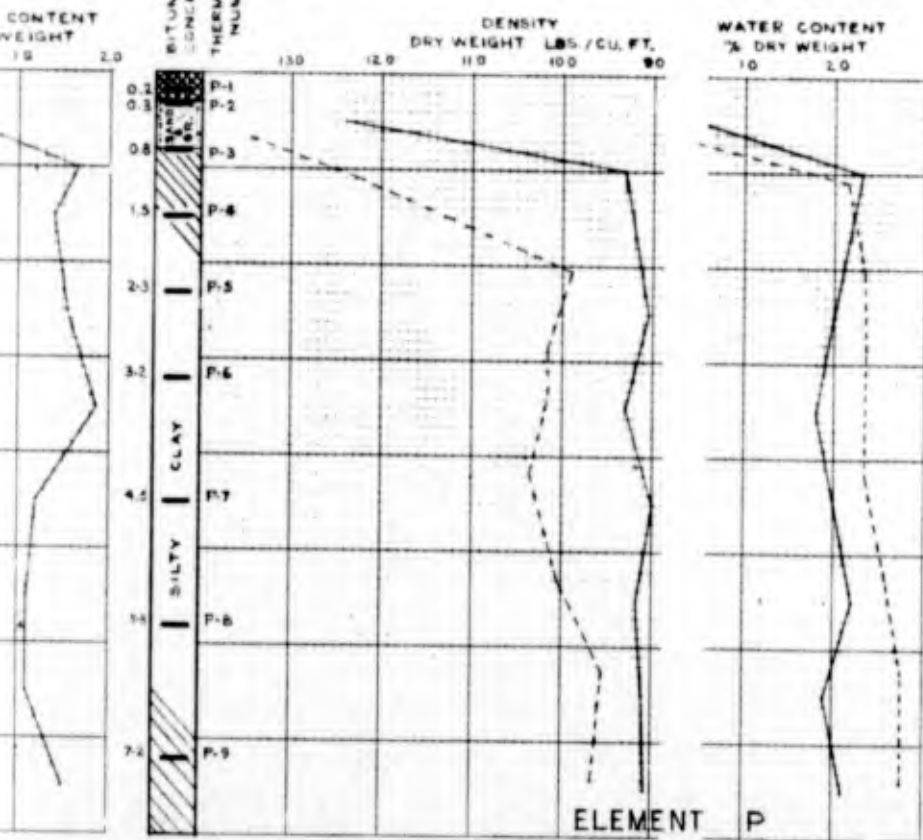
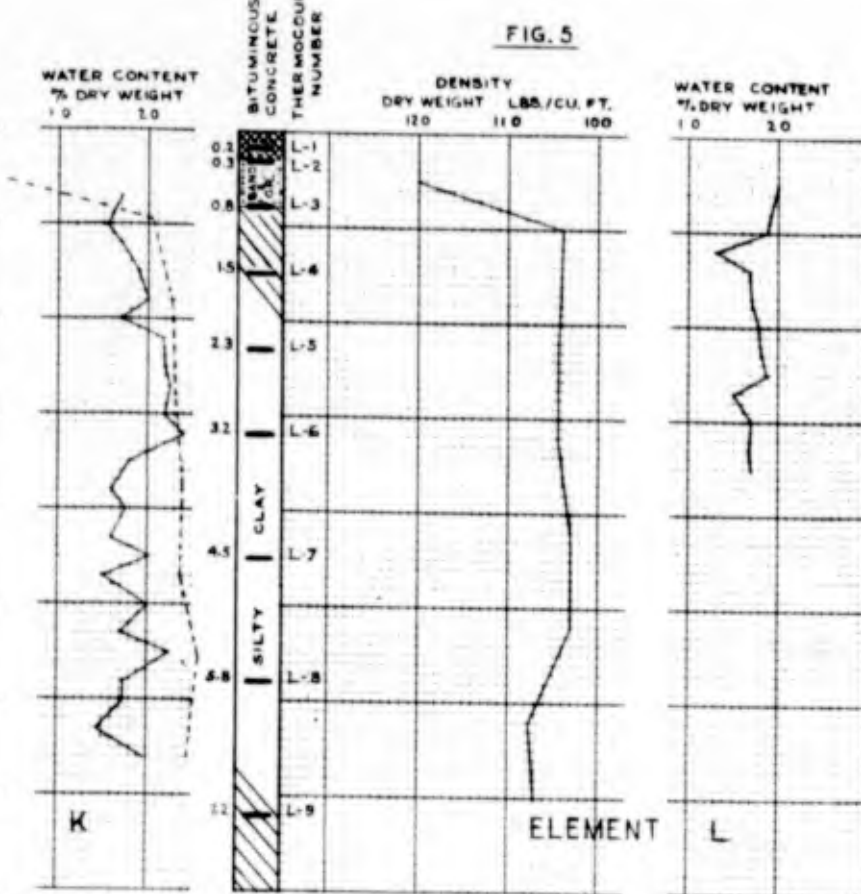
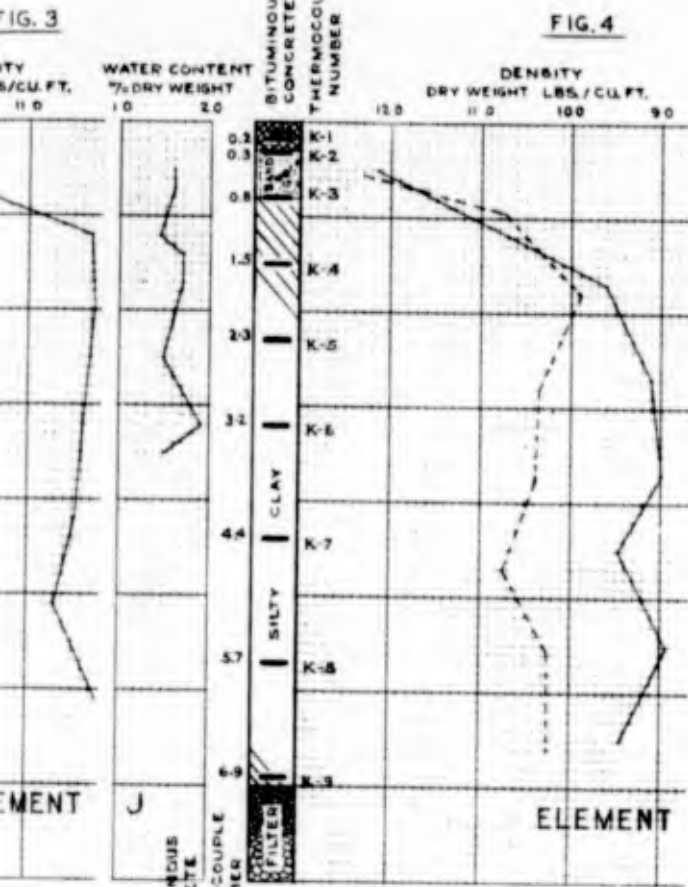
Density of crushed rock in element E determined by pre-weighing material before compacting in place in layers of predetermined thickness.



FROST INVESTIGATION  
 TEST SECTION, DOW FIELD, BANGOR, ME.  
 DENSITY AND WATER CONTENT  
 IN TEST ELEMENTS  
 WITH LOCATION OF THERMOCOUPLES  
 SOIL CLASSIFICATION DATA  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947



*[Handwritten signature]*



**NOTES -**

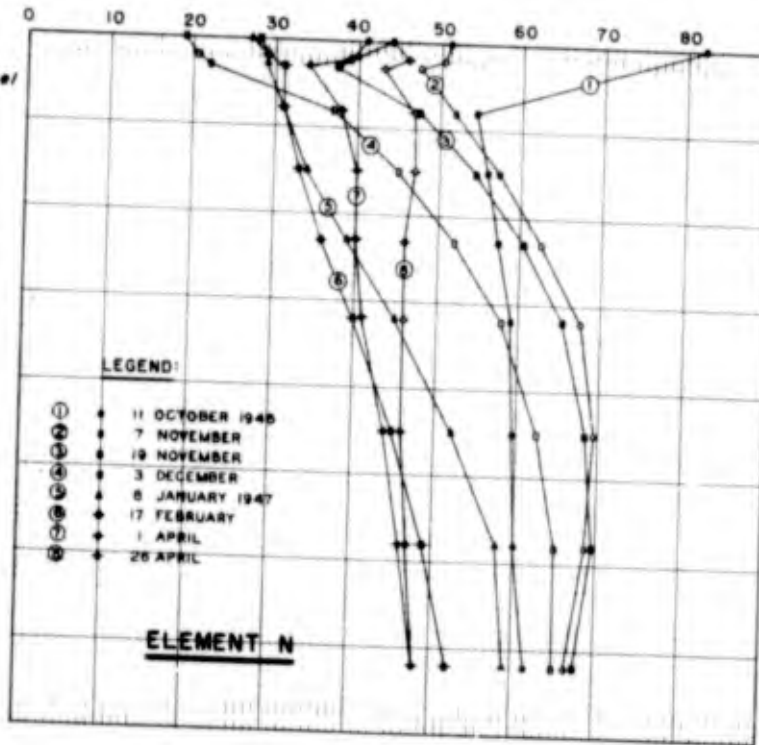
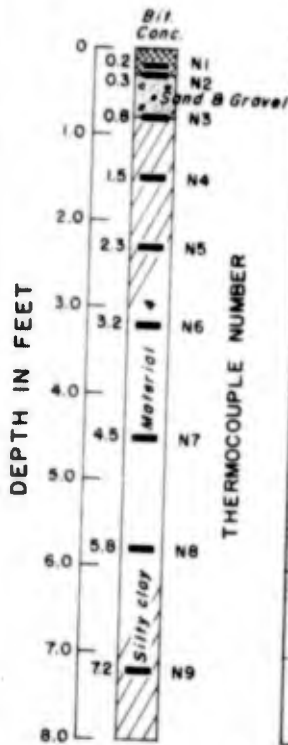
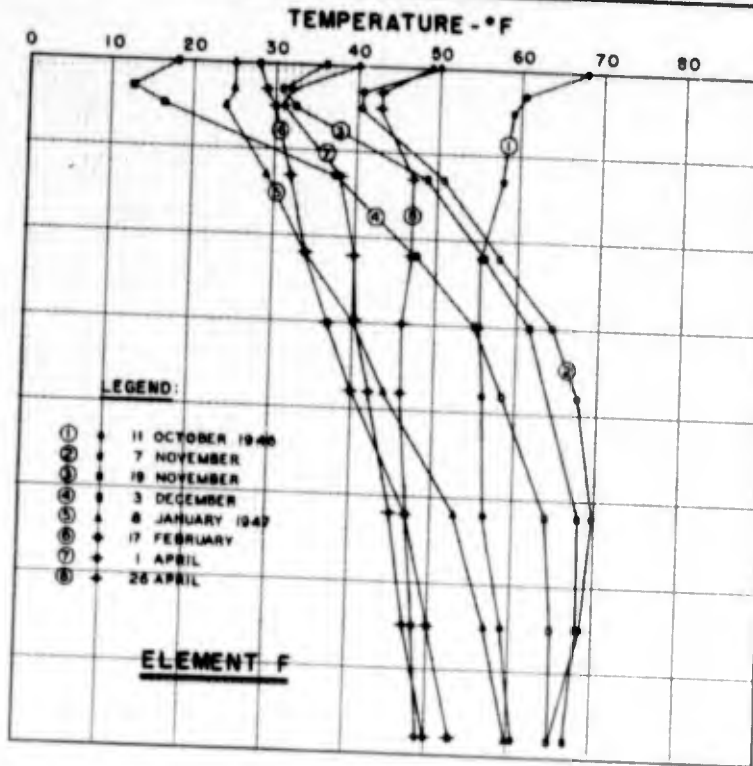
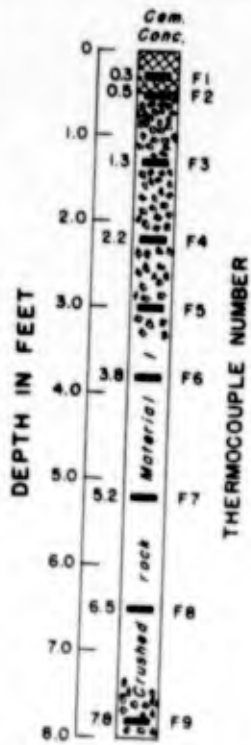
Density and water content in test elements as originally built shown thus ———

Density and water content in test elements rebuilt from June 23 to June 30, 1947 due to subsidence of loosely placed materials shown thus - - - - -

FROST INVESTIGATION  
 TEST SECTION, DOW FIELD, BANGOR, ME.  
 DENSITY AND WATER CONTENT  
 IN TEST ELEMENTS  
 WITH LOCATION OF THERMOCOUPLES

SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947

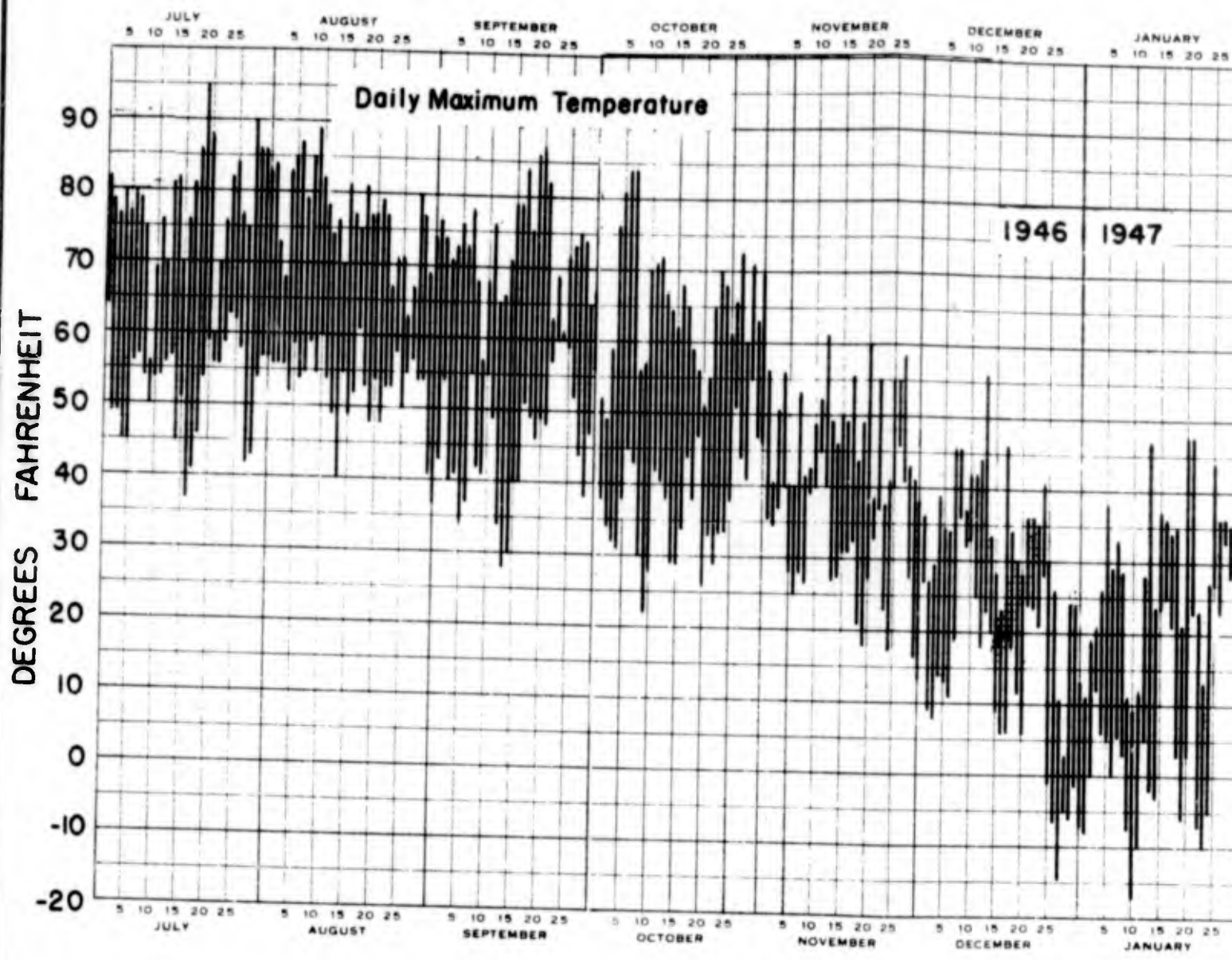
03



FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE

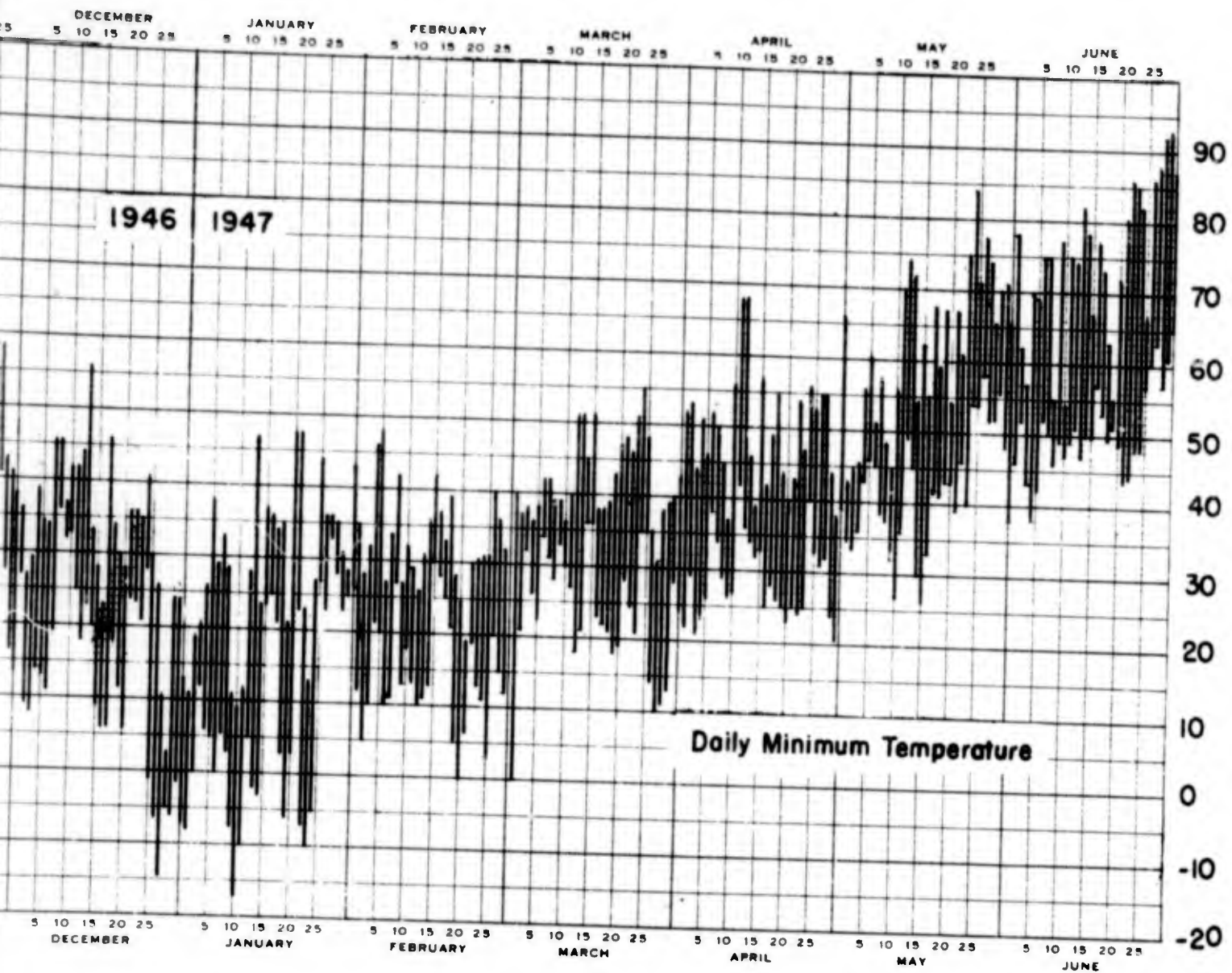
TEST SECTION  
 TYPICAL SUBSURFACE  
 TEMPERATURES

SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947



**NOTES:**  
**SOURCE OF DATA**  
*U.S. Weather Bureau (Bangor Hydro-Electric Company) 1 July-10 October, 1946.*  
*New England Division Thermograph, continuous record, 11 October, 1946-1 July, 1947.*

A

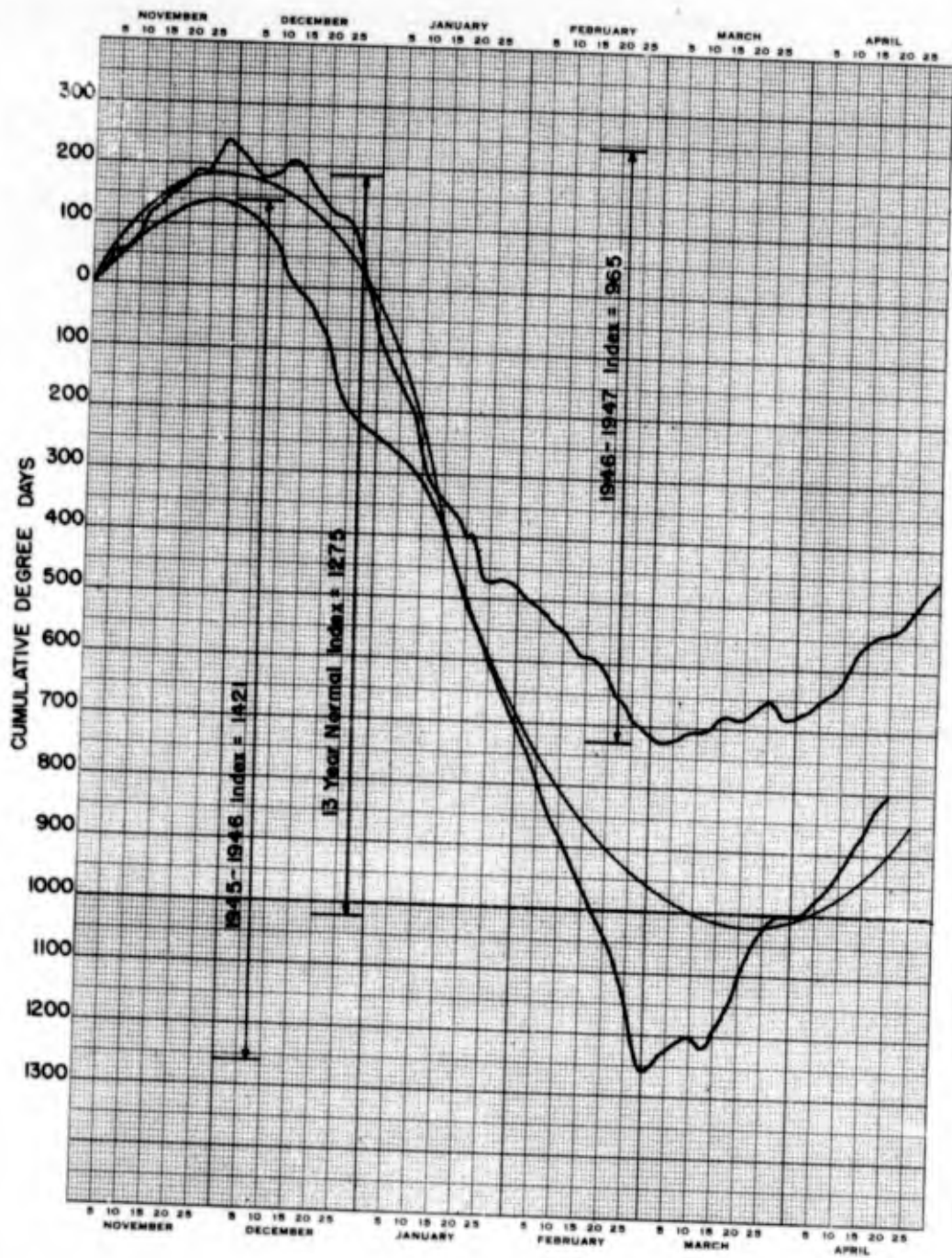


*-Electric*  
*,continuous*

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE

MAXIMUM AND MINIMUM  
DAILY TEMPERATURES

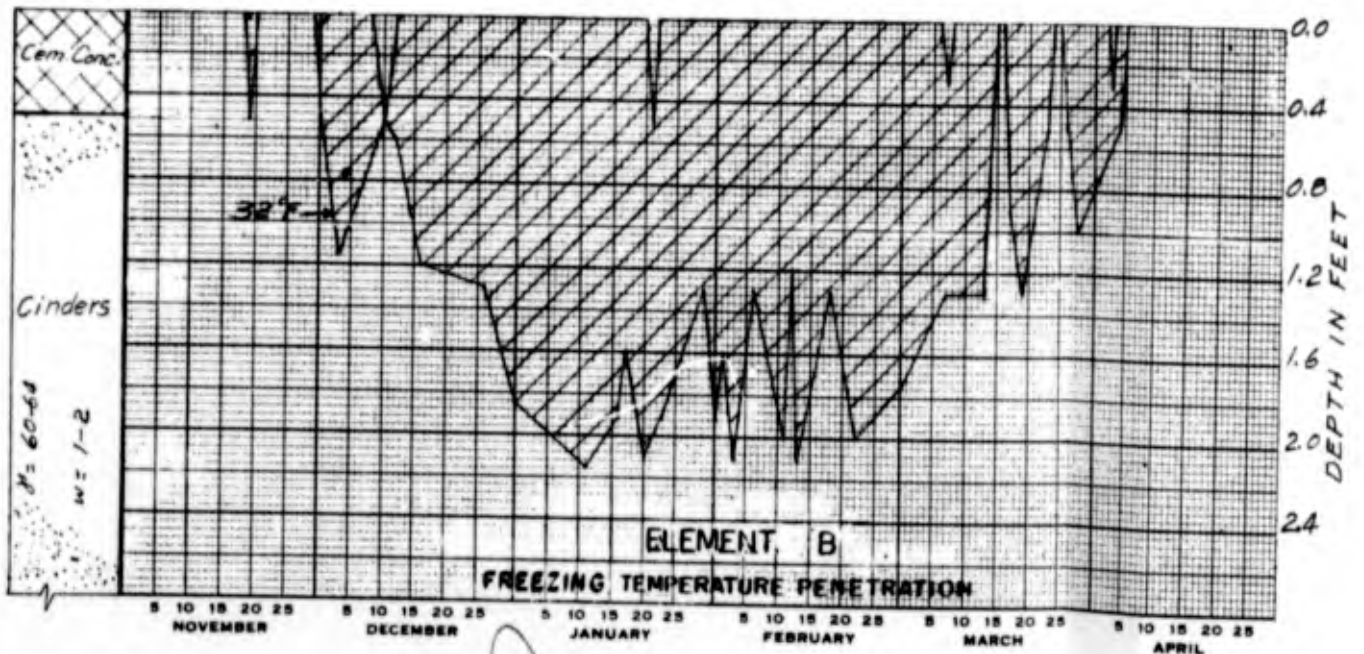
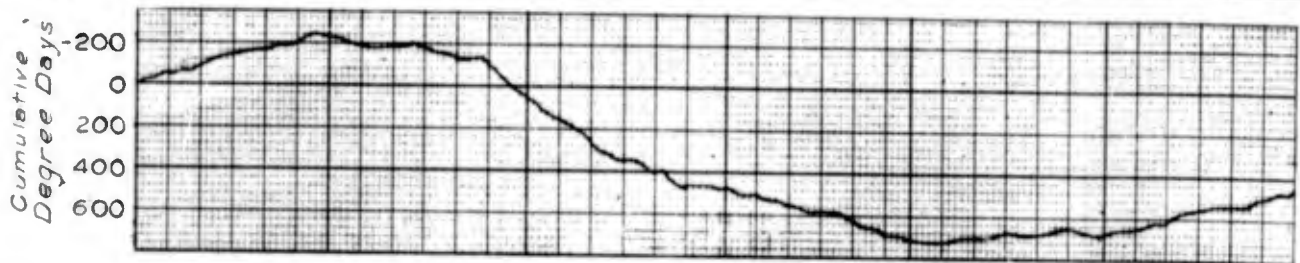
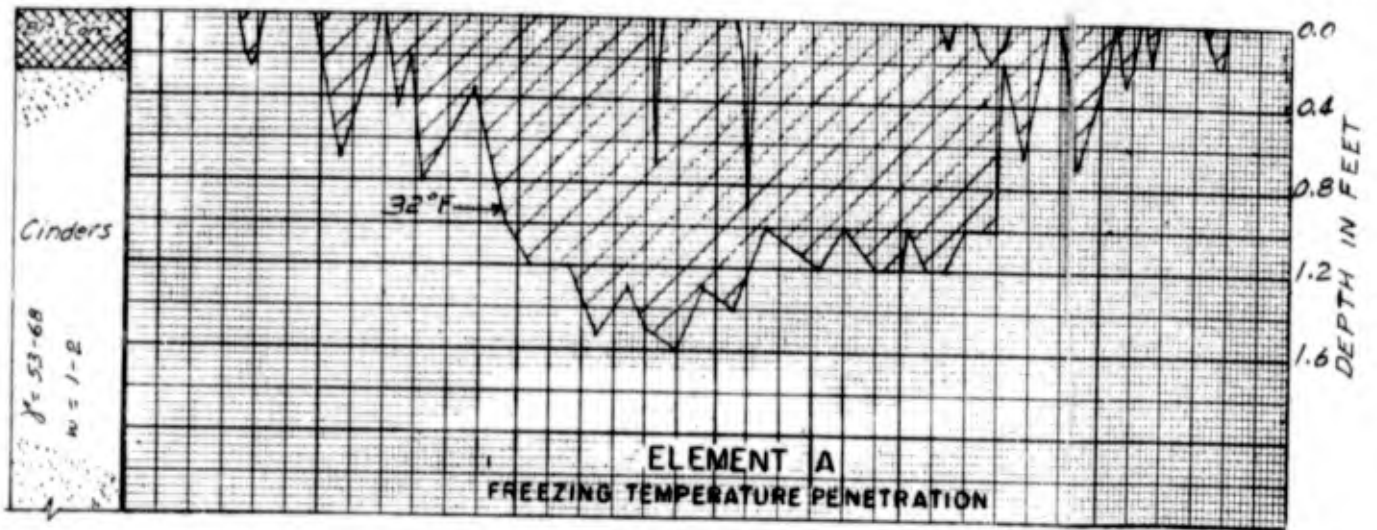
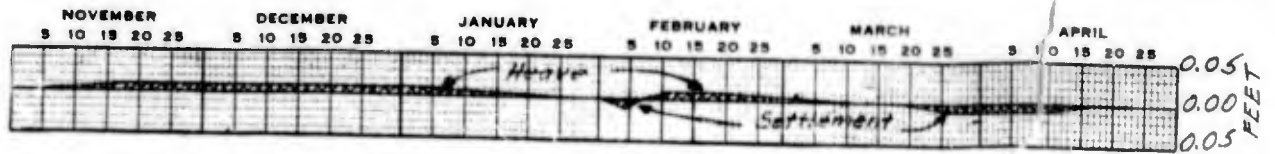
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE

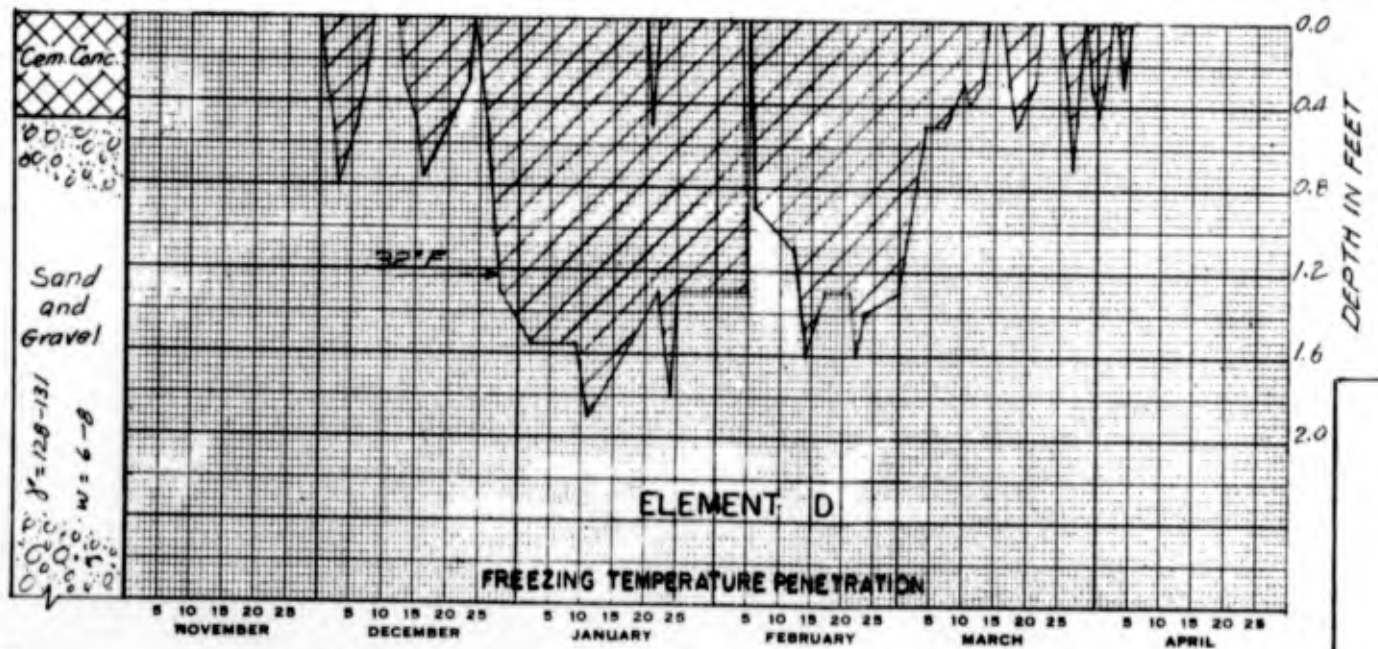
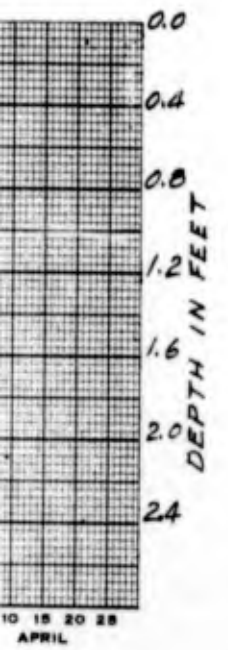
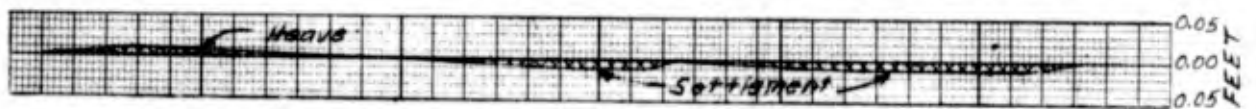
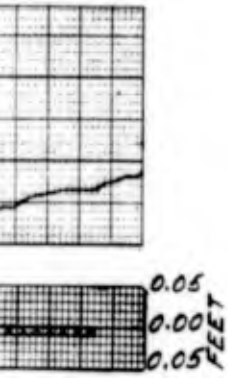
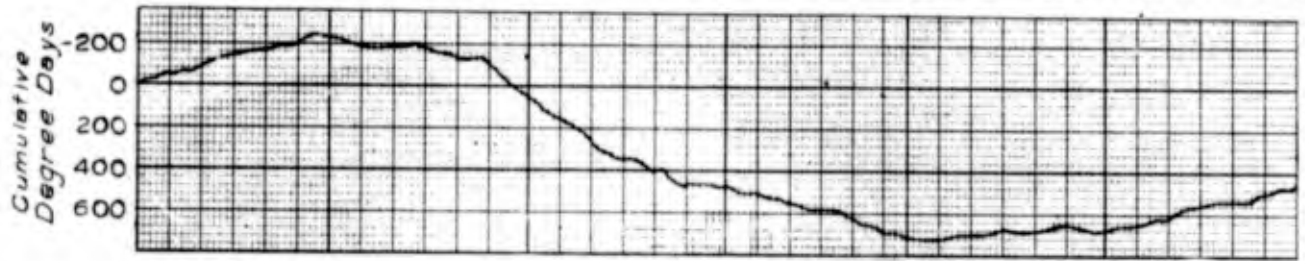
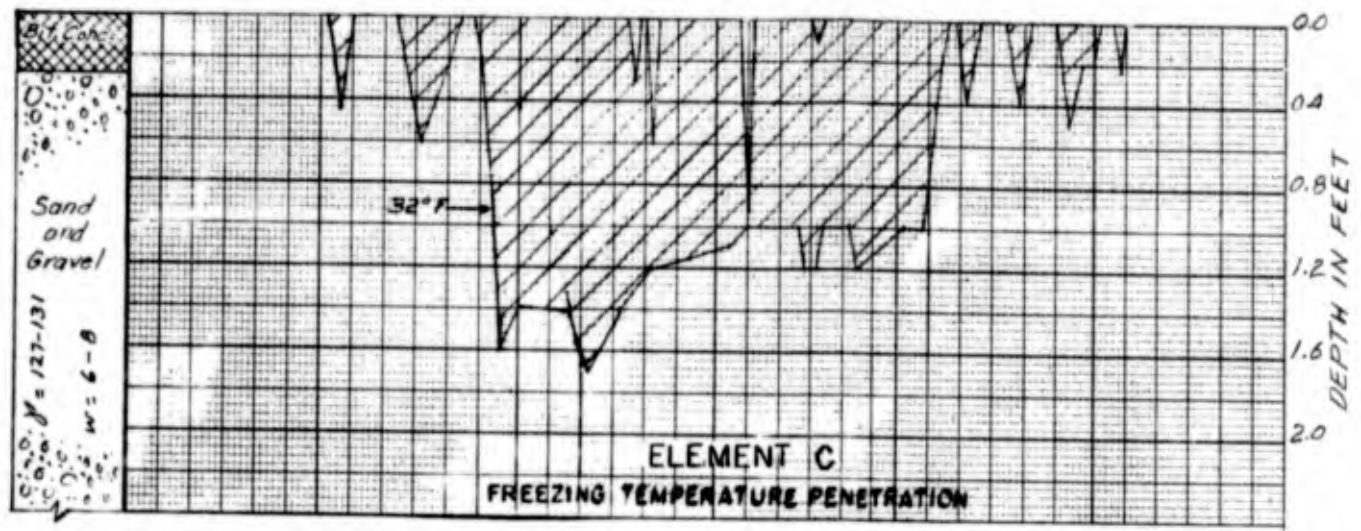
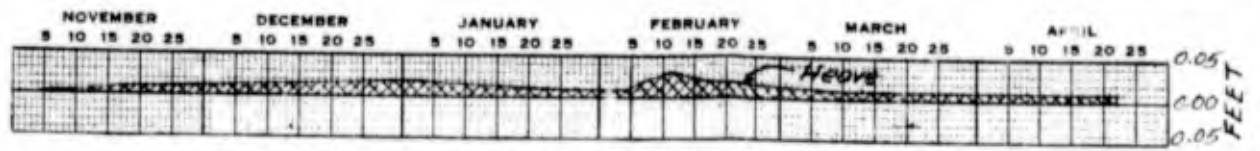
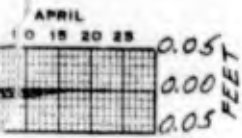
**FREEZING INDEX**

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



A

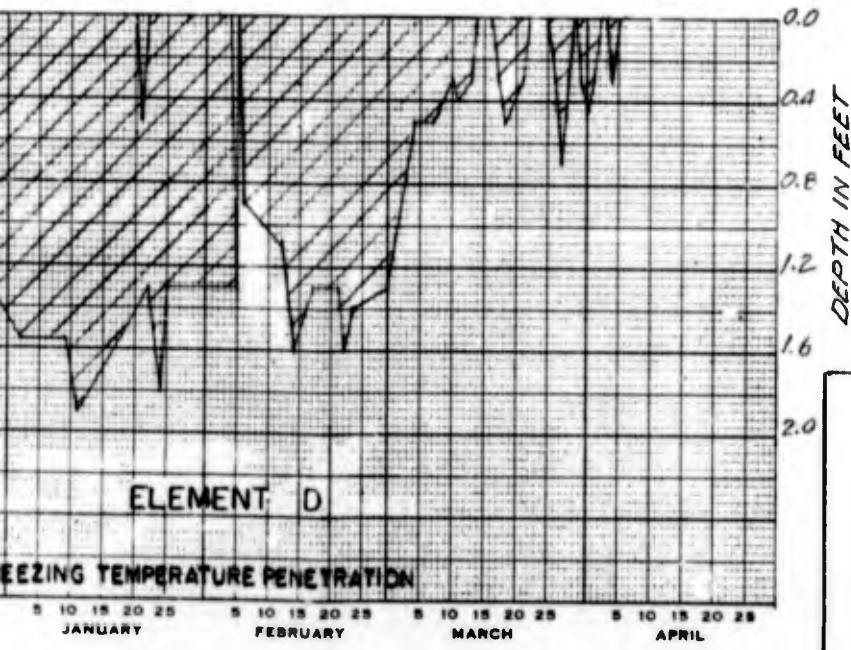
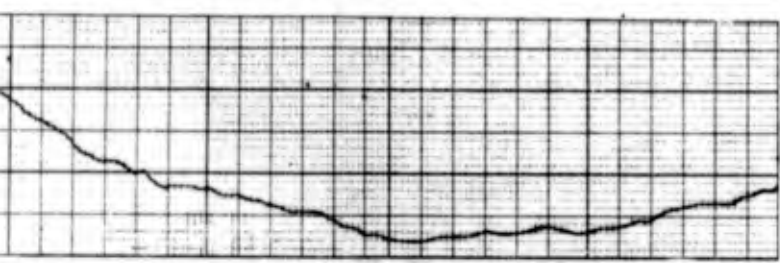
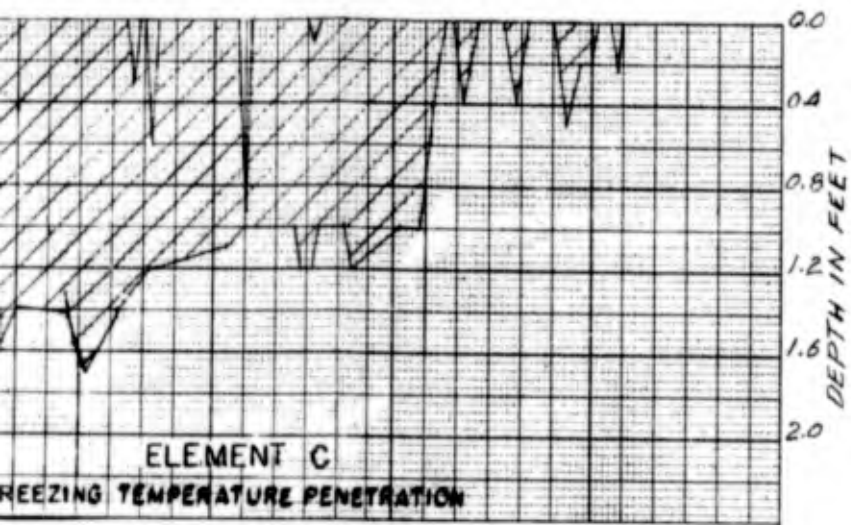
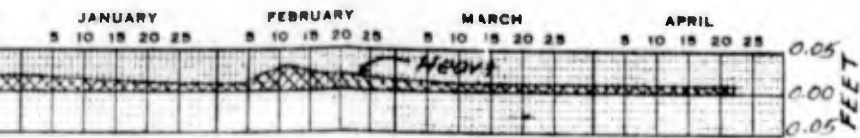
B



FR  
AN  
NEW ENGLA

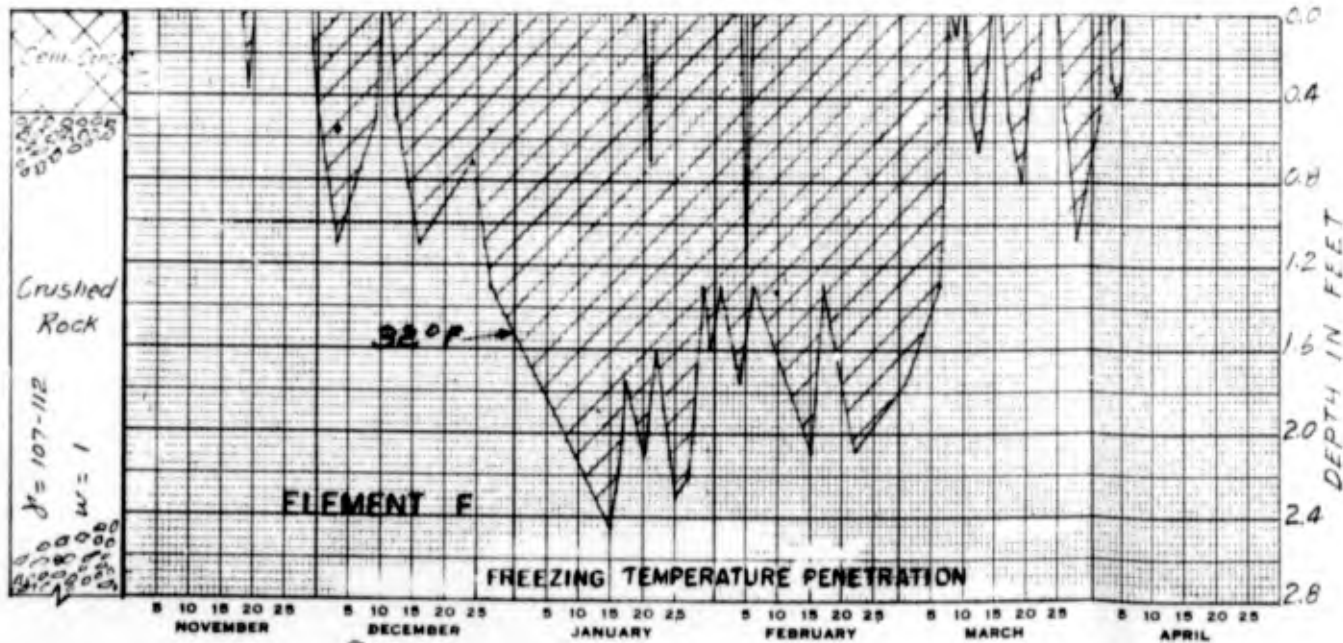
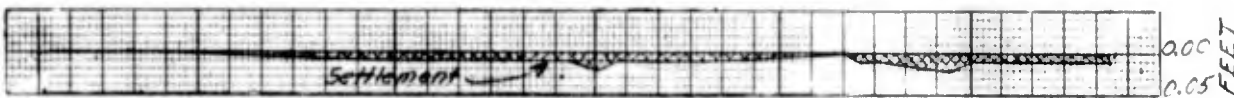
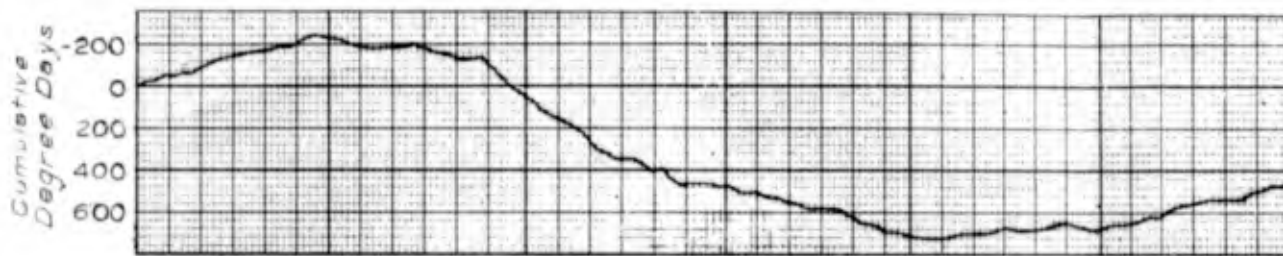
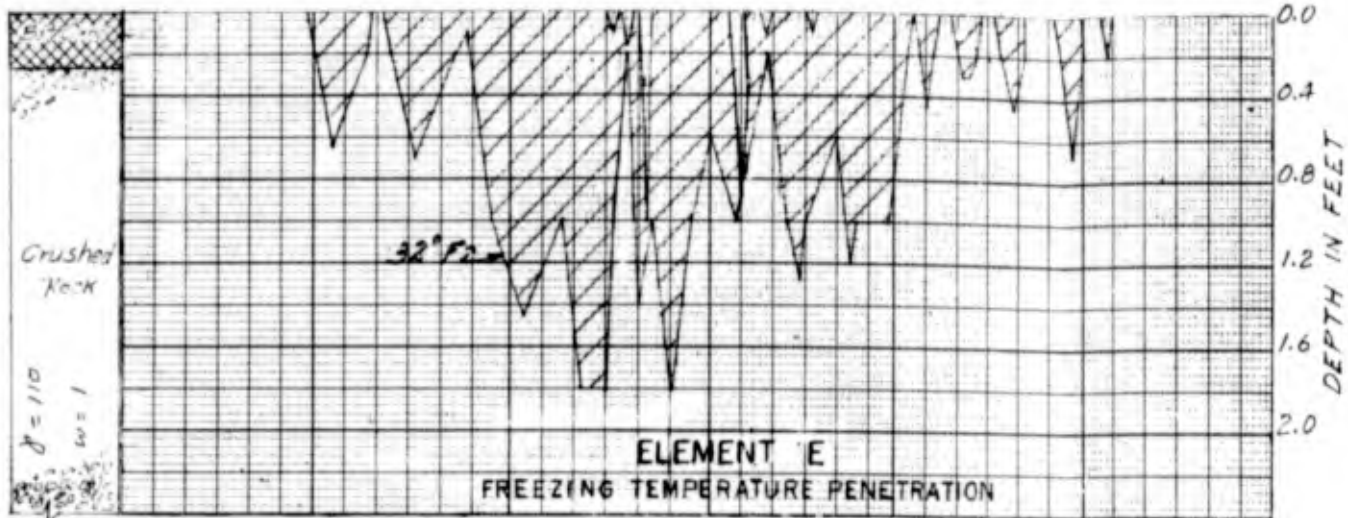
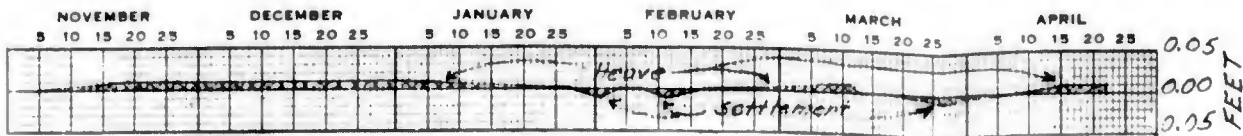
13

C



NOTE  
 Effect of air temperature  
 on Elements modified by  
 heat generated by sawdust  
 insulation around element.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 FREEZING TEMPERATURE  
 AND PAVEMENT HEAVE  
 VS TIME  
 ELEMENTS A, B, C, D.  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947



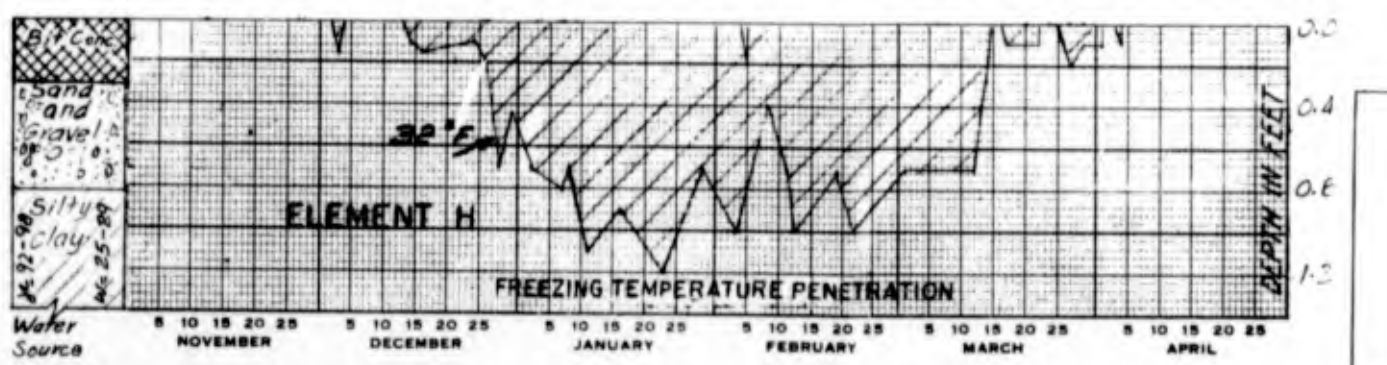
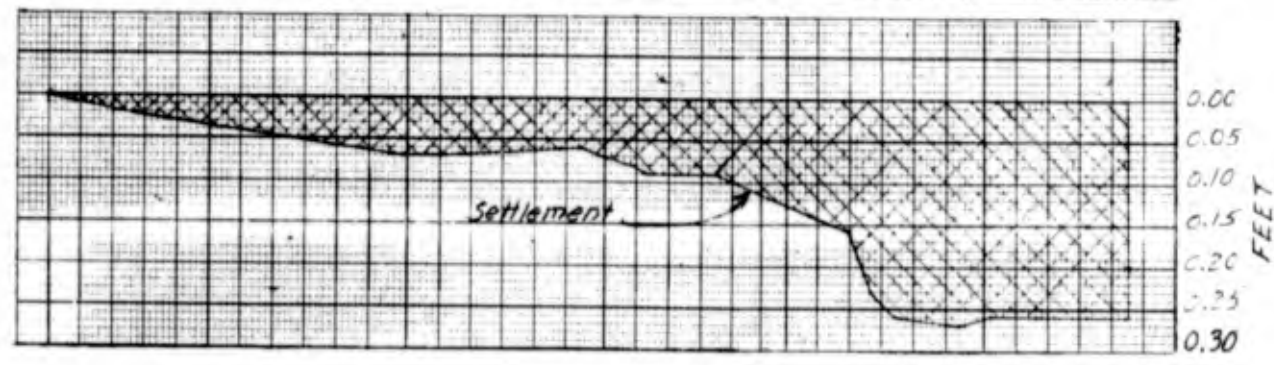
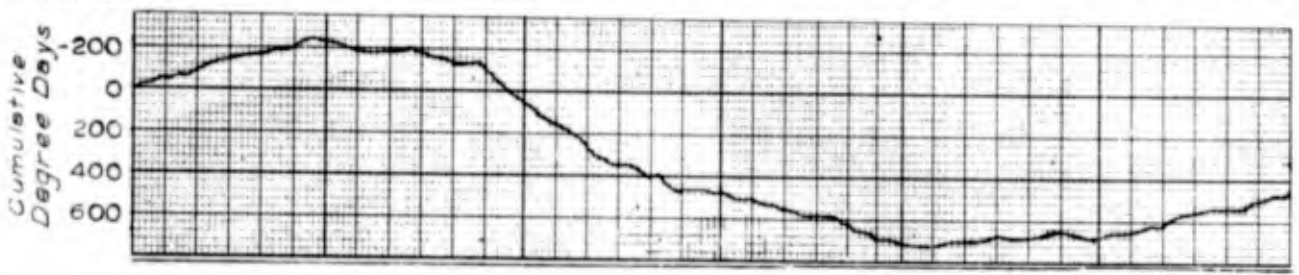
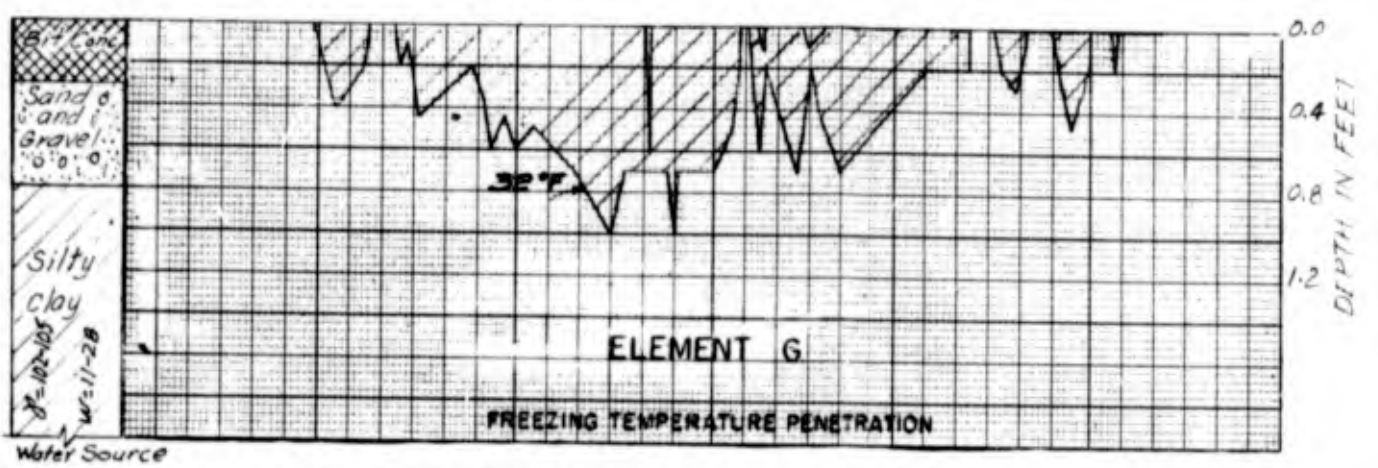
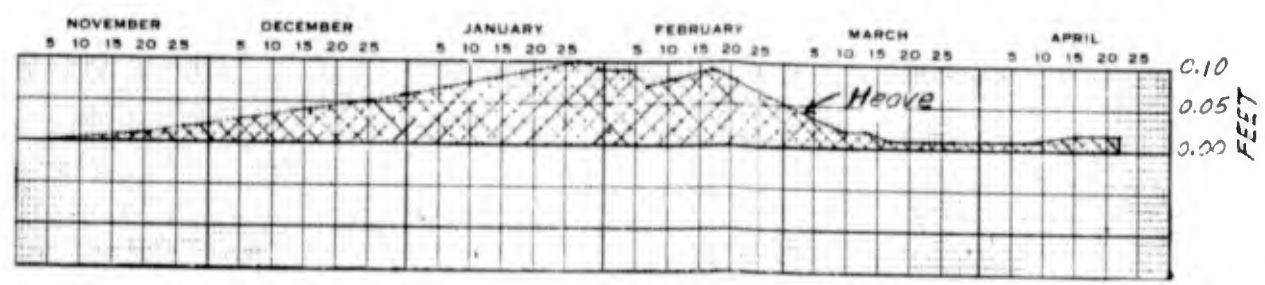
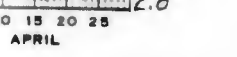
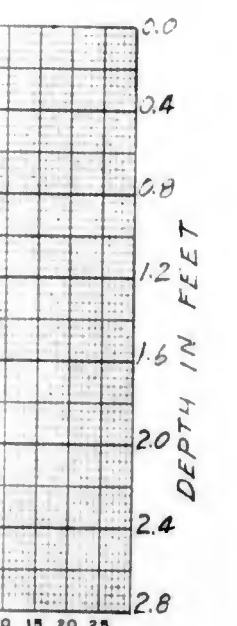
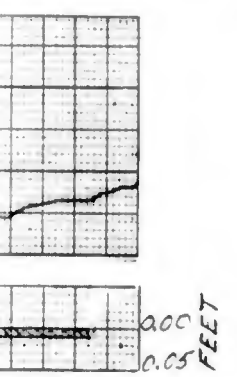
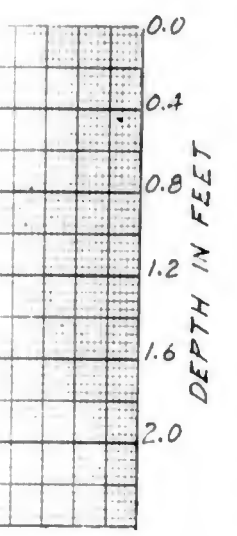
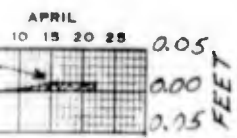
A

Bit. Conc.  
Sand and Gravel  
Silty clay  
 $\gamma = 102-105$   
 $w = 11-28$   
Water Source

Cumulative Degree Days  
-200  
0  
200  
400  
600

Bit. Conc.  
Sand and Gravel  
Silty clay  
 $\gamma = 97-98$   
 $w = 20-29$   
Water Source

B



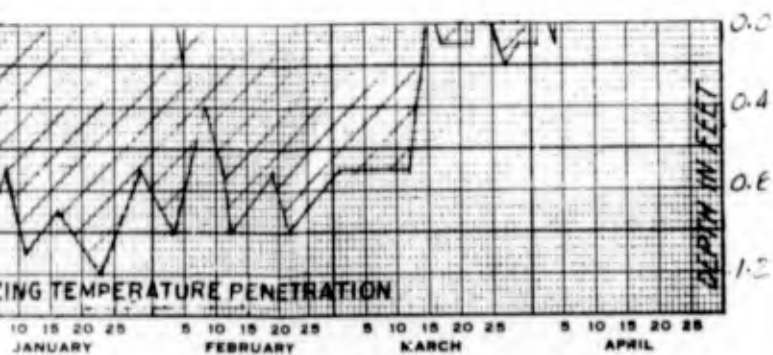
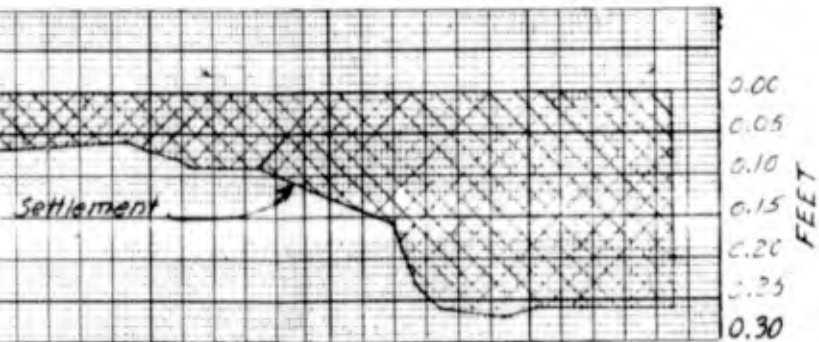
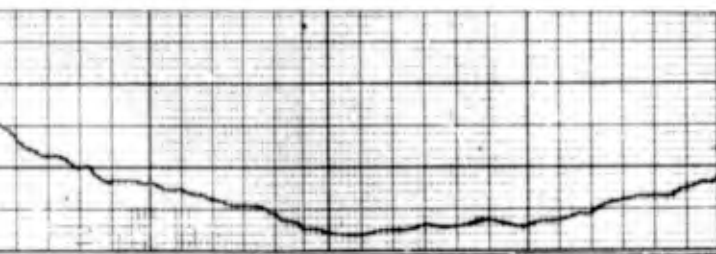
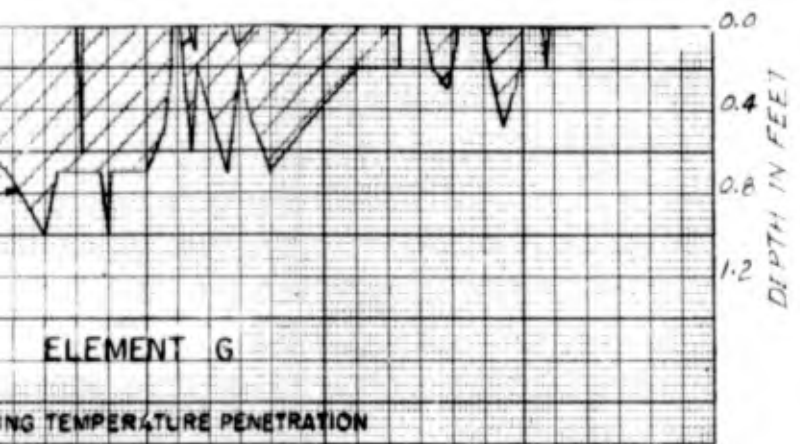
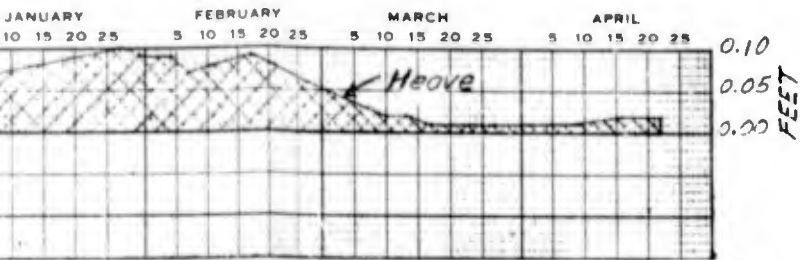
B

C

NO  
Efr  
on  
hea  
ins

FR

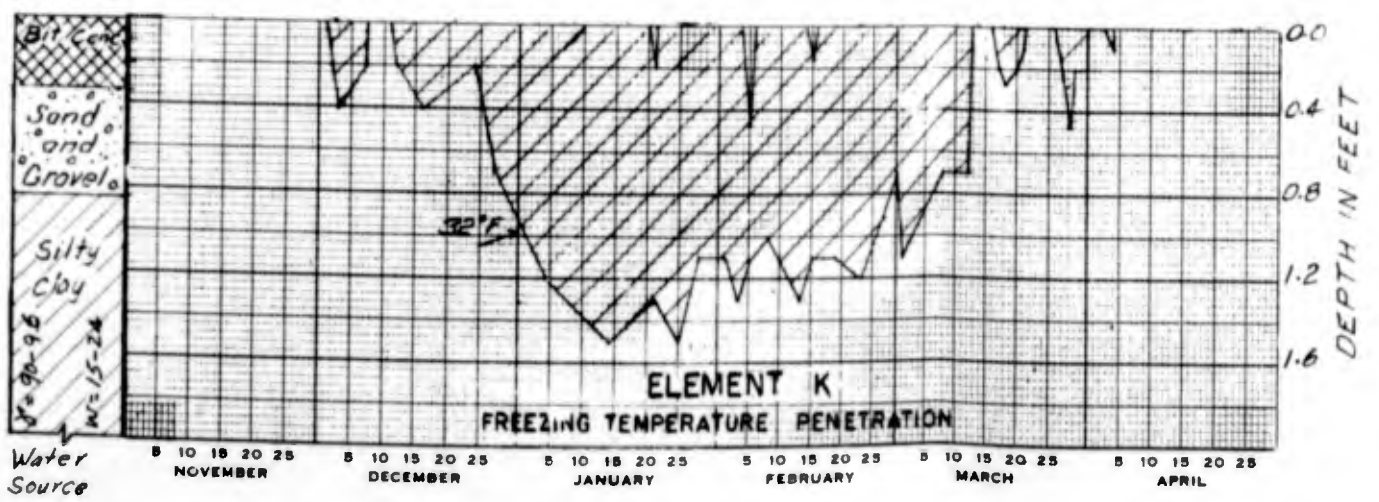
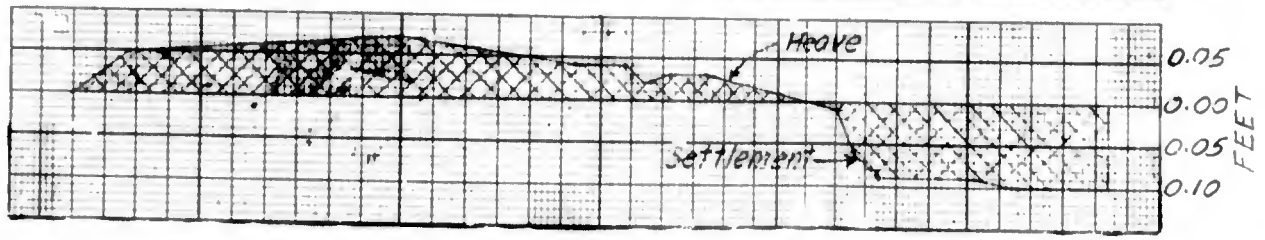
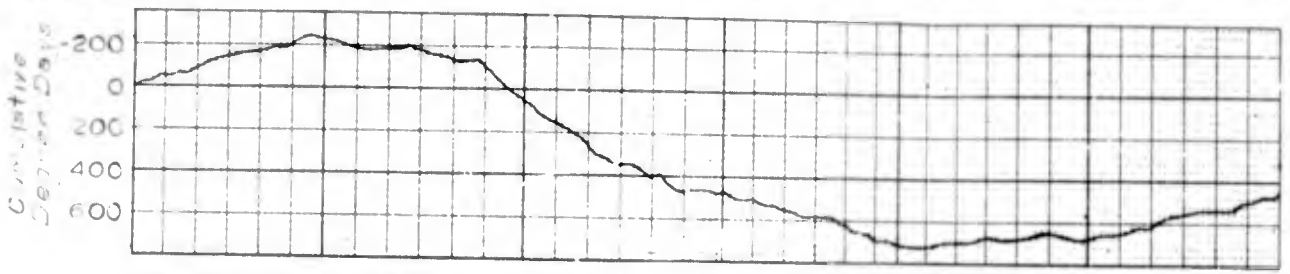
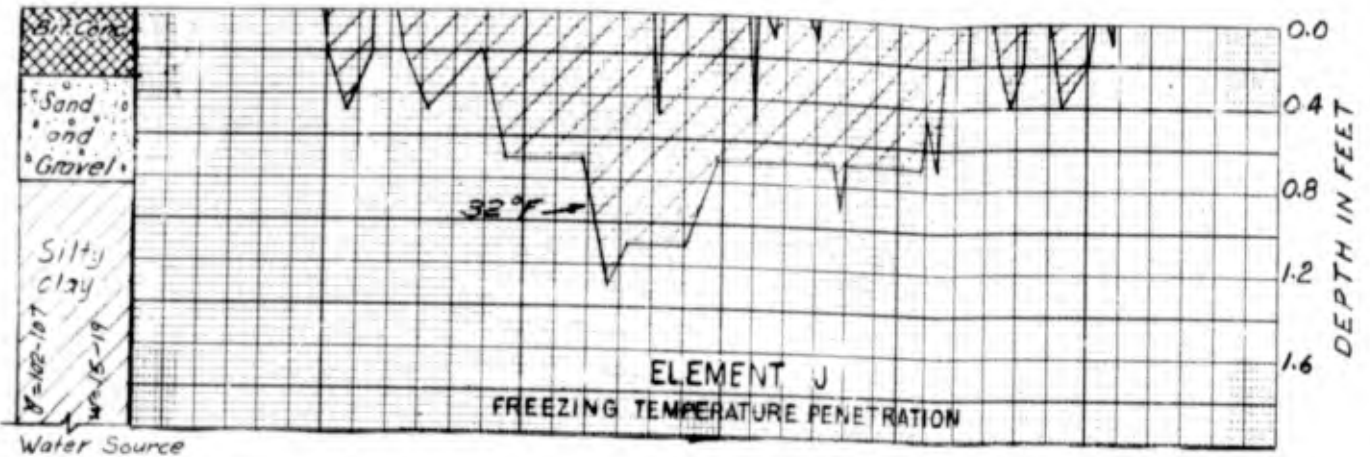
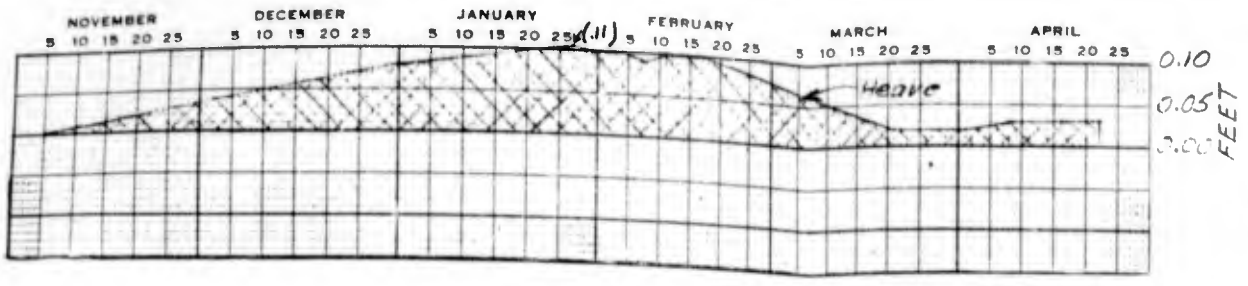
NEW ENGL



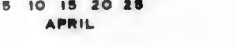
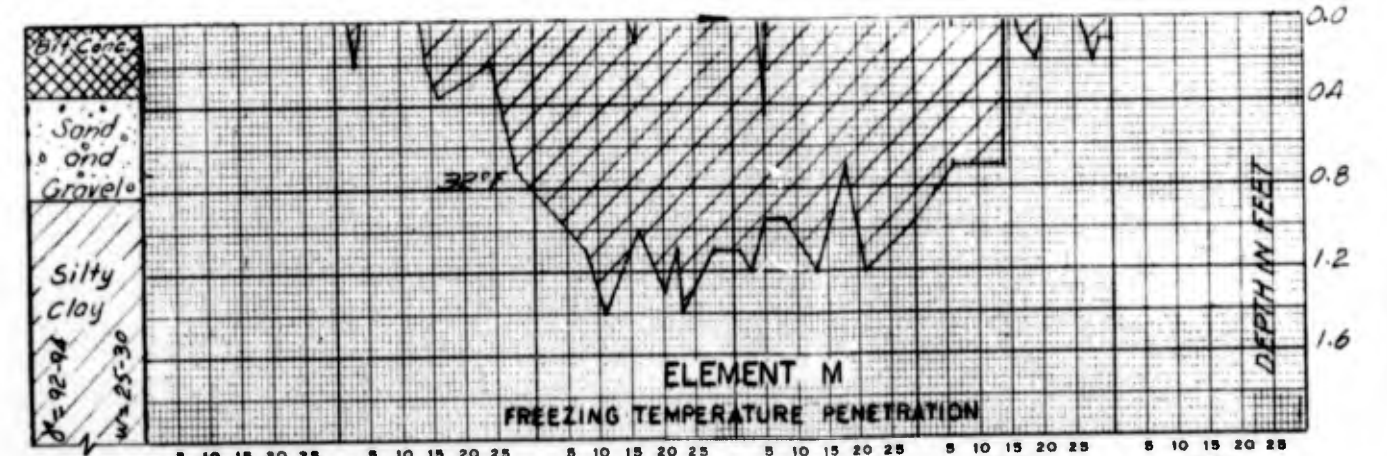
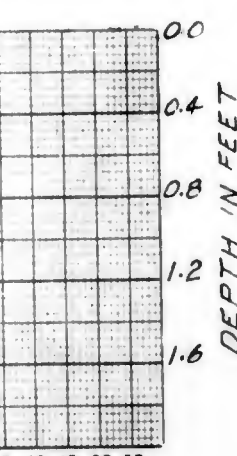
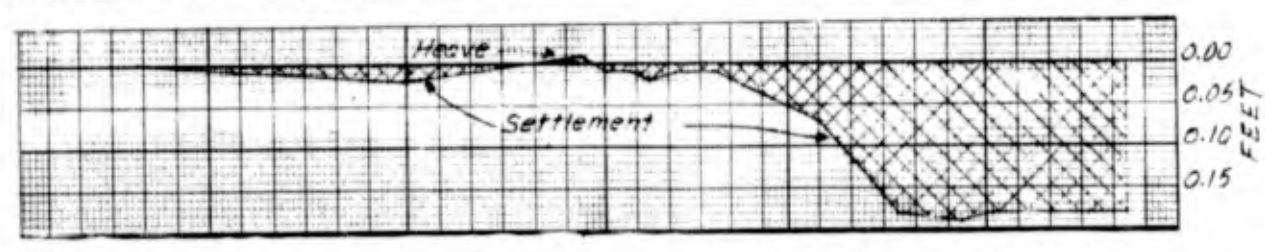
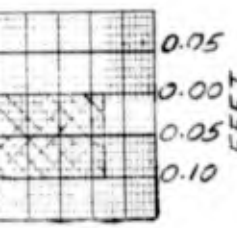
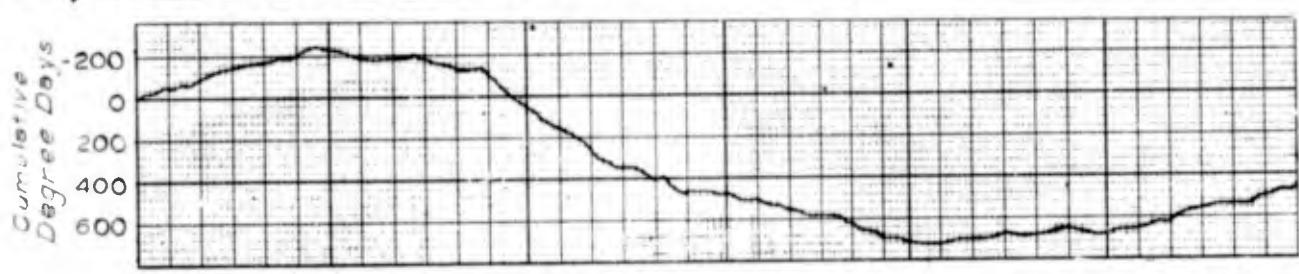
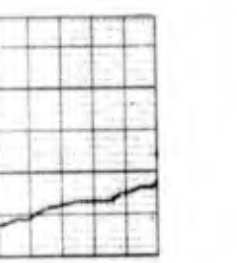
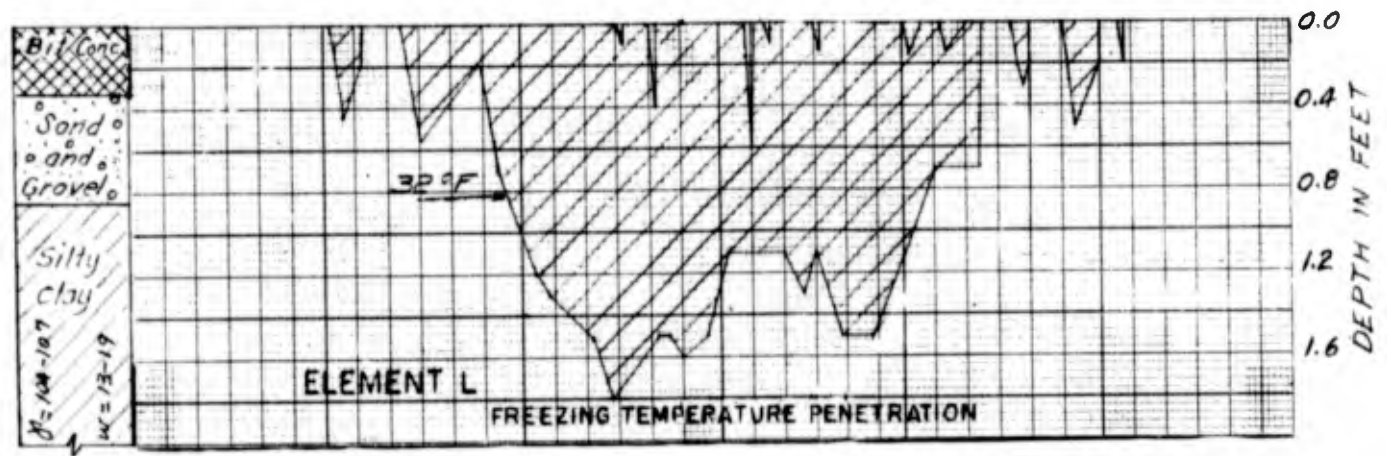
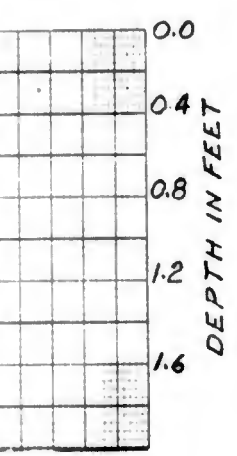
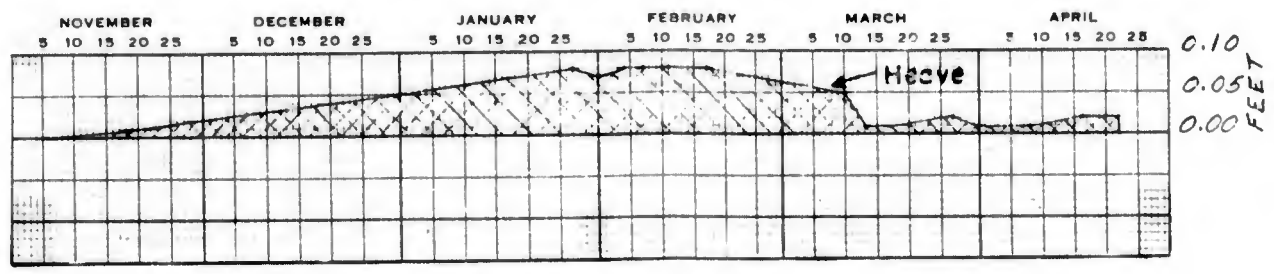
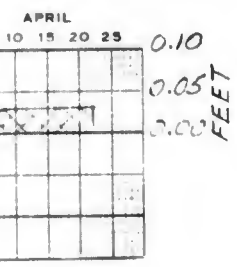
NOTE  
Effect of air temperature  
on Elements modified by  
heat generated by sawdust  
insulation around element.

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
FREEZING TEMPERATURE  
AND PAVEMENT HEAVE  
VS TIME  
ELEMENTS E, F, G, H.

SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947



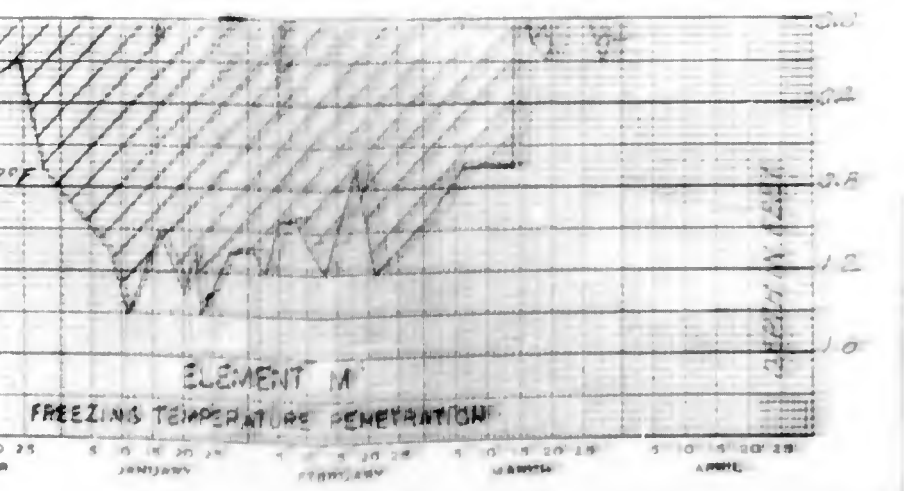
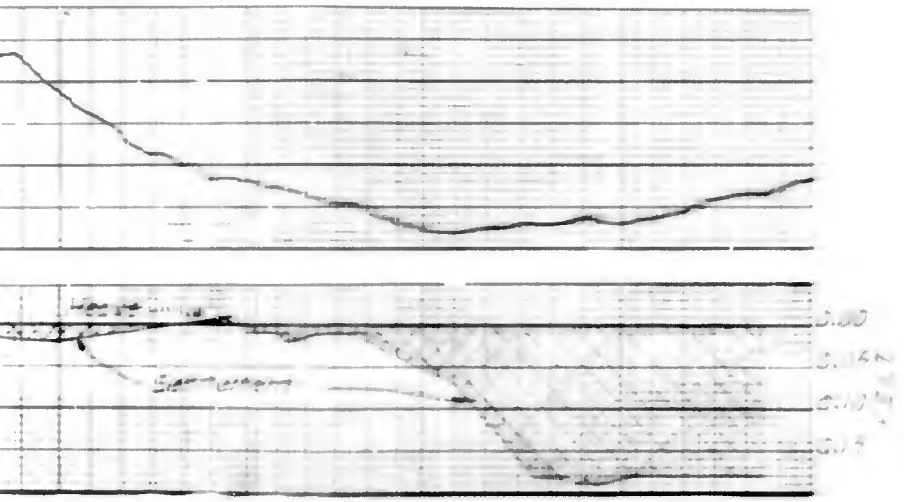
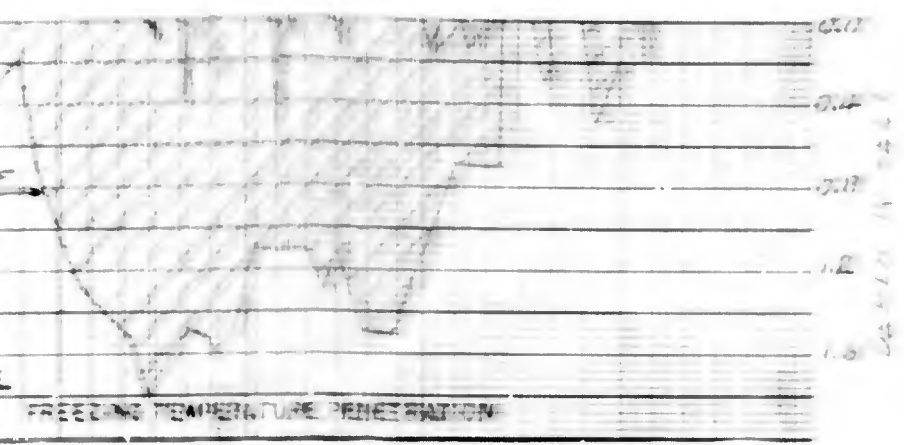
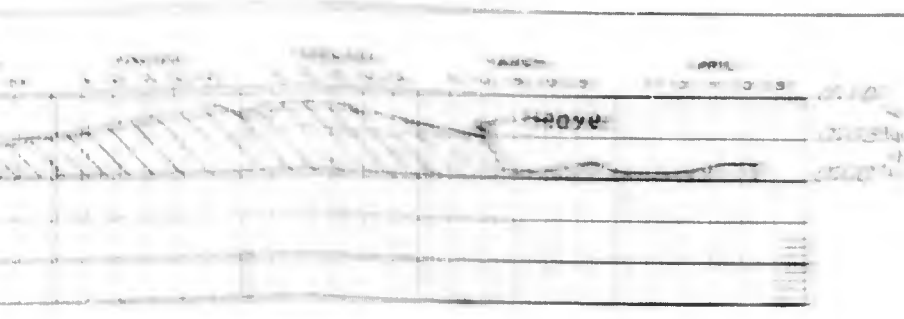
A



B

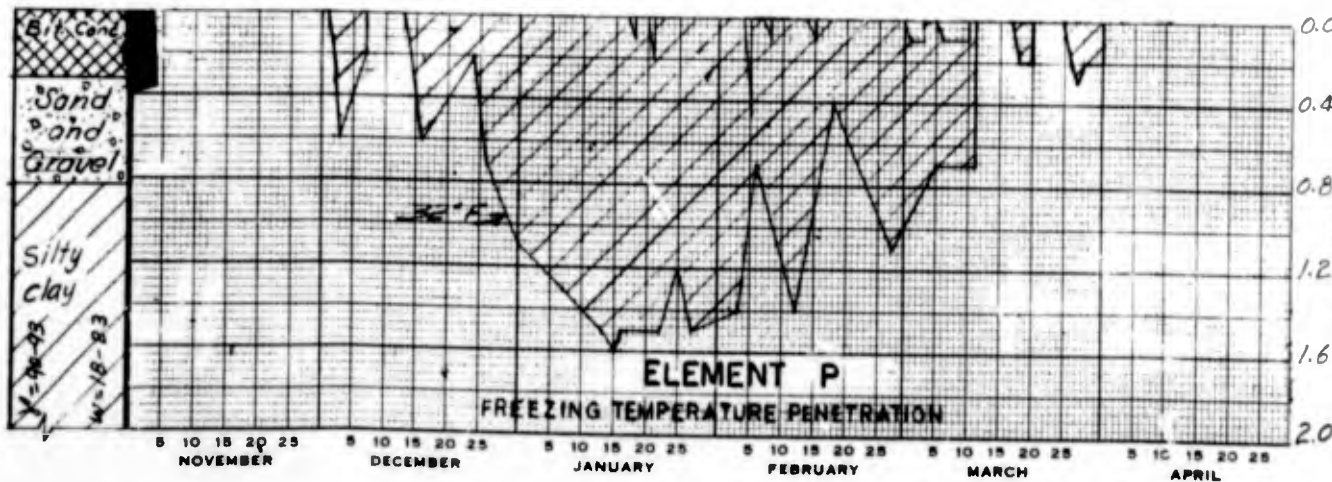
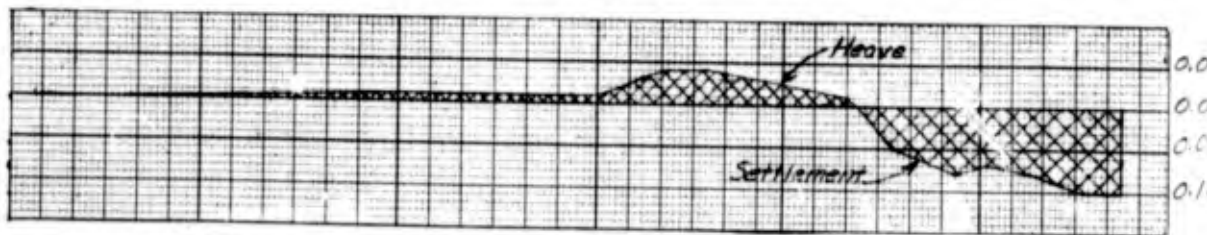
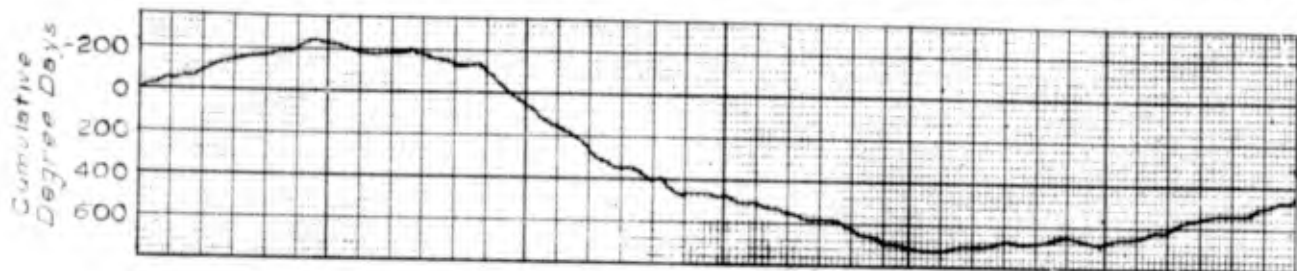
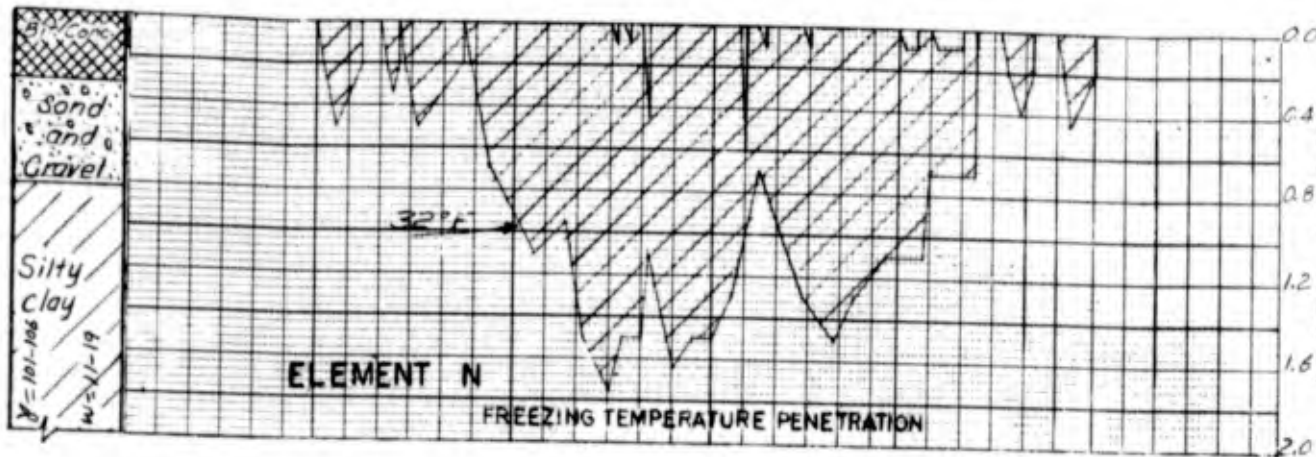
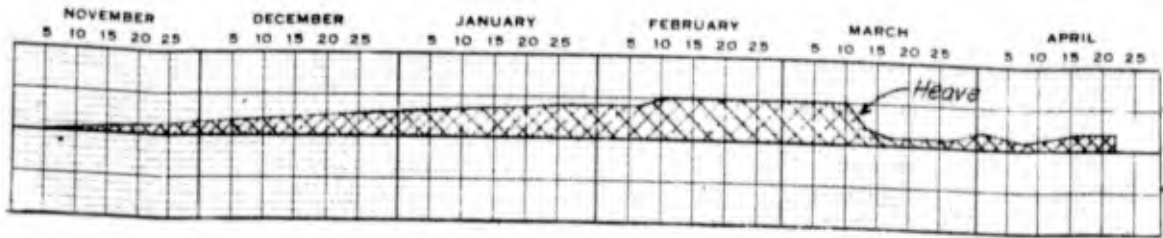
C

NEW

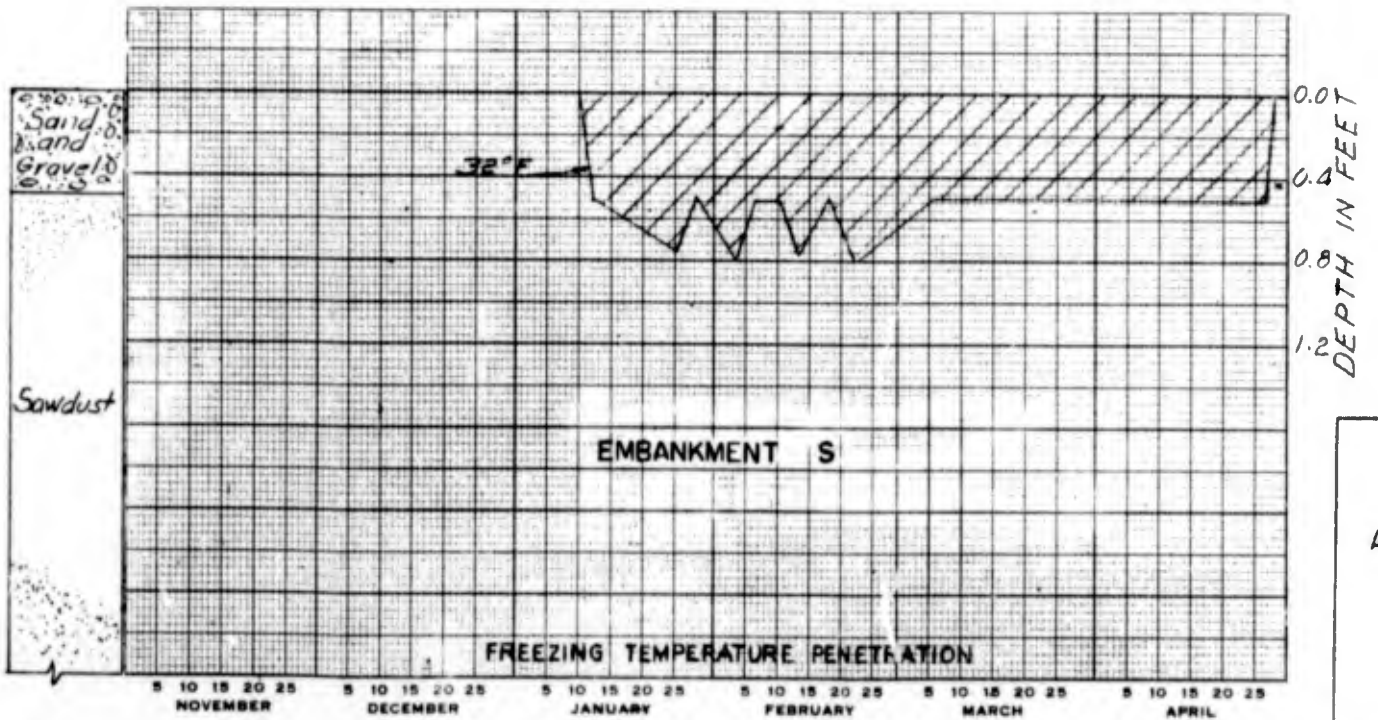
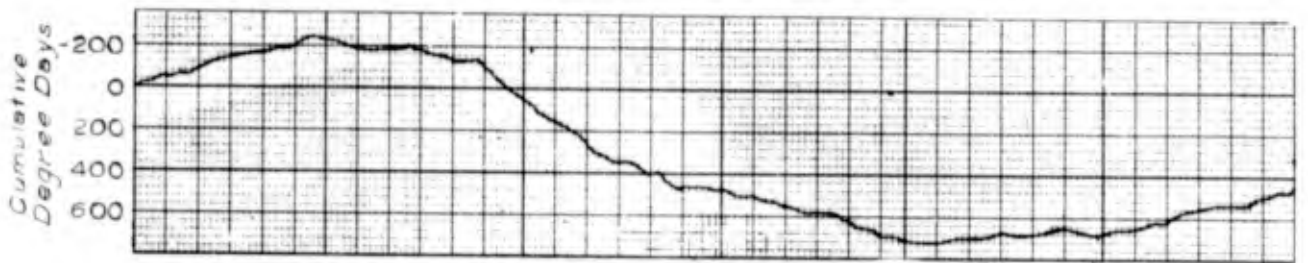
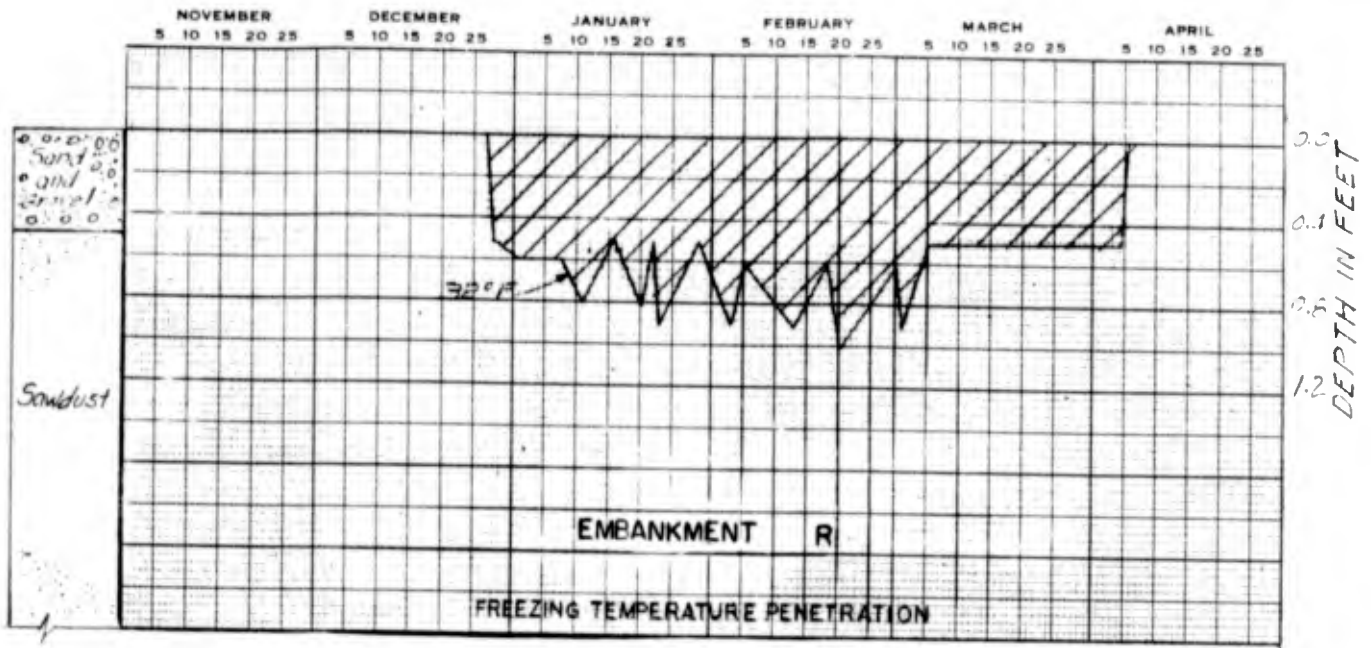
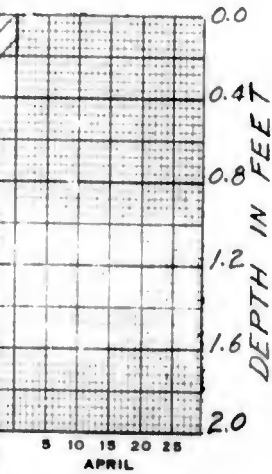
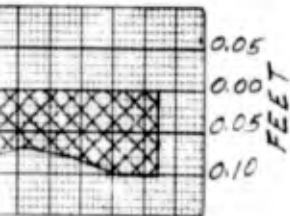
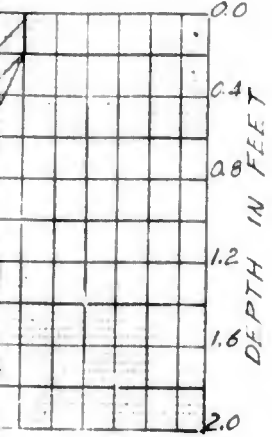
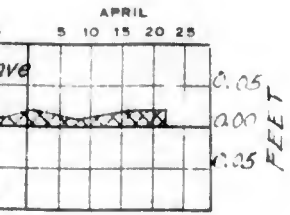


NOTES:  
 1. Frost depth is measured from the surface of the pavement to the depth of the unfrozen soil.  
 2. Frost depth is measured from the surface of the pavement to the depth of the unfrozen soil.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE.  
 FREEZING TEMPERATURE  
 AND PAVEMENT HEAVE  
 VS. TIME  
 ELEMENTS J, K, L, M  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947



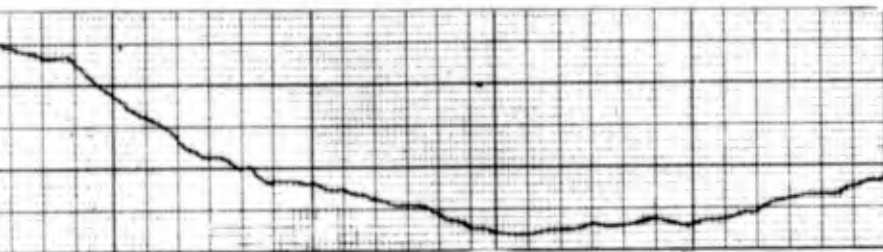
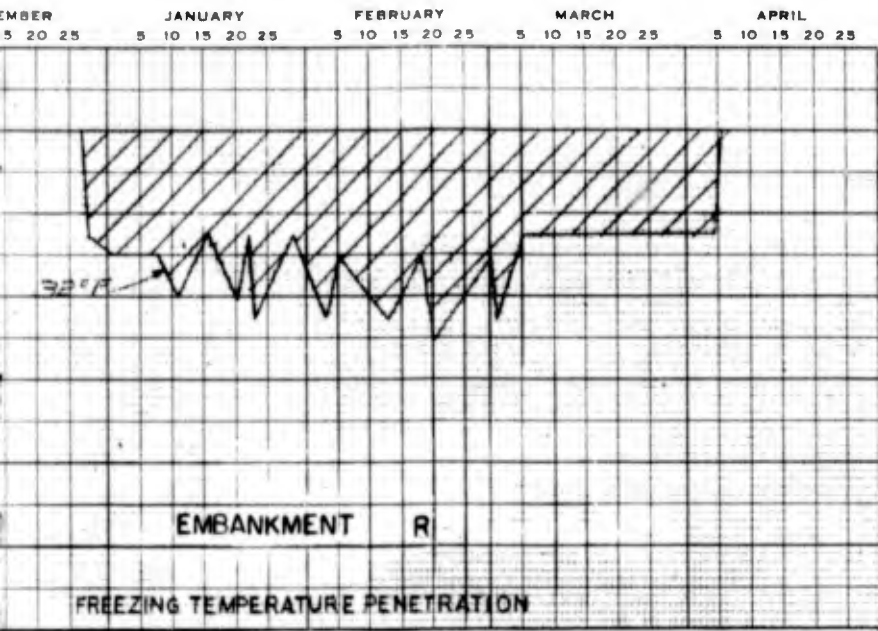
A



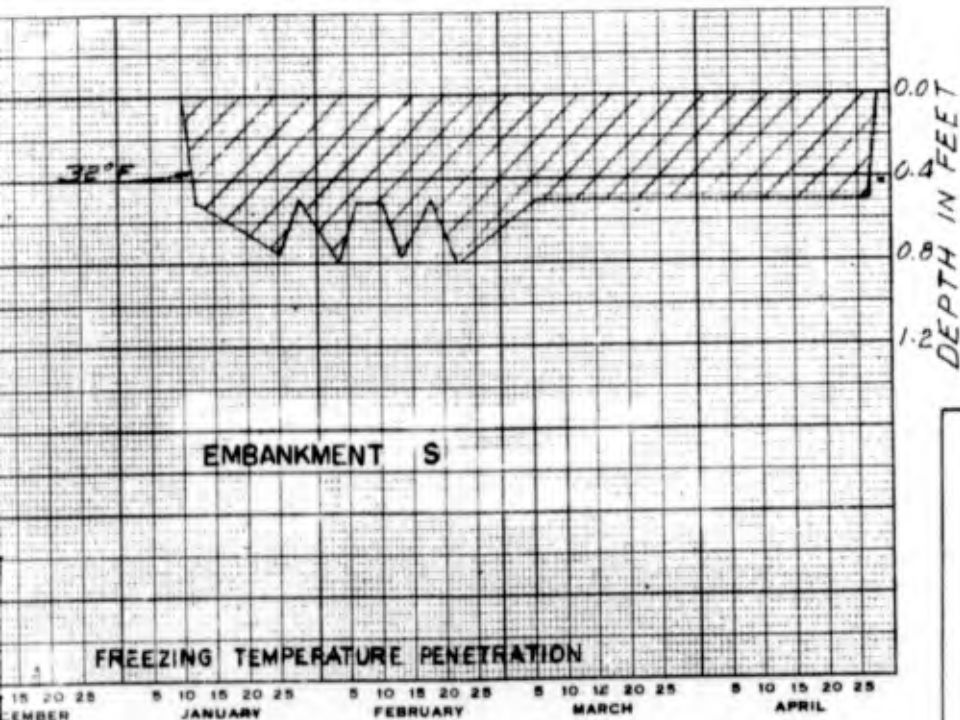
B

C

AN  
NEW



NOTE  
 Effect of air temperature  
 on Elements modified by  
 heat generated by sawdust  
 insulation around element.



FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 FREEZING TEMPERATURE  
 AND PAVEMENT HEAVE VS TIME  
 ELEMENTS N, P  
 EMBAKMENTS R, S  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947

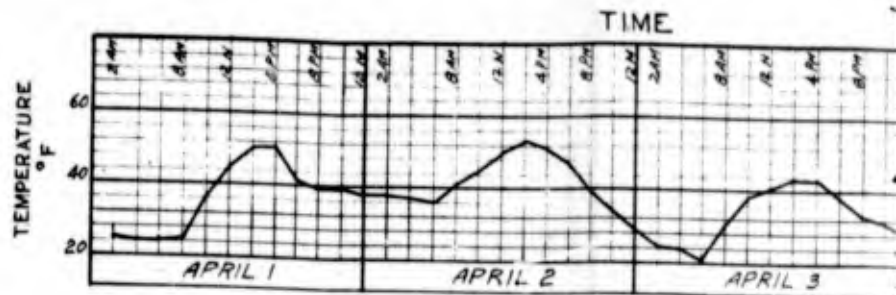


FIG. 1-AIR TEMPERATURE

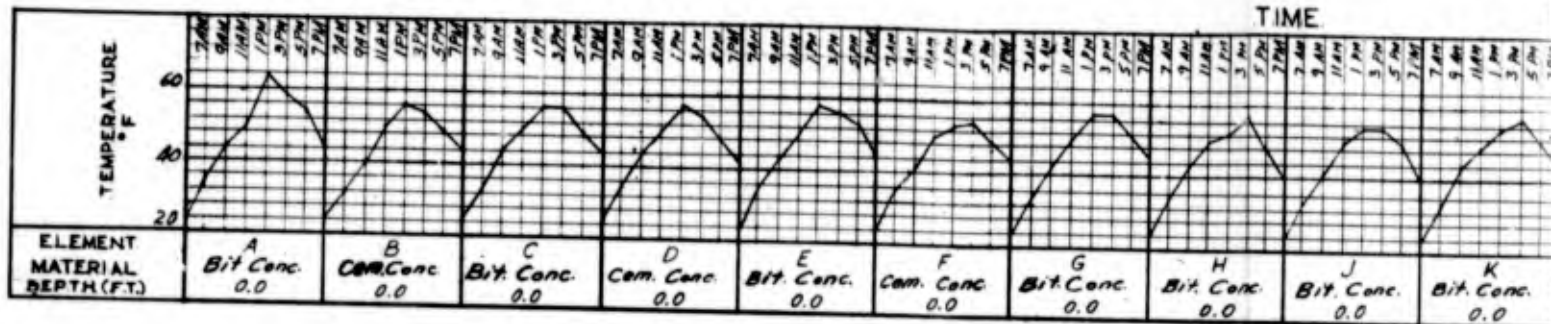


FIG. 2-SURFACE TEMPERATURE

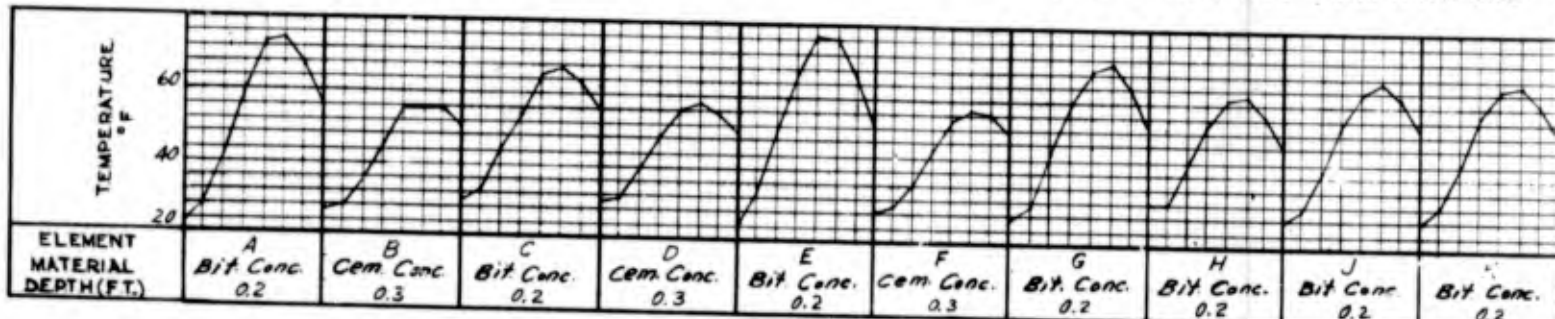


FIG. 3-MID-POINT OF PAVEMENT

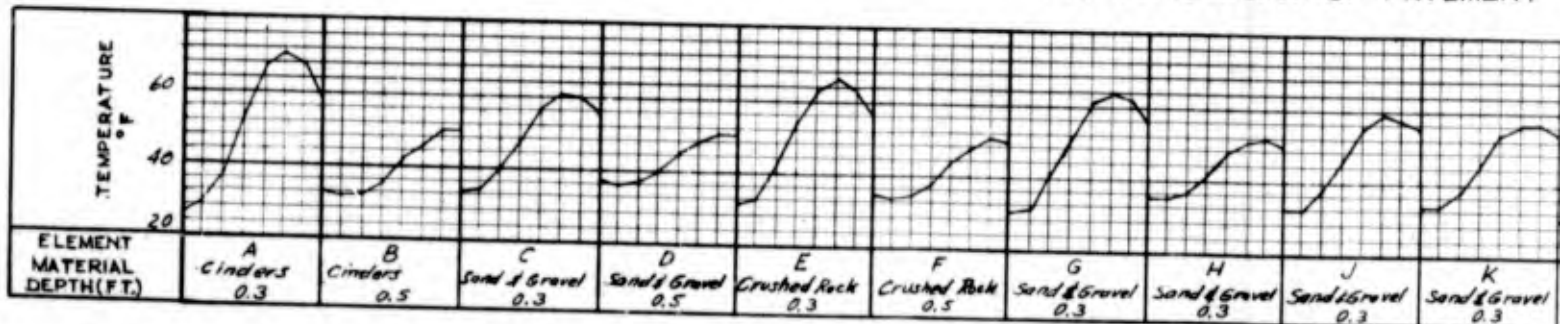


FIG. 4-TOP OF BASE COURSE

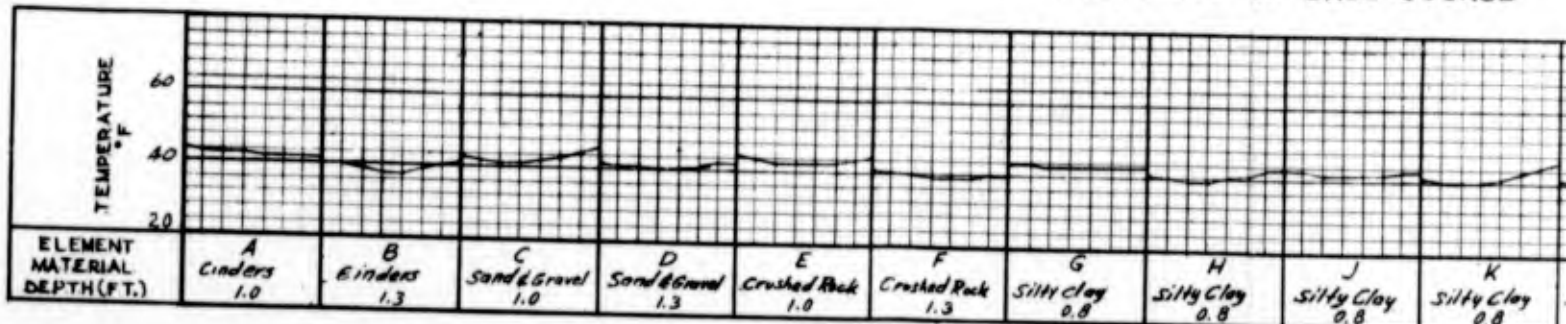
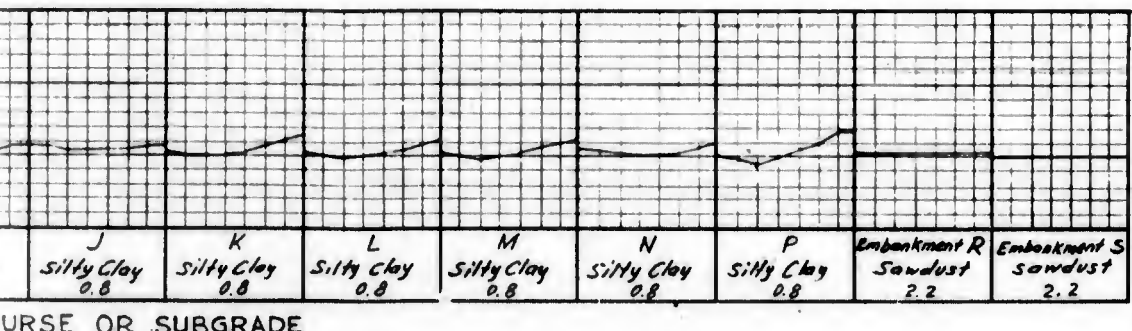
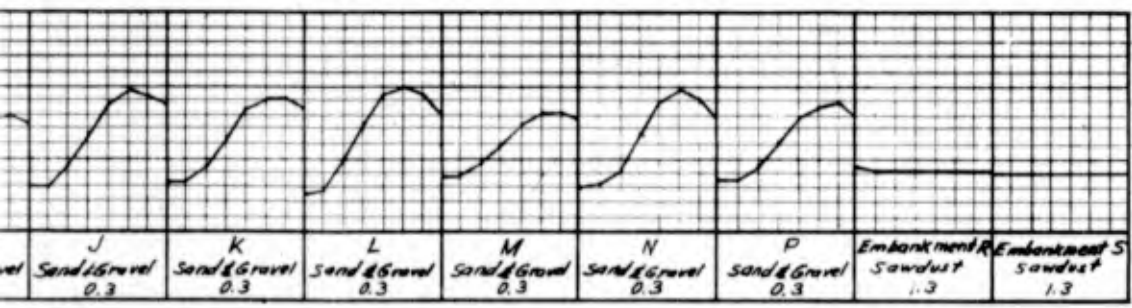
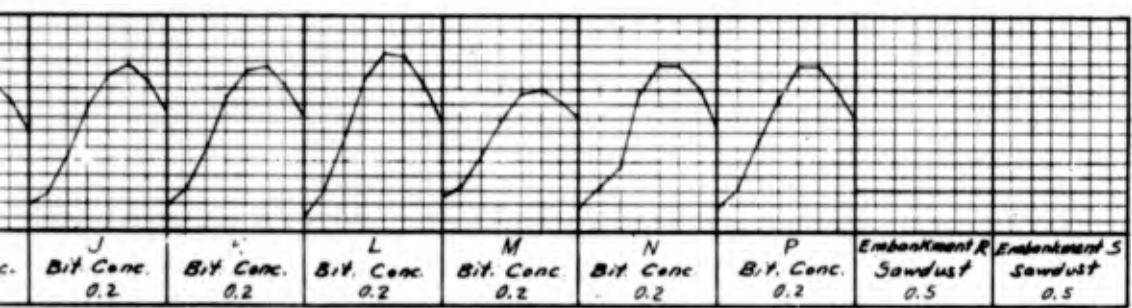
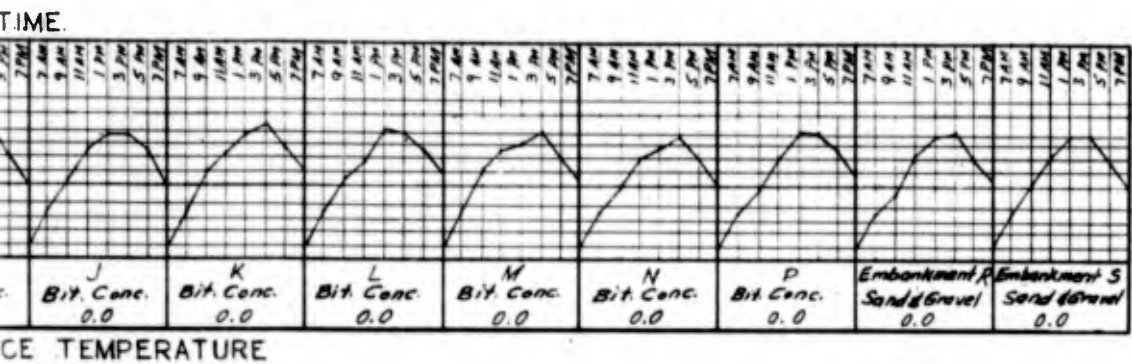
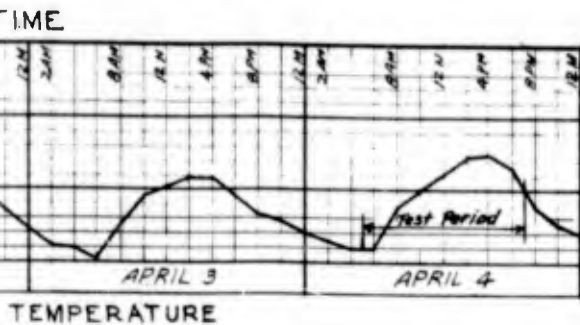


FIG. 5-BASE COURSE OR SUBGRADE

A



Notes:-  
 Weather: Clear, northerly wind, gentle breeze.  
 Air temperatures, Fig 1, taken from thermograph records.  
 Surface temperatures, Fig 2, made by mercury thermometer placed on pavement surface and shielded from the sun.  
 Subsurface temperatures, Figs. 3, 4, 5, made by thermocouple installations.  
 Readings made every two hours, beginning at 5 A.M. and ending at 7 P.M. 4 April 1947.

FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE  
 TEMPERATURES  
 AT TWO HOUR INTERVALS  
 ON 4 APRIL 1947  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASSAUGJ947

B

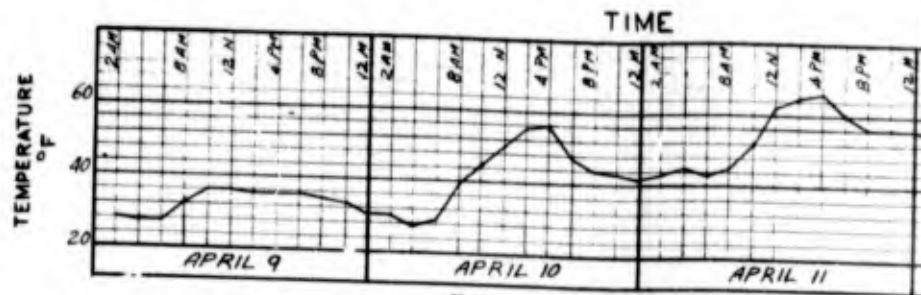


FIG. 1 - AIR TEMPERATURE

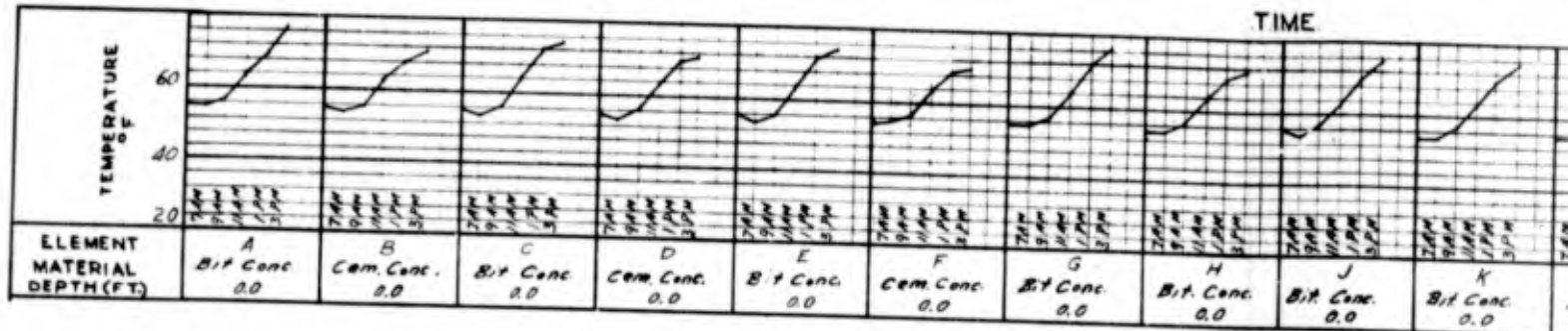


FIG. 2 - SURFACE TEMPERATURE

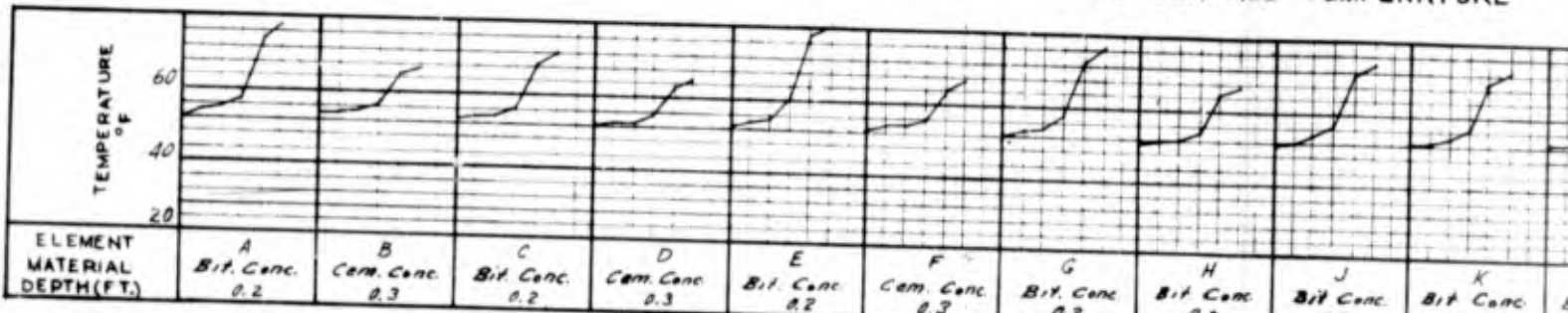


FIG. 3 - MID-POINT OF PAVEMENT

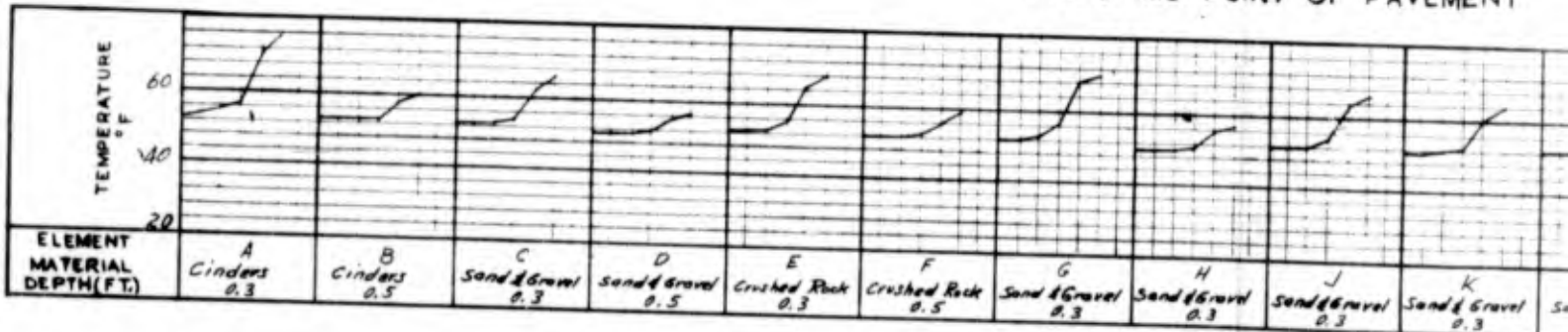


FIG. 4 - TOP OF BASE COURSE

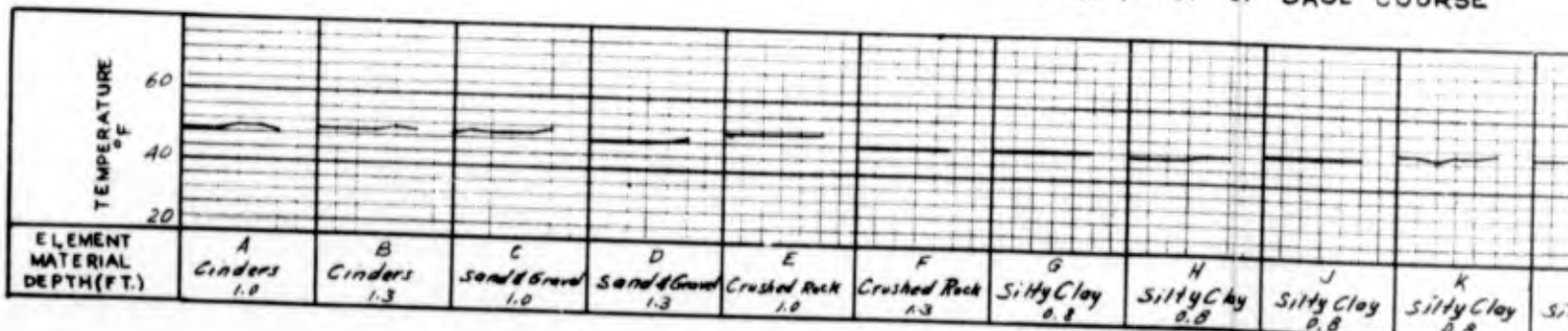
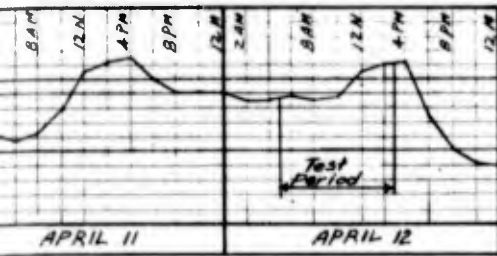


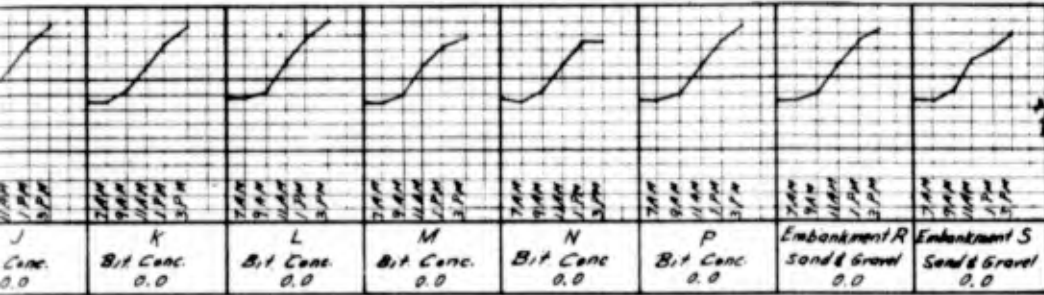
FIG. 5 - BASE COURSE OR SUBGRADE

A

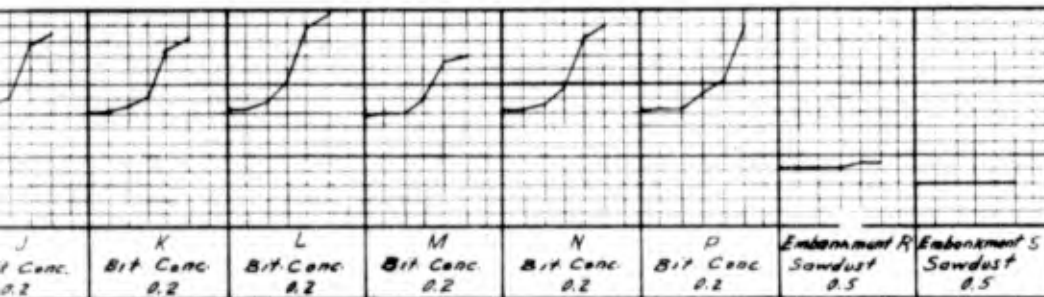
1



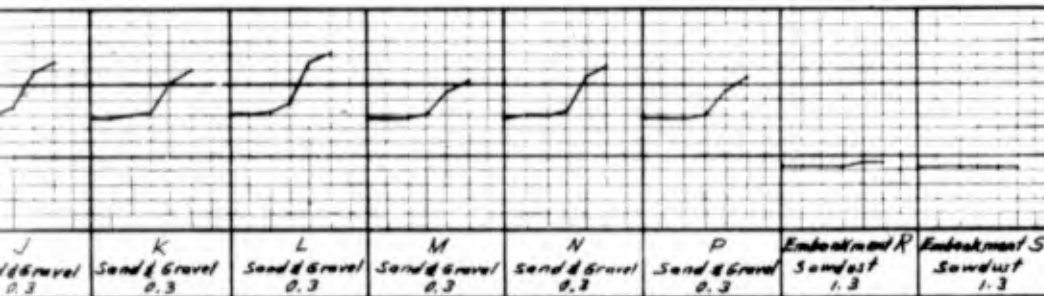
TEMPERATURE



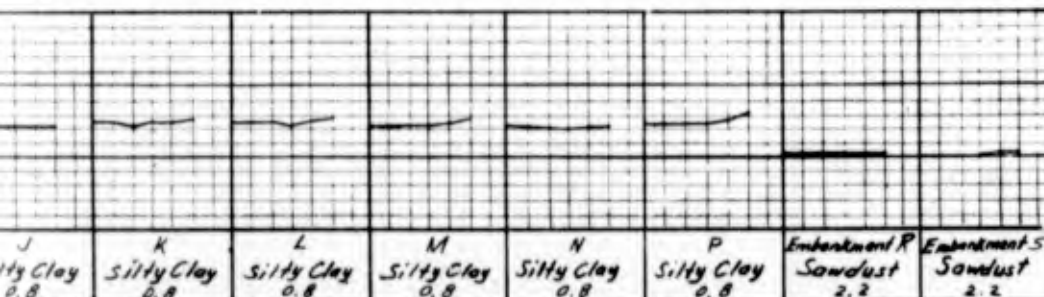
TEMPERATURE



OF PAVEMENT



BASE COURSE



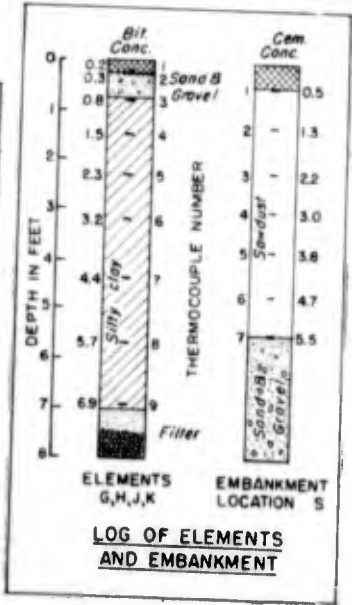
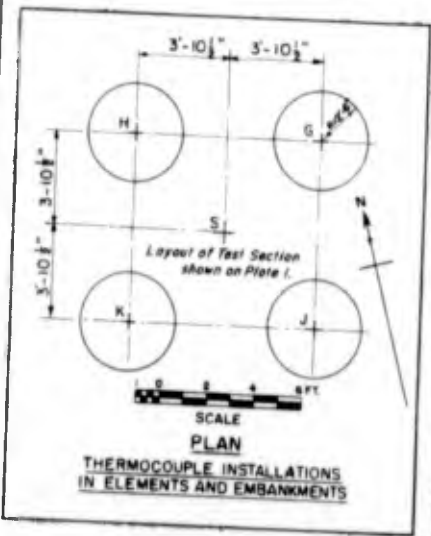
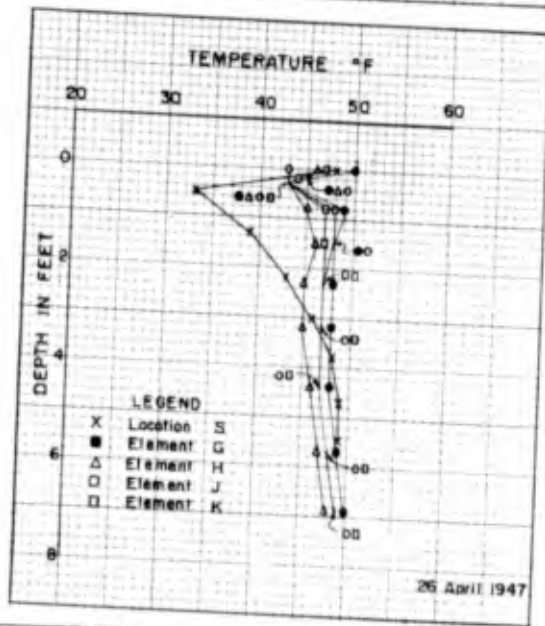
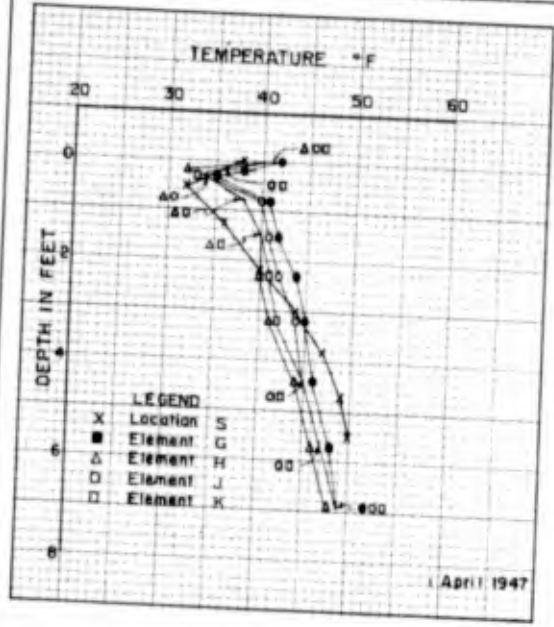
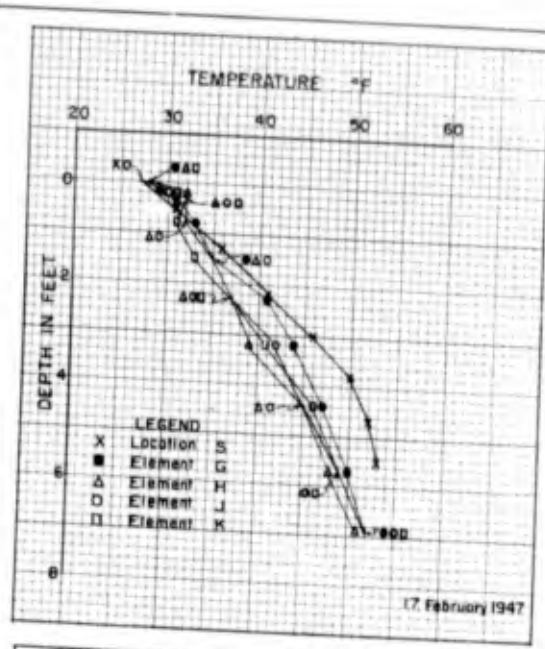
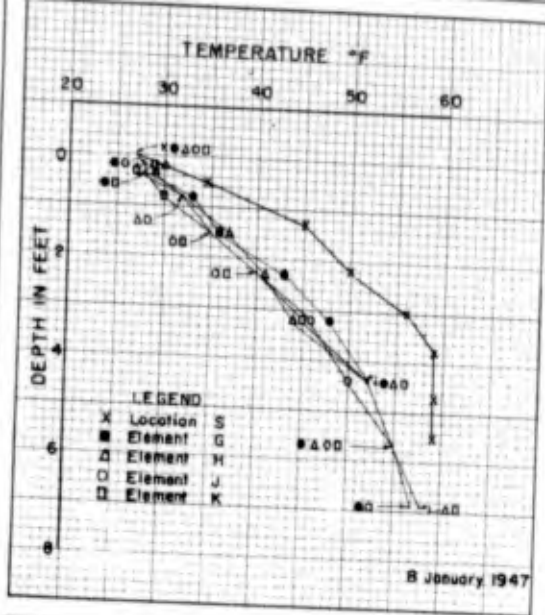
OR SUBGRADE

Notes -

Weather: Southwesterly wind, gentle breeze. Cloudy from 5 A.M. to 7 A.M. Rain from 7 A.M. to 11 A.M. Clearing at 2 P.M. Air temperatures, Fig 1 taken from thermograph records. Surface temperatures Fig 2 made by mercury thermometer placed on pavement surface and shielded from the sun. Subsurface temperatures, Figs 3, 4, 5 made by thermocouple installations. Readings made every two hours, beginning at 5 A.M. and ending at 3 P.M. 12 April 1947

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
TEMPERATURES  
AT TWO HOUR INTERVALS  
ON 12 APRIL 1947

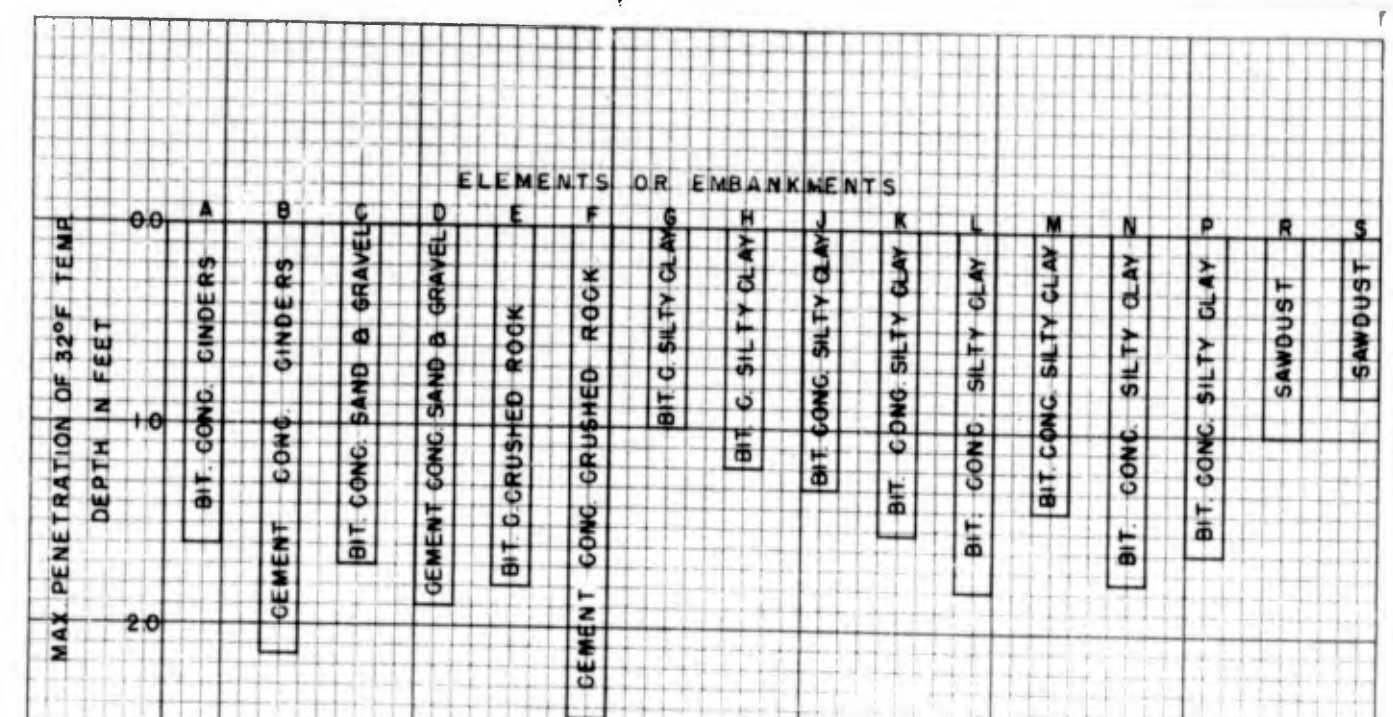
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASSAUG. 1947



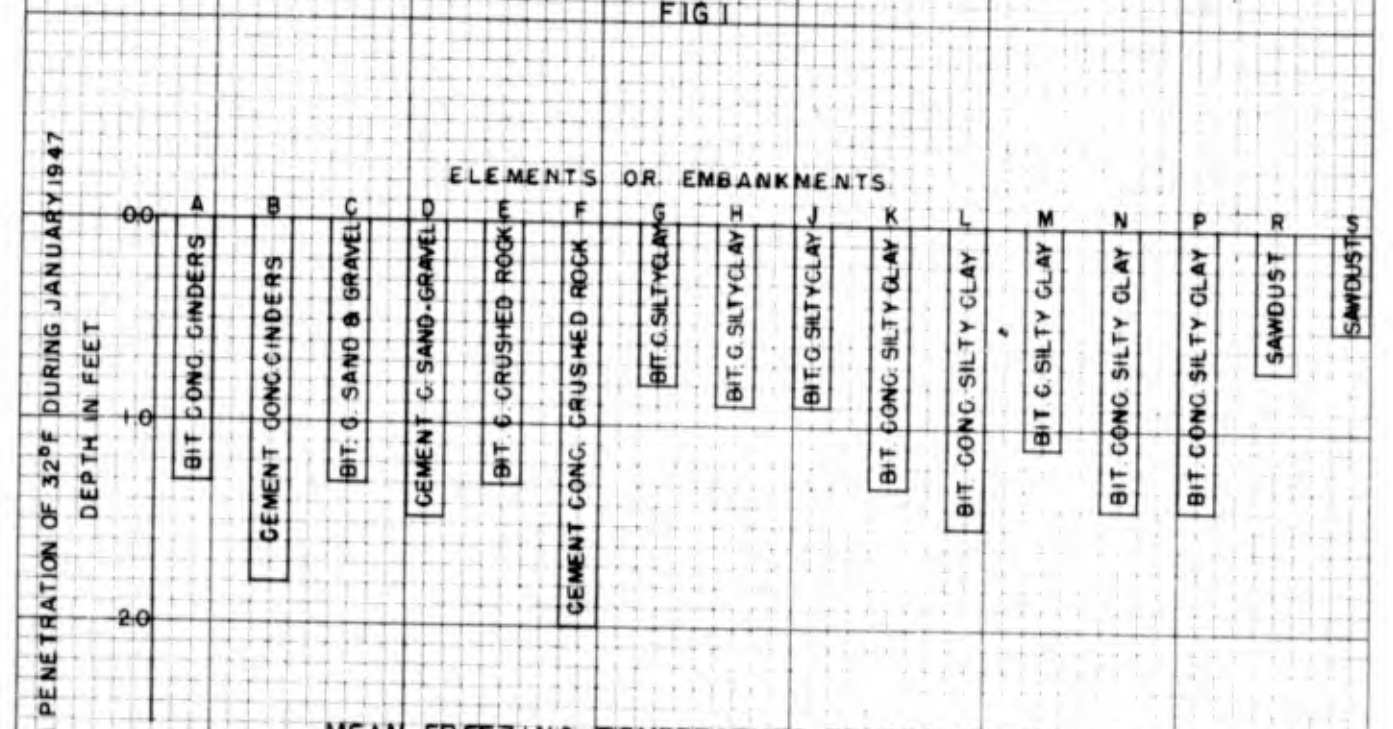
FROST INVESTIGATION  
 DOW FIELD, BANGOR, MAINE

COMPARATIVE  
 TEMPERATURE GRADIENTS  
 IN  
 ELEMENTS AND EMBANKMENT

SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS., AUG. 1947



MAXIMUM FREEZING TEMPERATURE PENETRATION DURING THE WINTER  
FIG 1



MEAN FREEZING TEMPERATURE PENETRATION DURING JANUARY 1947  
FIG 2

NOTE:

Elements G, H, J, K, I, M, N and P had a six inch layer of sand and gravel between the pavement and silty clay subgrade.

Embankments R and S had a six inch layer of sand and gravel overlying a five foot layer of sawdust.

FROST INVESTIGATION  
DOW FIELD, BANGOR, MAINE  
DEPTH OF FREEZING  
TEMPERATURE PENETRATION  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUG. 1947



Figure 1. Detail of concrete foundation  
for element A



Figure 2. Placing a concrete cylinder during  
test section construction

DCW FIELD TEST SECTION  
DETAILS OF CONSTRUCTION



Figure 1. All concrete cylinders and gravel backfill in place



Figure 2. General view of test section prior to placing sawdust insulation backfill

DOW FIELD TEST SECTION  
GENERAL VIEW OF TEST ELEMENTS DURING CONSTRUCTION



Figure 1. Subgrade material in element V,  
placed at density of 90 PCF and at  
water content of 28 per cent



Figure 2. Subgrade material in element P,  
placed at density of 90 PCF and at  
water content of 22 per cent

DOW FIELD TEST SECTION  
SUBGRADE MATERIAL IN ELEMENTS



Figure 1. Settlement of pavement in  
Element H on 11 April 1947



Figure 2. Settlement of pavement in  
Element W on 11 April 1947

DOW FIELD TEST SECTION  
TEST ELEMENTS SHOWING PAVEMENT SETTLEMENT

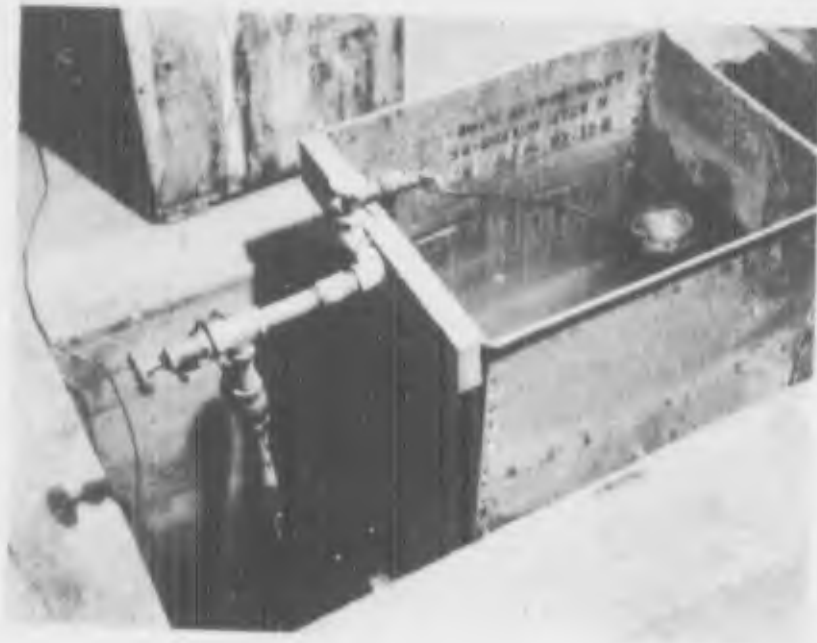


Figure 1. ball and cork valve control for constant ground water level in elements G, H, J, and K



Figure 2. ball and cork valve control for constant ground water level in elements G, H, J, and K

DOW FIELD TEST SECTION  
WATER SUPPLY TANK



Figure 1. Thermocouples in element prior to placing soil



Figure 2. Thermocouple leads in trench from elements to instrument room

LOW FIELD TEST SECTION  
THERMOCOUPLES AND THERMOCOUPLE LEADS



Figure 1. Entrance of thermocouple leads  
to instrument room



Figure 2. Thermocouple leads to instrument  
DCW FIELD TEST SECTION  
THERMOCOUPLE LEADS TO INSTRUMENT ROOM



DOW FIELD TEST SECTION  
THERMOCOUPLE SWITCHING PANEL AND TEMPERATURE  
INDICATING SCALE

NEW ENGLAND DIVISION  
CORPS OF ENGINEERS  
DEPARTMENT OF THE ARMY  
BOSTON, MASSACHUSETTS

APPENDIX 1

PART 3

REPORT ON  
BEDFORD AIRFIELD, BEDFORD, MASS.

FROST INVESTIGATION

1946-1947

FROST INVESTIGATION

TABLE OF CONTENTS

<u>Paragraph</u>	<u>Title</u>	<u>Page</u>
	List of Tables	ii
	List of Plates	ii
	I. INTRODUCTION	
1-01	Authorization	1
1-02	Purpose	1
1-03	Scope	1
1-04	Definitions	1
1-05	General Conditions	2
	II. TEST AREAS A AND B	
2-01	Location and Description	3
2-02	Installations	3
2-03	Observations and Measurements	4
	III. CONCLUSIONS	
3-01	Conclusions	5

FROST INVESTIGATION

LIST OF TABLES

TABLE

TITLE

- |   |   |
|---|---|
| 1 | Record of Subsurface Temperatures<br>Test Area A. |
| 2 | Record of Subsurface Temperatures<br>Test Area B. |

LIST OF PLATES

PLATE

TITLE

- |   |   |
|---|---|
| 1 | Geographical Location Map.                                |
| 2 | Weather and Frost Penetration Data.                       |
| 3 | Plan and Profile Test Areas A and B.                      |
| 4 | Subsurface Temperatures and Ther-<br>mometer Well Detail. |
| 5 | Thermocouple Installation and Switch<br>Box Details       |

FROST INVESTIGATION

1946 - 1947

APPENDIX 1

PART 3

REPORT ON

BEDFORD AIRFIELD, BEDFORD, MASSACHUSETTS

I. INTRODUCTION

1-01. Authorization. The frost investigation program was continued by authorization contained in two letters from the Chief of Engineers to the Division Engineer, New England Division, dated 25 July 1946 and 12 August 1946, subject: "Funds For Investigational Program For Fiscal Year 1947", and subsequent indorsements.

1-02. Purpose. The purpose of this investigation is to augment the tests made and data obtained in the frost investigations conducted during the fiscal year 1945-1946.

1-03. Scope. This report presents the results of frost investigations conducted at Bedford Airfield, Bedford, Massachusetts, during the period from 8 July 1946 to 18 August 1947. The investigation was conducted at two test areas where subsurface temperatures were recorded by means of thermocouple and thermometer readings. Climatic and other general conditions related to frost action at Bedford Airfield are also included.

1-04. Definitions. The description of the tests and analysis of results involve a specialized use of certain terms and words. The words and terms are defined for use in Glossary Part 1 of this report.

1-05. General Conditions.

a. Location and Terrain. Bedford Airfield is located approximately 14 miles northwest of the city of Boston in the towns of Bedford, Concord, and Lexington, in Middlesex County, Massachusetts. (See Plate 1). The airfield site is an area of rolling terrain of low relief. The hills surrounding the field are composed of glacial till with bedrock generally at shallow depths or exposed. The low area at the site generally consists of a glacio-fluvial deposit of sand with gravelly phases varying in thickness from three to ten feet overlying silt and fine sand of depths in excess of 15 feet.

b. Types and Condition of Pavements. The airfield consists of three runways, 5,000 feet by 300 feet, paved with 3-1/2 inches of bituminous concrete. The main service aprons, the turn-arounds, and the hard stands are paved with portland cement concrete. The taxiways, stub end taxiways, and two parking aprons are bituminous surface treated. All pavements were in good condition and remained in good condition throughout the frost investigation period.

c. Previous History of Frost Heave Data. No pavement heave or pavement failures due to frost action have been noted during the period of operation of the airfield or during this investigation.

d. Climatic Conditions. Winter temperatures at Bedford Airfield are moderate and temperatures below freezing prevail from December to March. The normal freezing index is 680 based on a 56 year record at Concord, Massachusetts, and the 1946-1947 freezing index was 422 or 38 per cent below normal. The normal rainfall for the three month period prior to freezing, September through November, over a 57 year

period as recorded by the U. S. Weather Bureau at nearby Concord, Massachusetts is 10.2 inches. From September 1946 through November 1947, the cumulative rainfall at Bodford Airfield was 3.33 inches or 67 per cent less than normal. A summary of the weather data is included as Plate 2.

## II. TEST AREAS A AND B

2-01. Location and Description. Test Area A is located at the south side of Hangar No. 2 on the portland cement concrete service apron. The six inch slab is uniformly thickened to nine inches at the longitudinal expansion joints and edges. The slab was constructed on a base of approximately 16 inches of free draining bankrun sand and gravel on the natural subgrade of sand and gravelly sand. Test Area B is located at the northeast end of the NE-SW runway on the bituminous concrete pavement. The pavement in this area is approximately five inches thick, and was constructed on a base of sand and gravel approximately 1 1/4 inches thick placed on the natural sand and gravelly sand subgrade. Plans and profiles of Test Areas A and B are shown on Plate 3.

2-02. Installations. One thermocouple installation T332p and one thermometer well installation T332p (TW1) were made in the portland cement concrete pavement at Test Area A. One thermometer well installation T335a (TW2) was made in the bituminous concrete pavement at Test Area B. At Test Area A the thermocouples and thermometer wells were installed as close together as practicable so that subsurface conditions would be as similar as possible. A plan of the location of the thermocouple installation and thermometer wells is shown on Plate 3. Details of the thermocouple installation are shown Plate 5. Detailed description of this installation is presented in Part I paragraph 3-03b. The thermometer well

installation consisted of seven separate wells, installed at pre-determined depths which vary by approximately six inch intervals from 0.6 foot to five feet. Each well consisted of one-inch diameter plastic pipe (Saran) plugged at each end with a rubber stopper. The lower end contained not less than three inches of anti-freeze in which was suspended a mercury thermometer. The mercury thermometers were insulated from the tip of the bulb to the immersion line with paraffin and plastic tubing to allow sufficient time for withdrawing the thermometers without appreciable change in readings. The thermometers were withdrawn as rapidly as possible for readings. The top of the well consisted of a standard galvanized iron pipe nipple, three inches in diameter which was capped with a standard coupling and plug. The nipple was attached to the one-inch plastic tubing by means of a rubber bushing which fitted tightly inside the pipe nipple. Details of the thermometer and thermometer well construction are shown on Figure 4, Plate 4.

#### 2-03. Observations and Measurements.

a. Thermocouple Readings. Readings of the thermocouples for subsurface temperatures were made by means of a direct reading potentiometer. Readings were made periodically from 8 July 1946 through 18 August 1947. The maximum measured depth of freezing temperature penetration was 1.8 feet on 7 January when the freezing index was 207. A summary of the readings is presented in tabular form in Table 1. In Figure 1 Plate 4 is shown a typical temperature pattern versus depth below top of pavement.

b. Thermometer Wells. Readings of the subsurface temperatures in the thermometer wells were made periodically and as near as possible to the time of reading the thermocouple. The maximum measured depth of freezing

temperature penetration under the bituminous concrete pavement was 1.9 feet put on 21 January when the freezing index was 275. A summary of the thermometer well readings is shown in Tables 1 and 2 for Test Areas A and B respectively. Typical curves showing the variation of temperatures with the depth below the pavement are shown in Figures 2 and 3 Plate 4. A plot of the depth and progress of the 32°F temperatures for the thermocouple and thermometer readings is shown in Figure 2, Plate 2.

### III. CONCLUSIONS

3-01. Conclusions. The conclusions for Test Areas A and B are summarized as follows:

- a. Soils. The base and subgrade soils are considered non-frost susceptible.
- b. Freezing Index and Precipitation. The freezing index for 1946-1947 was 422 or 38 per cent below normal. The cumulative rain fall from September 1946 through November 1946 was 3.33 inches or 67 per cent less than normal.
- c. Freezing Temperature Penetration. The maximum measured depth of freezing temperature penetration occurred under the portland cement concrete pavement of Test Area A at a depth of 2.3 feet. The maximum measured depth of freezing temperature penetration under the bituminous concrete pavement of Test Area B was 1.9 feet. The thermometer wells under the portland cement concrete pavement consistently indicated greater depths of freezing temperature penetration than were recorded from the adjacent thermocouple installation.

FROST INVESTIGATION  
BEDFORD AIRFIELD, BEDFORD,  
SUMMARY OF THERMOCOUPLE DATA AT IN  
TEST AREA A

THERMO- COUPLE NO.	DEPTH IN FEET	1946 JULY 8	AUGUST 6	AUGUST 6	OCTOBER 7	OCTOBER 22	NOVEMBER 12	NOVEMBER 25	DECEMBER 9	DECEMBER 23	1947 JANUARY 7	JANUARY 20	FEBRUARY 10
0	0.2	108.0	79.0	106.0	74.0	57.0	62.0	47.5	41.0	30.5	26.0	41.0	30.0
1	0.6	93.5	78.5	88.5	65.0	50.5	58.0	43.0	40.5	31.0	24.5	33.5	28.0
2	1.0	88.0	77.5	81.7	64.5	52.5	56.0	42.0	40.5	33.0	26.0	33.5	29.0
3	1.4	87.5	78.0	80.3	60.0	55.0	56.0	42.5	40.5	33.5	28.0	34.0	31.0
4	1.7	88.0	78.5	80.3	66.5	57.5	55.5	44.0	41.0	34.0	30.5	34.0	33.0
5	1.9	88.0	78.0	80.0	67.0	58.0	55.5	44.5	41.0	34.5	32.5	34.0	33.0
6	2.4	86.5	77.0	79.5	67.0	59.5	56.0	46.0	41.5	36.0	33.5	34.5	34.0
7	2.8	85.5	76.0	78.5	66.5	60.5	56.5	47.0	43.0	37.0	35.0	35.0	35.0
8	3.4	82.5	75.5	77.3	66.0	61.5	57.0	49.0	44.0	38.5	36.5	36.5	36.0
9	4.0	-	74.5	75.3	66.5	62.5	58.0	50.5	46.0	40.5	38.5	38.0	37.0
10	4.5	76.0	73.7	73.5	66.5	63.5	59.5	52.5	48.0	43.5	40.5	39.5	39.0
Time	(A)	P.M. 2:00	A.M. 11:25	P.M. 2:45	A.M. 10:45	A.M. 10:55	P.M. 3:05	A.M. 9:40	A.M. 10:00	A.M. 10:20	P.M. 1:20	A.M. 11:20	A.M. 11:50
Ground Temperature	(B)	102.0	93.0	97.0	83.5	61.0	62.0	50.0	41.5	32.0	29.0	45.0	33.0
Air Temperature	(C)	90.0	84.0	86.0	79.0	55.0	57.0	57.0	40.5	37.0	39.0	49.0	32.0
Switch Box Temperature	(D)	115.0	84.0	91.0	71.0	52.0	56.0	46.0	39.0	33.0	29.0	38.0	31.0
Indicator Temperature	(E)	80.0	-	86.0	77.0	57.0	57.0	58.0	56.0	40.0	50.0	54.0	43.0
Weather	(F)	Clear	Clear	Clear	Clear	Clear	Fair	Cloudy	Cloudy	Clear	Clear	Clear	Cloudy

SUMMARY OF THERMOMETER DATA AT IN  
TEST AREA A

THERMOMETER NO.	DEPTH IN FEET	1946 JULY 8	JULY 29	AUGUST 6	SEPTEMBER 11	OCTOBER 7	OCTOBER 22	NOVEMBER 12	NOVEMBER 25	DECEMBER 9	DECEMBER 23	1947 JANUARY 7	JANUARY 21	JANUARY 28	FEBRUARY 10
1	0.2	86.0	79.0	78.0	75.0	66.0	52.0	55.0	40.0	37.0	30.0	25.0	30.0	31.0	28.0
2	1.0	88.0	81.0	78.0	76.0	67.0	53.0	54.0	40.5	38.0	32.0	26.0	31.0	31.5	29.0
3	1.5	86.0	82.0	77.5	76.0	67.5	57.0	55.0	42.0	39.0	33.5	30.0	32.0	32.0	31.0
4	2.0	85.0	81.5	76.0	75.5	67.0	58.5	54.0	43.5	39.5	34.5	31.0	32.5	32.0	32.0
5	2.5	86.0	82.0	78.0	75.5	68.0	61.0	55.0	44.5	40.0	35.0	33.0	33.0	33.0	33.0
6	3.0	83.0	82.0	78.0	74.0	67.0	61.5	55.5	46.5	41.0	36.5	34.0	33.5	34.0	33.0
7	4.5	77.0	82.0	74.5	73.0	67.0	64.0	58.0	52.0	46.0	42.0	39.0	38.0	38.0	37.0
Time	(A)	P.M. 2:15	A.M. 11:35	A.M. 11:45	A.M. 9:45	A.M. 10:45	A.M. 11:20	P.M. 12:20	A.M. 9:55	A.M. 10:15	A.M. 10:35	P.M. 1:30	A.M. 11:20	A.M. 10:20	A.M. 11:10
Ground Temperature	(B)	102.0	83.0	93.0	76.0	88.5	62.0	62.0	50.0	41.5	36.0	29.0	33.0	32.0	30.0
Air Temperature	(C)	90.0	72.5	83.0	75.0	79.0	56.0	57.0	57.0	40.5	39.0	39.0	34.0	33.5	28.0
Weather	(F)	Clear	-	Clear	-	Clear	Clear	Fair	Cloudy	Cloudy	Clear	Clear	Cloudy	Overcast	Clear

NOTES:

- (A) Time of taking readings within 15 minute period.
- (B) Reading of mercury thermometer placed on surface of ground at installation.
- (C) Reading of mercury thermometer suspended in air in vicinity of installation.
- (D) Reading of mercury thermometer placed near rotary switch at time of obtaining thermocouple.
- (E) Reading of mercury thermometer placed on potentiometer usually located in automobile.
- (F) Weather at time readings were obtained.

A

FROST INVESTIGATION  
 BEDFORD AIRFIELD, BEDFORD, MASS.  
 OF THERMOCOUPLE DATA AT INSTALLATION T 332 p  
 CEMENT CONCRETE PAVEMENT

NOVEMBER 12	NOVEMBER 25	DECEMBER 9	DECEMBER 23	1947 JANUARY 7	JANUARY 21	JANUARY 25	FEBRUARY 10	FEBRUARY 24	MARCH 11	APRIL 22	MAY 12	MAY 26	JUNE 10	JULY 9	JULY 21	AUGUST 5	AUGUST 19
62.0	47.5	41.0	30.5	26.0	41.0	30.0	31.5	42.5	57.5	76.5	76.0	74.5	84.0	90.0	91.5	81.0	81.0
56.0	43.0	40.5	31.0	24.5	33.5	28.0	27.0	36.5	44.5	64.0	68.0	64.5	79.0	82.0	82.0	76.5	76.5
56.0	42.0	40.5	33.0	26.0	33.5	29.5	28.5	35.0	42.5	61.0	66.5	64.0	79.5	81.0	81.0	76.5	76.5
56.0	42.5	40.5	33.5	28.0	34.0	31.5	30.5	35.0	44.0	60.5	66.5	65.0	80.0	82.5	82.5	78.0	78.0
55.5	44.0	41.0	34.0	30.5	34.0	33.5	33.0	35.5	46.5	59.0	66.0	66.5	80.5	83.0	83.0	79.0	79.0
55.5	44.5	41.0	34.5	32.5	34.0	33.5	32.5	36.0	47.5	58.5	66.0	65.5	80.5	83.0	83.5	79.5	79.5
56.0	46.0	41.5	36.0	33.5	34.5	34.5	33.0	36.5	48.8	56.5	64.0	65.5	80.0	82.5	82.5	80.5	80.5
56.5	47.0	43.0	37.0	35.0	35.0	35.0	34.0	37.0	49.5	55.0	63.0	65.5	79.0	82.0	82.0	80.5	80.5
57.0	49.0	44.0	38.5	36.5	36.5	36.0	35.0	37.0	51.0	53.5	61.5	65.5	78.0	80.0	80.5	80.0	80.0
58.0	50.5	46.0	40.5	38.5	38.0	37.5	35.0	37.0	51.5	58.5	59.0	65.0	76.0	78.0	78.5	79.0	79.0
59.5	52.5	48.0	43.5	40.5	39.5	39.0	38.0	39.5	51.0	51.0	57.5	64.5	73.5	76.0	77.0	78.0	78.0
P.M. 12:05	A.M. 9:40	A.M. 10:00	A.M. 10:20	P.M. 11:20	A.M. 11:20	A.M. 11:50	A.M. 11:10	A.M. 11:55	A.M. 11:00	A.M. 11:15	A.M. 10:45	A.M. 10:45	A.M. 11:00	A.M. 11:30	A.M. 11:30	A.M. 11:30	A.M. 11:50
62.0	50.0	41.5	32.0	29.0	45.0	33.0	32.0	38.0	54.0	84.0	78.0	85.0	83.0	87.0	94.0	79.0	79.0
57.0	57.0	40.5	37.0	39.0	49.0	32.0	26.0	46.5	41.5	76.0	65.0	66.0	78.0	83.0	82.0	74.0	74.0
56.0	46.0	39.0	33.0	29.0	38.0	31.0	31.0	36.0	46.0	67.0	69.0	66.0	80.0	86.0	85.0	74.0	74.0
57.0	58.0	56.0	40.0	50.0	54.0	41.0	46.0	44.0	48.0	76.0	66.0	71.0	83.0	82.0	86.0	76.0	76.0
Fair	Cloudy	Cloudy	Clear	Clear	Clear	Cloudy	Clear	Fair	Fair	Clear	Clear	Clear	Clear	Cloudy	Overcast	Clear	Cloudy

OF THERMOMETER DATA AT INSTALLATION TW-1  
 CEMENT CONCRETE PAVEMENT

NOVEMBER 25	DECEMBER 9	DECEMBER 23	1947 JANUARY 7	JANUARY 21	JANUARY 25	FEBRUARY 10	FEBRUARY 24	MARCH 11	MARCH 25	APRIL 22	MAY 12	MAY 26	JUNE 10	JULY 9	JULY 21	AUGUST 5	AUGUST 19	
40.0	37.0	30.0	25.0	30.0	31.0	26.0	26.0	32.0	44.0	40.0	62.0	66.0	62.0	80.0	81.0	80.5	76.0	
40.5	38.0	32.0	26.0	31.0	31.5	28.0	28.0	32.0	44.0	40.0	59.0	66.0	62.0	80.0	82.0	81.5	77.0	
42.0	39.0	33.5	30.0	32.0	32.0	31.0	31.0	32.0	44.0	42.0	59.0	67.0	65.0	81.0	83.0	83.5	79.0	
43.5	39.5	34.5	31.0	32.5	32.0	32.0	32.0	32.5	43.5	45.0	57.0	66.0	66.0	81.0	83.0	83.5	81.0	
44.5	40.0	35.0	33.0	33.0	33.0	33.0	33.0	33.0	43.0	46.5	56.0	65.0	66.0	82.0	83.0	84.0	82.0	
46.5	41.0	36.5	34.0	33.5	34.0	33.5	33.5	33.5	42.0	47.0	54.0	63.0	66.0	80.0	82.0	82.0	82.0	
52.0	46.0	42.0	39.0	38.0	38.0	37.0	37.0	36.5	40.5	49.0	51.5	58.0	64.0	75.0	78.0	79.0	80.0	
A.M. 9:55	A.P. 10:15	A.M. 10:35	P.M. 11:30	A.M. 11:00	A.M. 10:30	A.M. 11:20	A.M. 10:45	A.M. 11:55	A.M. 10:15	A.M. 11:15	A.M. 11:45	A.M. 10:30	A.M. 10:30	A.M. 10:50	A.M. 10:45	A.M. 11:10	A.M. 11:00	A.M. 11:40
50.0	41.5	36.0	29.0	33.0	32.0	30.0	32.0	38.0	46.0	54.0	84.0	78.0	85.0	82.0	88.0	94.0	79.0	
57.0	40.5	39.0	39.0	34.0	33.5	28.0	26.0	46.5	47.0	41.0	76.0	65.0	68.0	82.0	81.0	82.0	74.0	
Cloudy	Cloudy	Clear	Clear	Cloudy	Overcast	Cloudy	Fair	Cloudy	Rain	Fair	Clear	Clear	Clear	Clear	Cloudy	Overcast	Clear	Cloudy

This 15 minute period.  
 meter placed on surface of ground at installation.  
 meter suspended in air in vicinity of installation.  
 meter placed near rotary switch at time of obtaining thermocouple readings.  
 meter placed on potentiometer usually located in automobile.  
 were obtained.

FROST INVESTIGATION  
 BEDFORD AIRFIELD, BEDFORD, MASS.

RECORD OF SUBSURFACE  
 TEMPERATURES  
 TEST AREA A

SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

FROST INVESTIGATION  
BEDFORD AIRFIELD, BEDFORD, N

SUMMARY OF THERMOMETER DATA AT  
TEST AREA B

THERMOMETER NO.	DEPTH IN FEET	1946 JULY 8	AUGUST 6	SEPTEMBER 11	OCTOBER 7	OCTOBER 22	NOVEMBER 12	DECEMBER 9	DECEMBER 23	1947 JANUARY 21	JANUARY 29	FEBRUARY 10	FEBRUARY 24
1	0.3	94.0	83.0	77.0	66.0	52.0	55.0	39.0	30.5	31.0	31.0	28.0	32.0
2	1.0	87.0	78.5	76.0	66.0	54.0	54.0	39.0	32.0	31.0	31.0	30.0	32.0
3	1.5	88.0	78.5	78.0	67.0	58.0	55.0	40.0	34.0	29.5	32.0	32.0	37.5
4	2.0	-	79.0	77.5	70.0	61.0	56.0	41.0	35.5	33.0	33.0	34.0	34.5
5	2.5	-	78.5	76.0	69.5	62.0	56.0	42.0	37.0	34.5	34.5	35.0	36.0
6	3.0	84.0	77.5	75.0	67.0	63.0	57.0	43.0	39.0	35.0	35.5	36.0	36.5
7	4.5	-	75.0	73.0	67.0	66.0	60.0	49.0	45.5	40.5	40.0	40.0	40.0
Time	(A)	P.M. 1:30	P.M. 1:00	A.M. 10:15	A.M. 9:55	A.M. 10:35	A.M. 11:20	A.M. 9:35	A.M. 9:40	A.M. 11:00	A.M. 10:30	A.M. 10:00	A.M. 10:45
Ground Temperature	(B)	105.0	106.0	79.0	83.0	64.0	64.0	40.0	30.0	36.0	33.5	30.0	30.0
Air Temperature	(C)	93.0	89.0	76.0	77.0	62.0	63.0	44.0	38.0	34.0	34.0	28.0	28.0
Weather	(D)	Clear	Clear	-	Clear	Clear	Fair	Cloudy	Clear	Cloudy	Overcast	Cloudy	Clear

NOTES:

- (A) Time of reading thermometers within 15
- (B) Reading of mercury thermometer placed
- (C) Reading of mercury thermometer suspended
- (D) Weather at time readings were obtained

A

B

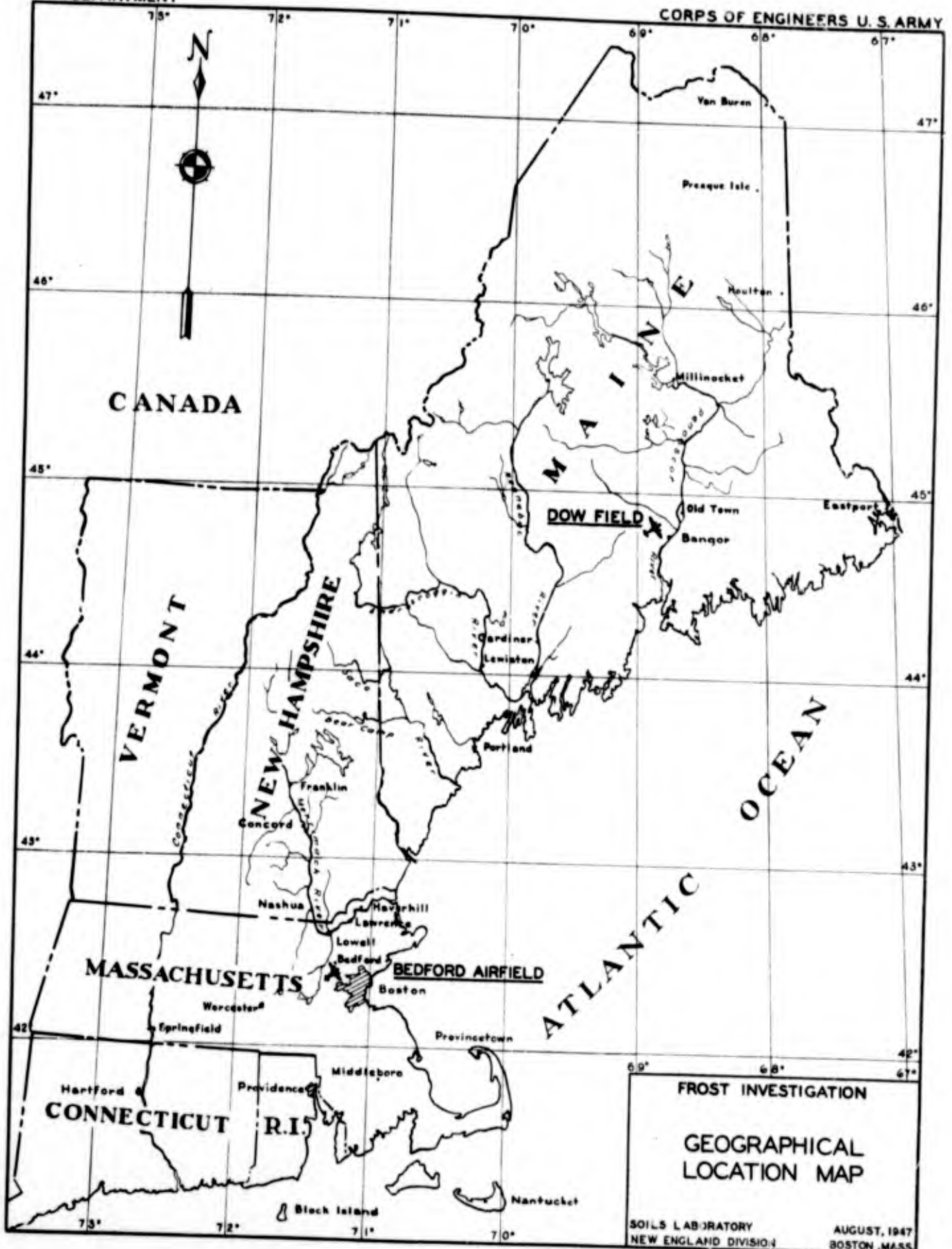
FROST INVESTIGATION  
 AIRFIELD, BEDFORD, MASS.  
 RECORD DATA AT INSTALLATION TW - 2  
 BITUMINOUS CONCRETE PAVEMENT

JANUARY 29	FEBRUARY 10	FEBRUARY 24	MARCH 11	MARCH 25	APRIL 22	MAY 12	MAY 26	JUNE 10	JULY 9	JULY 21	AUGUST 5	AUGUST 18
51.0	26.0	32.0	38.0	48.0	40.0	61.0	68.0	61.0	82.0	83.0	83.5	78.0
31.0	30.0	32.0	38.0	47.0	40.0	62.0	68.0	61.0	81.0	83.0	84.0	79.0
32.0	32.0	34.5	39.5	48.0	43.0	63.0	69.0	66.0	83.0	85.0	86.0	81.0
33.0	34.0	34.5	40.5	48.0	45.0	61.0	69.0	67.0	84.0	86.0	87.0	83.0
34.5	35.0	36.0	40.5	47.5	46.0	58.5	67.0	66.0	83.0	84.0	86.0	83.0
35.5	36.0	36.5	41.0	47.0	49.0	56.5	65.0	66.0	82.0	83.0	84.5	83.0
40.0	40.0	40.0	42.0	46.0	51.0	53.5	60.0	65.0	76.0	78.0	79.0	80.0
A.M. 10:30	A.M. 10:00	A.M. 10:45	A.M. 11:15	A.M. 9:55	A.M. 10:35	A.M. 10:50	A.M. 10:00	A.M. 10:15	A.M. 10:15	A.M. 10:40	A.M. 10:40	A.M. 11:15
33.5	30.0	30.0	47.0	48.0	51.0	86.0	78.0	84.0	83.0	94.0	98.0	85.0
34.0	26.0	28.0	40.0	44.5	40.0	75.0	70.0	66.0	76.0	77.0	82.0	72.0
Overcast	Cloudy	Clear	Fair	Rain	Fair	Clear	Clear	Clear	Cloudy	Overcast	Clear	Cloudy

ing thermometers within 15 minute period.  
 mercury thermometer placed on surface of ground at installation.  
 mercury thermometer suspended in air in vicinity of installation.  
 the readings were obtained.

FROST INVESTIGATION  
 BEDFORD AIRFIELD, BEDFORD, MASS.  
 RECORD OF SUBSURFACE  
 TEMPERATURES  
 TEST AREA 8  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947

TABLE 2



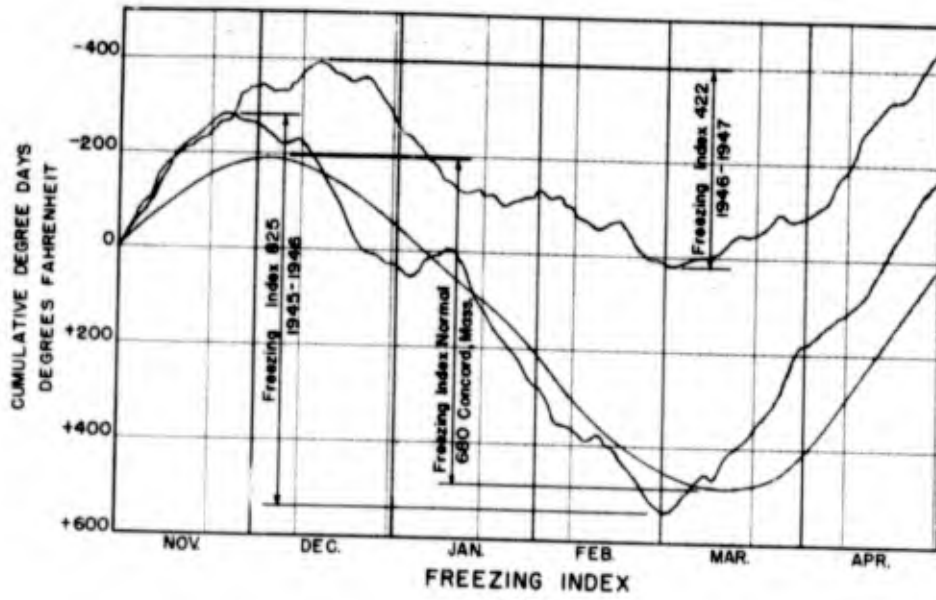
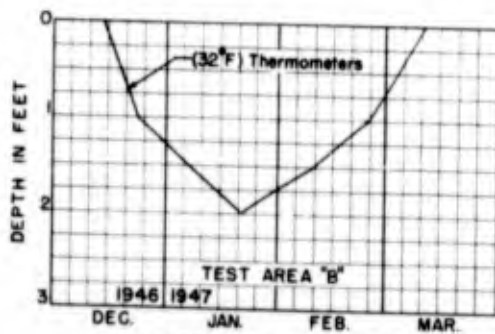
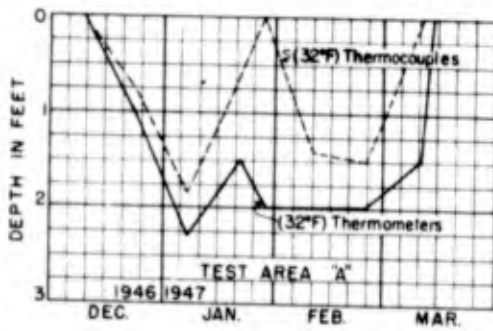
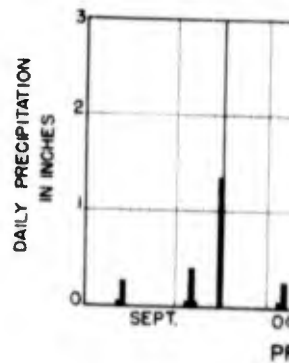
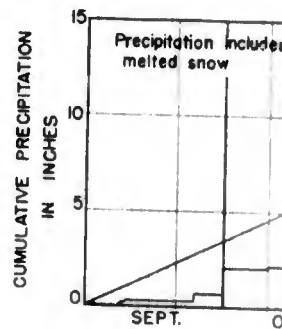


FIG. 1



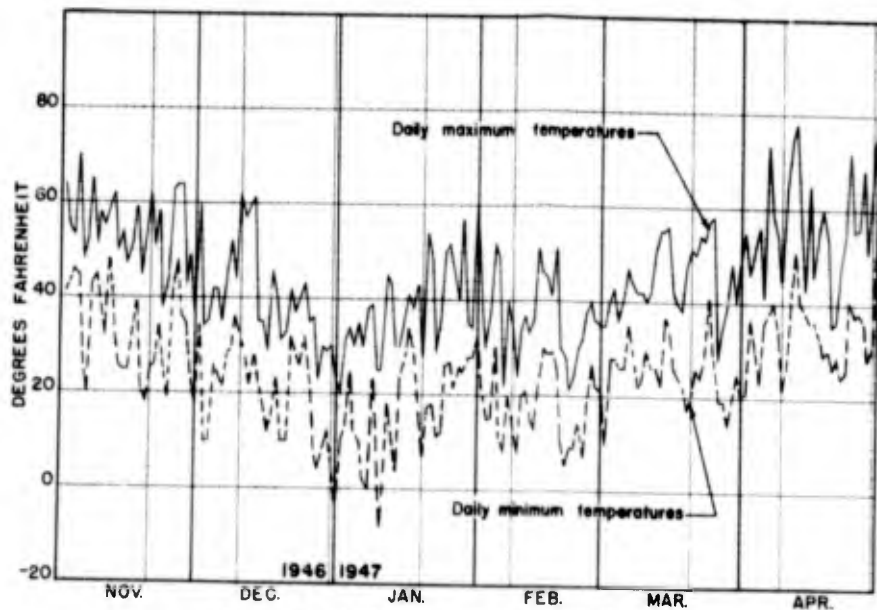
FROST PENETRATION

FIG. 2



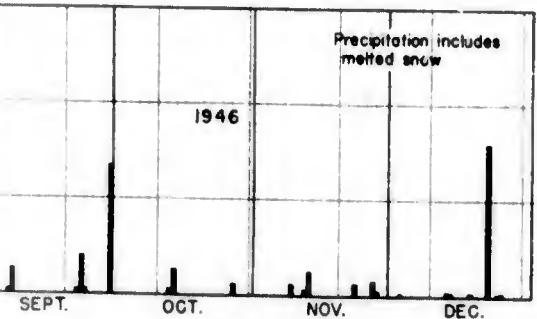
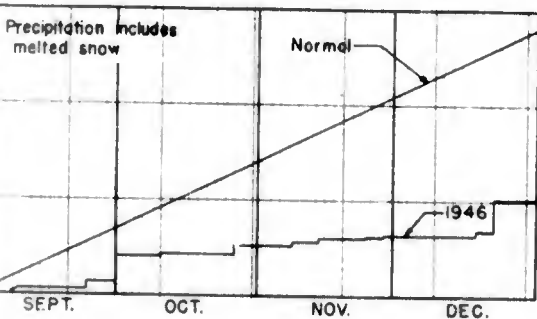
A

B



DAILY MAXIMUM & MINIMUM TEMPERATURES

FIG. 3



PRECIPITATION

FIG. 4

Notes:

Test Area A - Cement Concrete

Test Area B - Bituminous Concrete

Sources of Data:

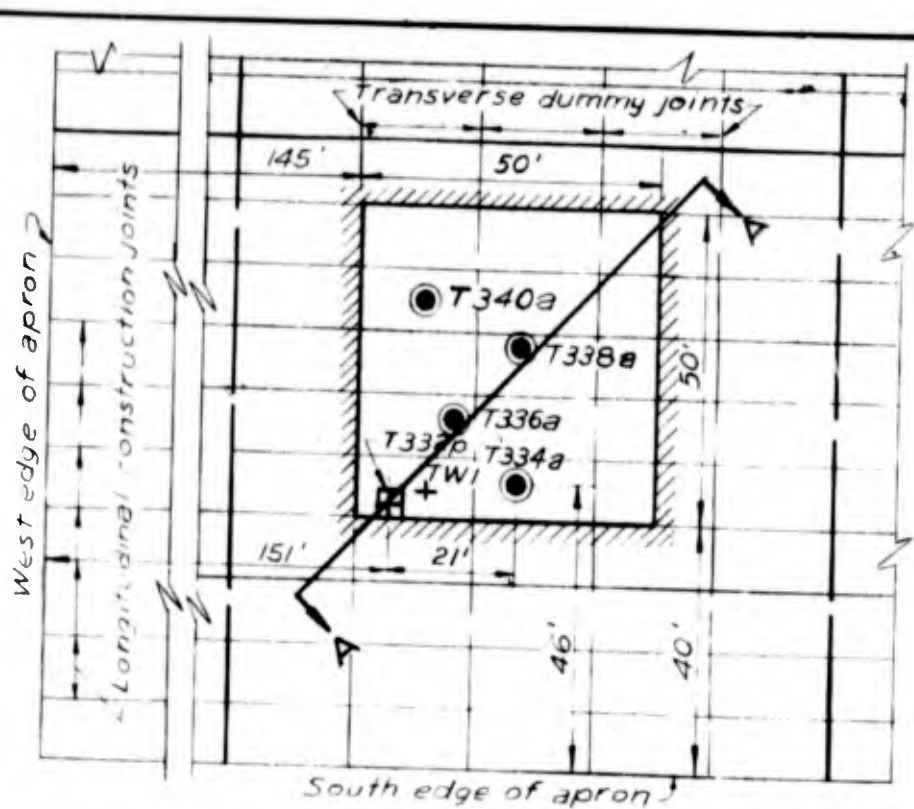
Normal temperatures and precipitation were obtained from U.S. Weather Bureau in Concord, Mass., approximately 4 miles from the airfield.

Daily temperatures and precipitation were obtained from the U.S. Army Air Force, Bedford Airfield.

FROST INVESTIGATION  
BEDFORD AIRFIELD, BEDFORD, MASS.

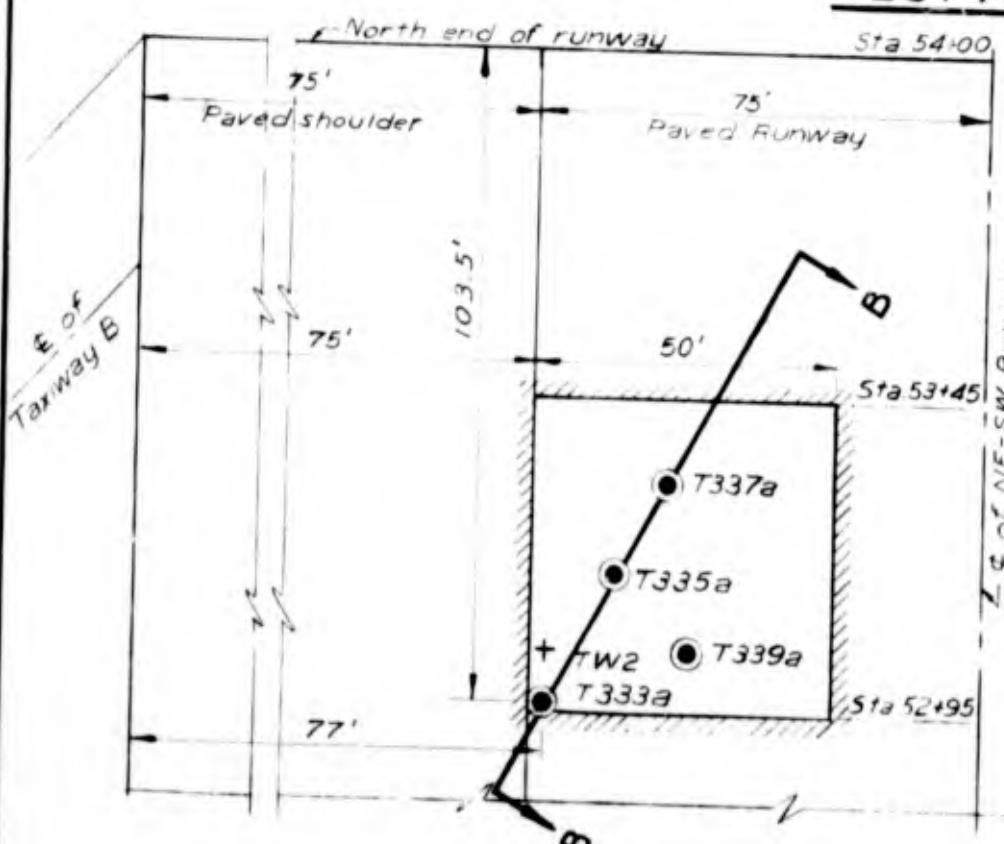
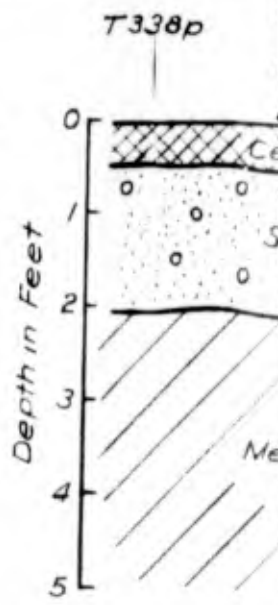
WEATHER AND FROST  
PENETRATION DATA

SOILS LABORATORY  
NEW ENGLAND DIVISION BOSTON, MASS. AUGUST, 1947



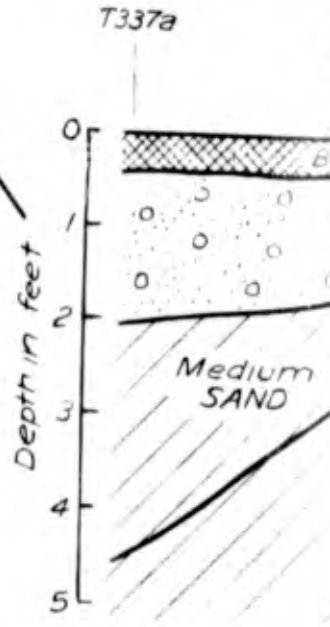
PLAN

TEST AREA A



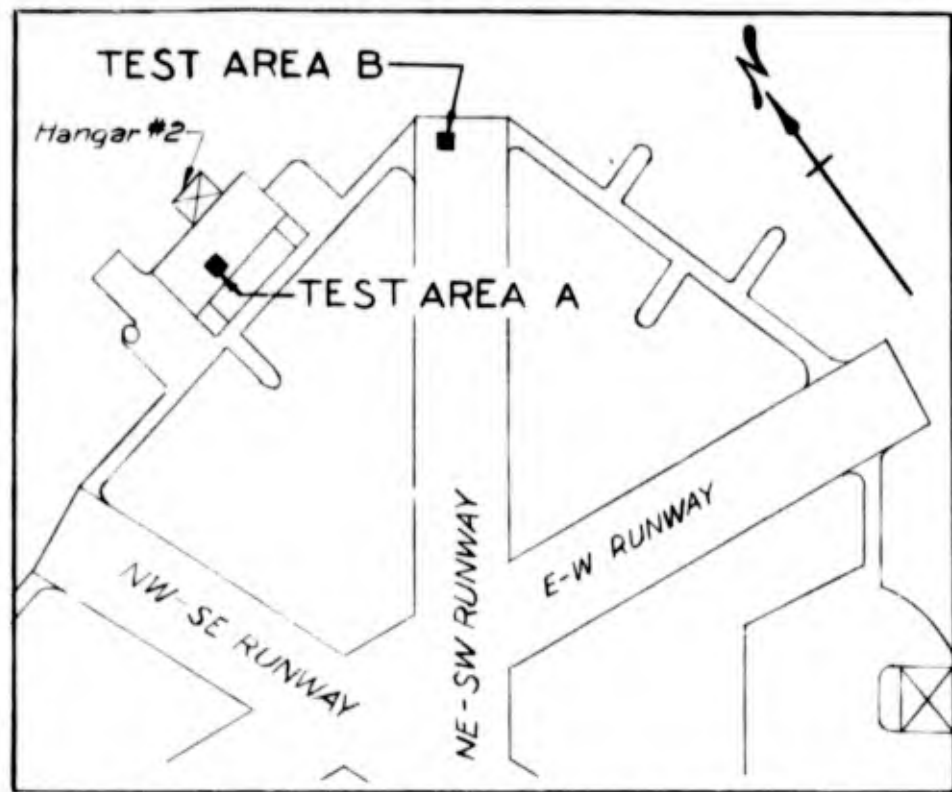
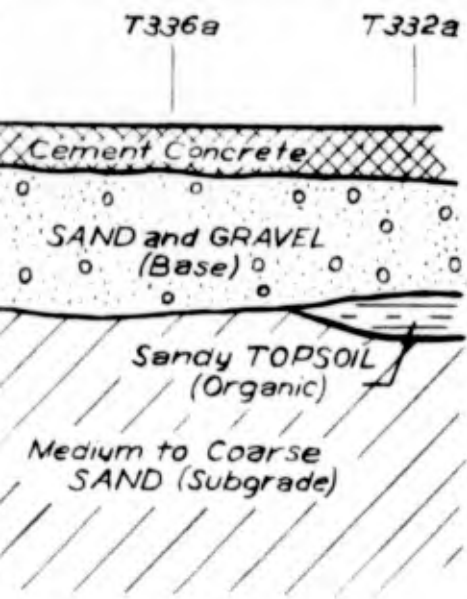
PLAN

TEST AREA B



A

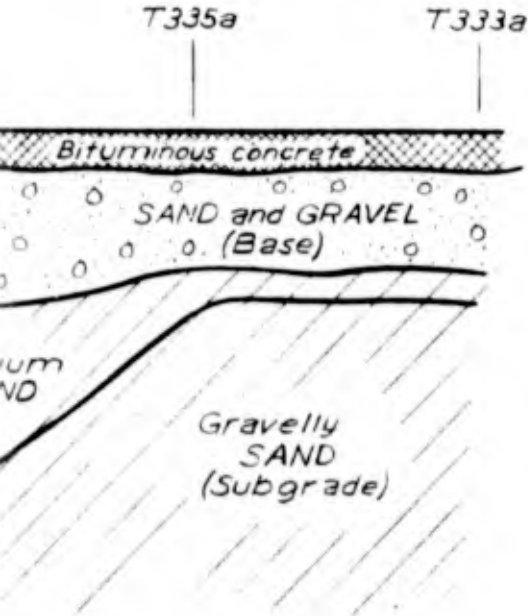
B



SECTION A-A

LOCATION MAP

SCALE: 1" = 600'

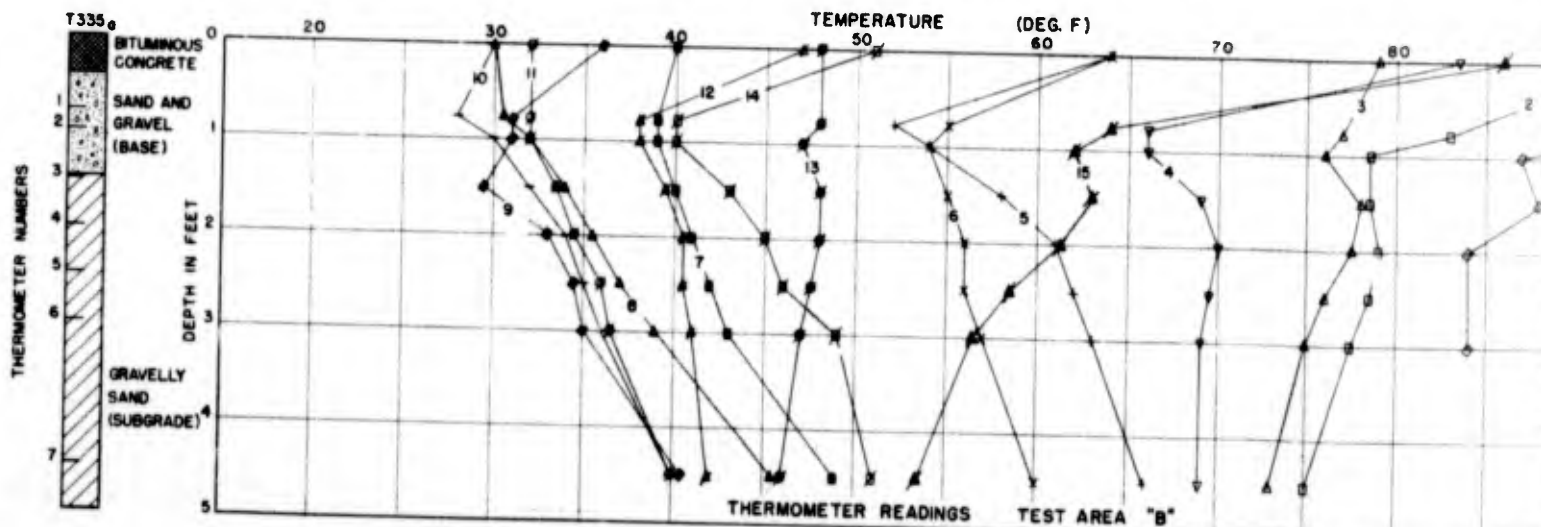
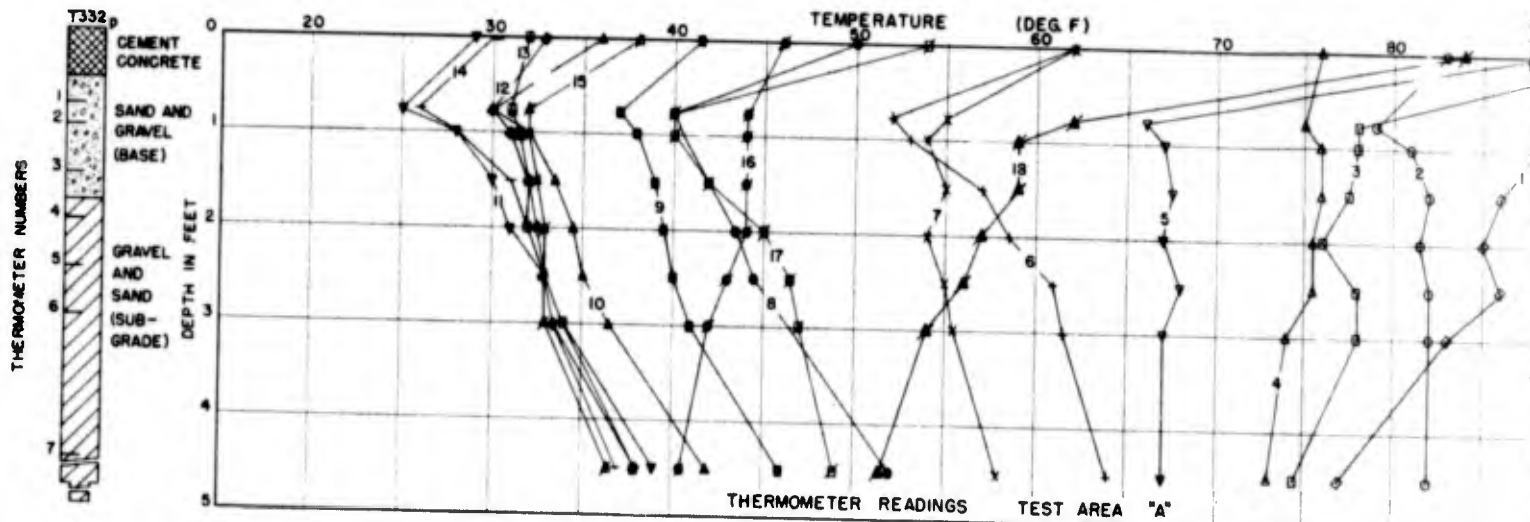
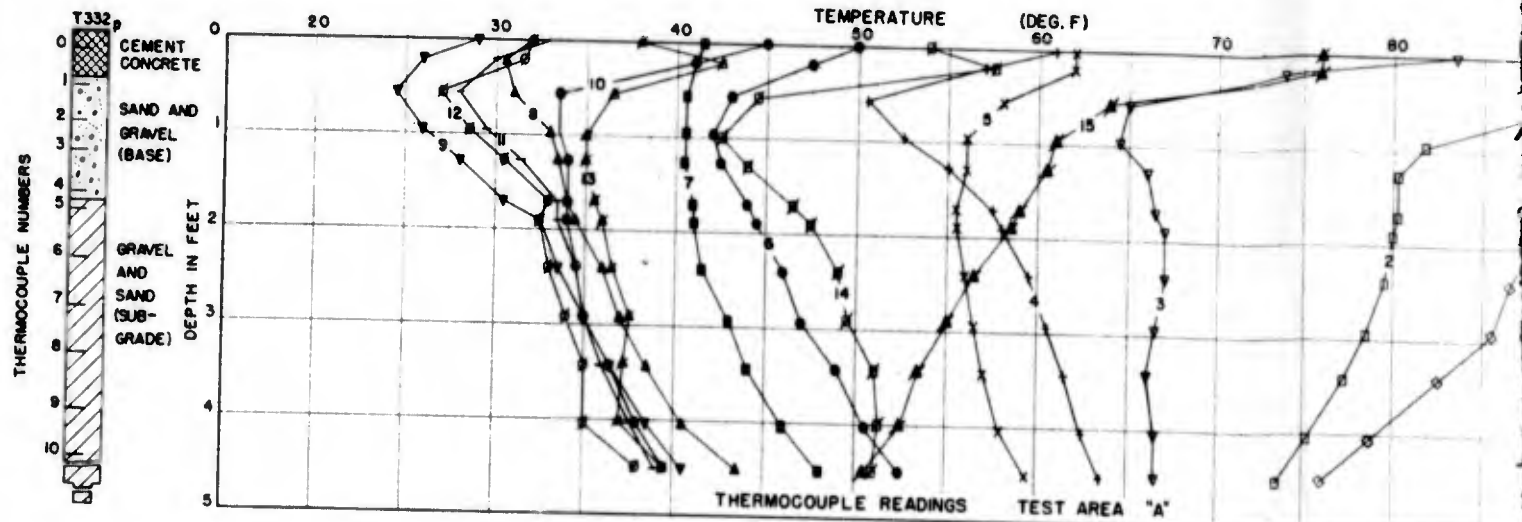


LEGEND

- ⊞ Test pit with thermocouple installation
- + Thermometer well
- Auger hole

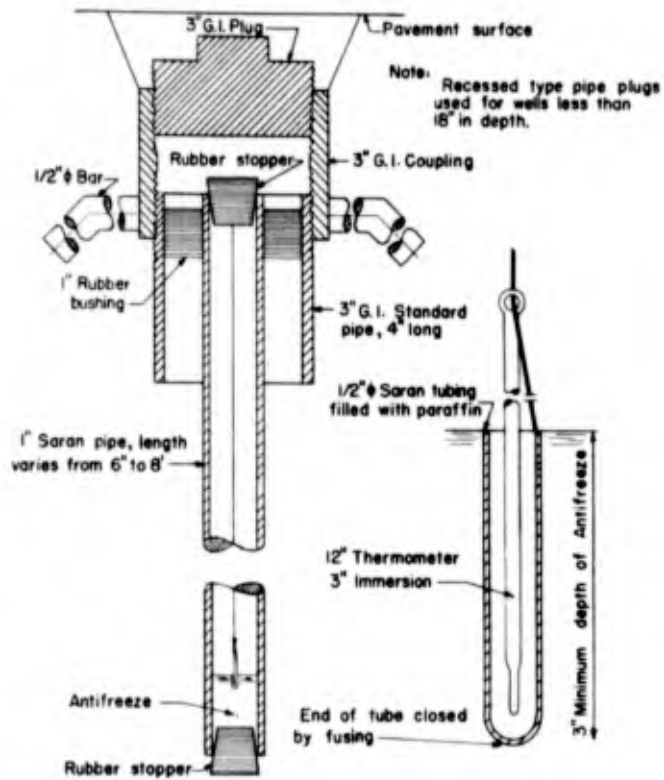
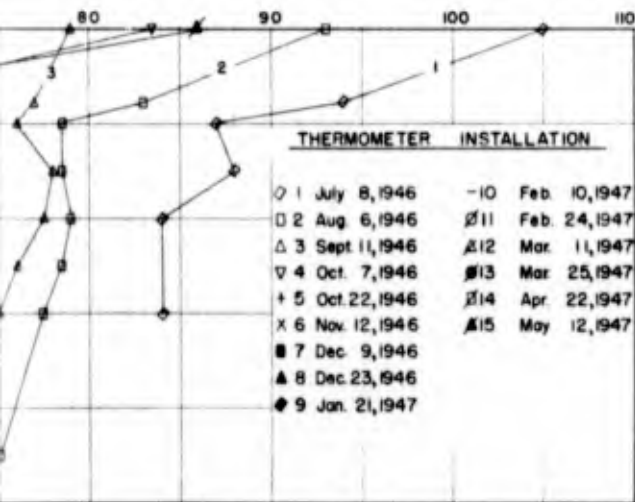
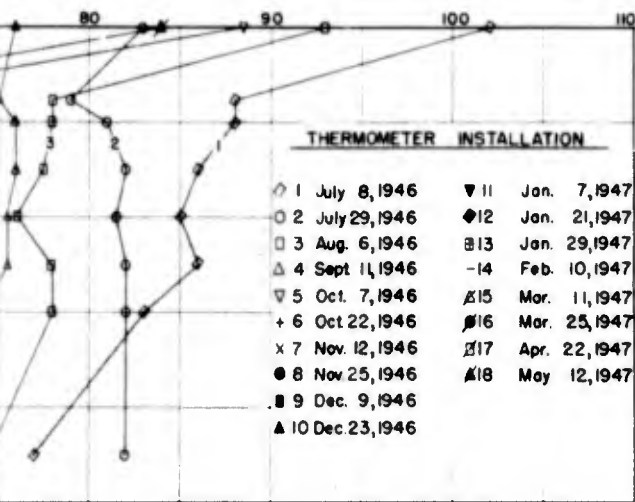
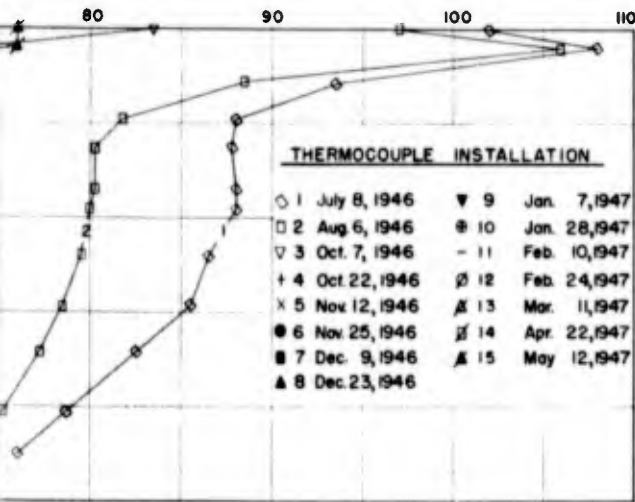
SECTION B-B

FROST INVESTIGATION  
 BEDFORD AIRFIELD  
**PLAN AND PROFILE  
 TEST AREAS A AND B**  
 SCALE: 1"=30'  
 SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON MASS. AUG. 1947



A

B

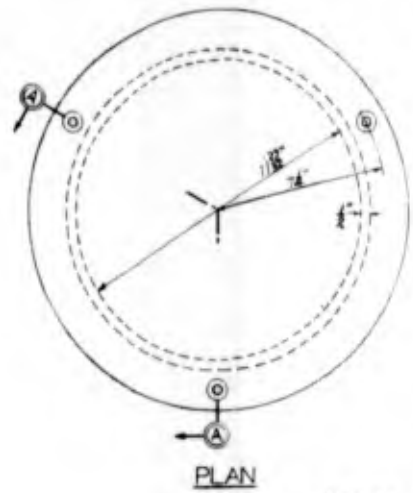
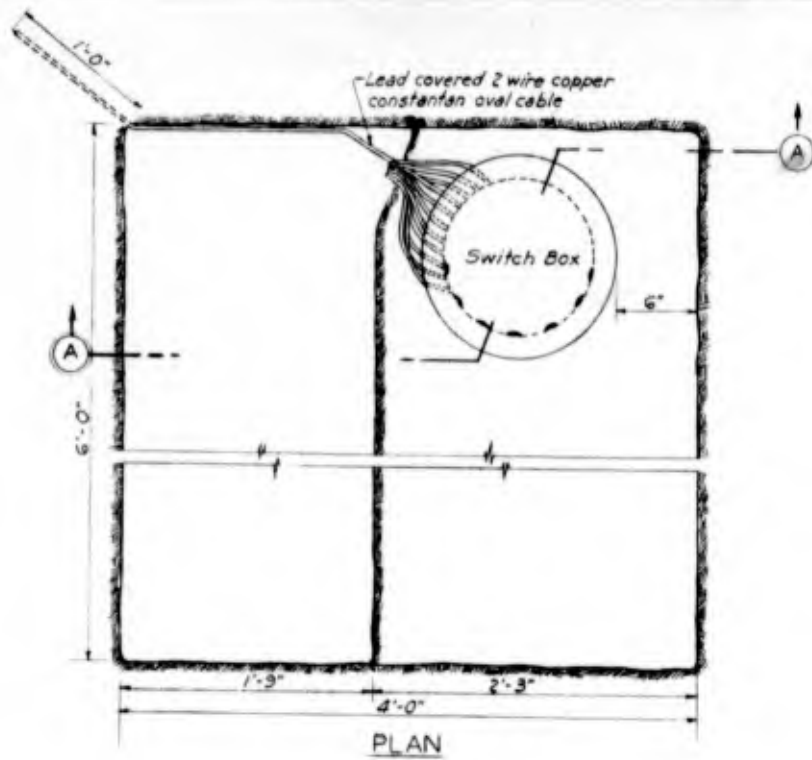


THERMOMETER WELL DETAILS

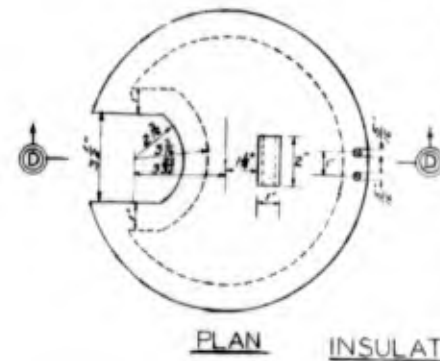
FIG. 4

FROST INVESTIGATION  
 BEDFORD AIRFIELD, BEDFORD, MASS.  
 SUBSURFACE TEMPERATURES  
 AND  
 THERMOMETER WELL DETAIL

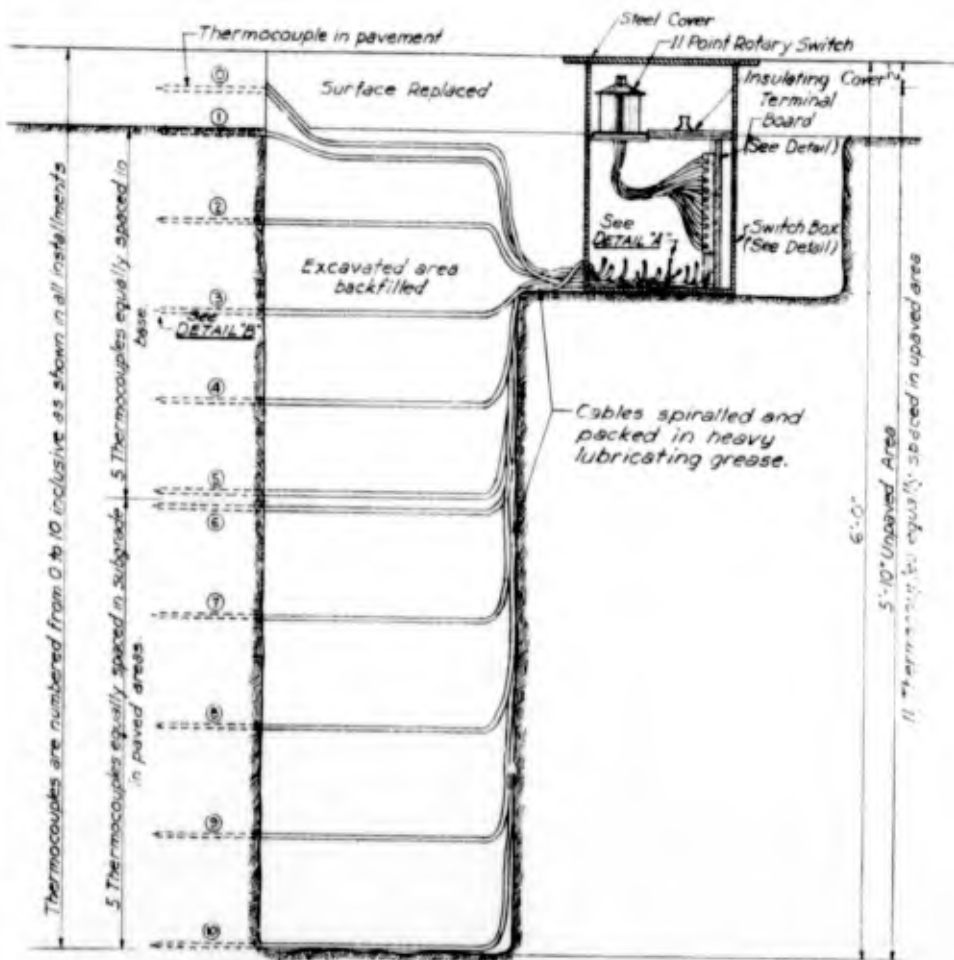
SOILS LABORATORY  
 NEW ENGLAND DIVISION BOSTON, MASS. AUGUST, 1947



STEEL COVER

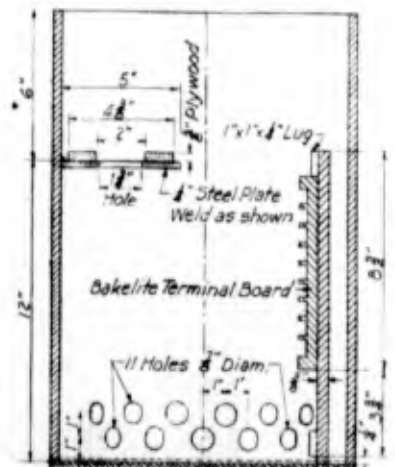
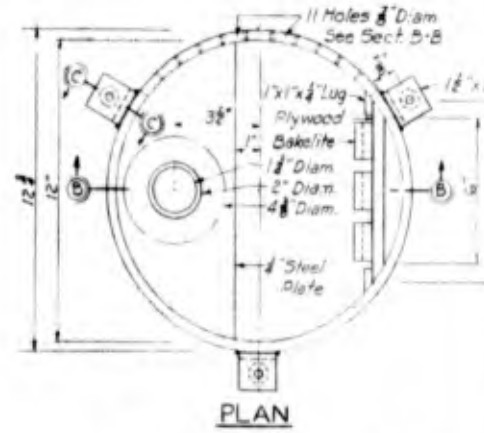


INSULATING COVER



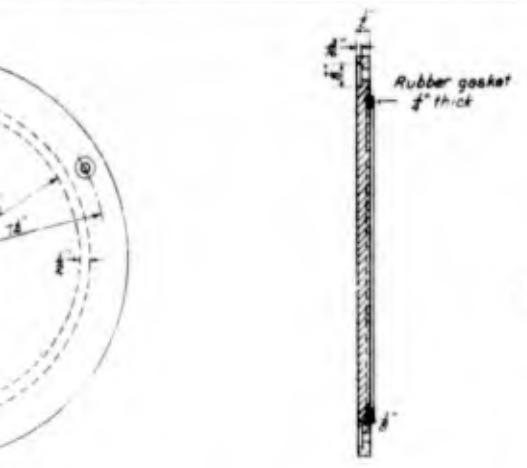
INSTALLATION OF THERMOCOUPLE EQUIPMENT

Scale 1/2" = 1'-0"



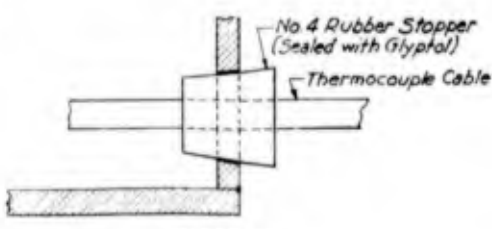
SWITCH BOX DETAILS

Quarter Scale

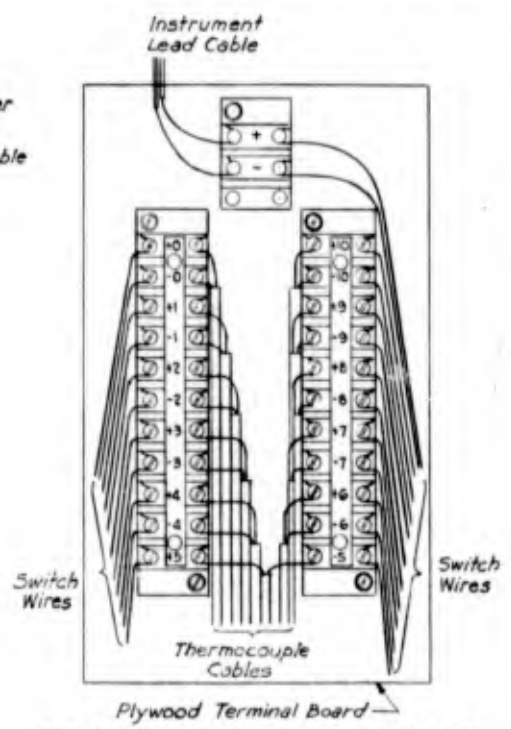


SECTION A-A

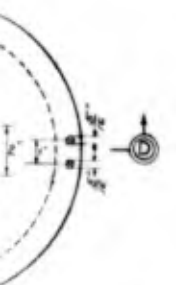
STEEL COVER



DETAIL A  
Not to Scale



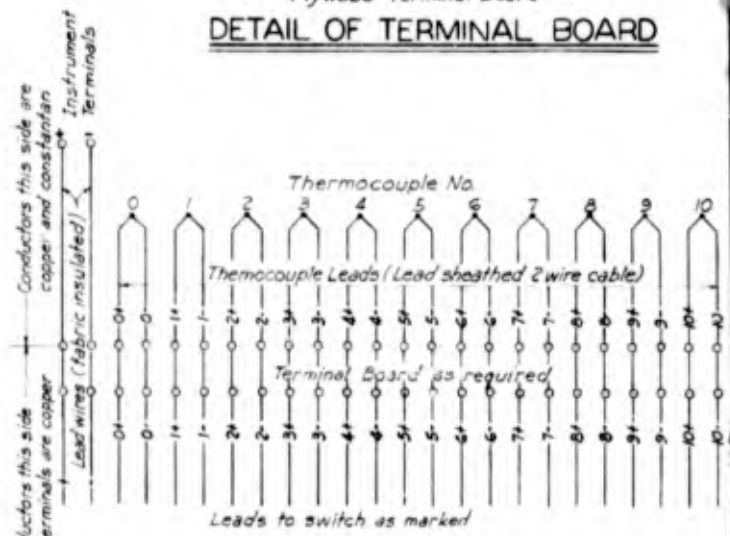
DETAIL OF TERMINAL BOARD



INSULATING COVER



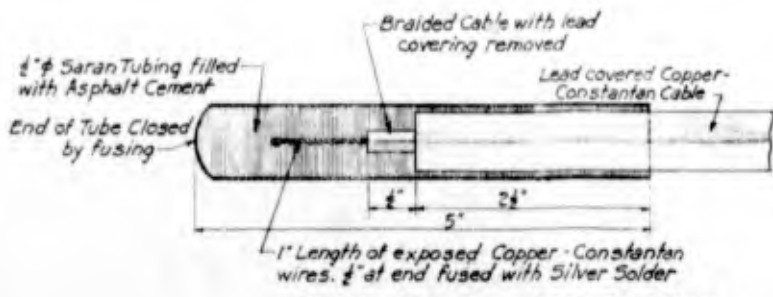
SECTION D-D



WIRING DIAGRAM



SECTION C-C  
Half Scale



THERMOCOUPLE CONSTRUCTION  
DETAIL B  
Full Scale

FROST INVESTIGATION  
**THERMOCOUPLE INSTALLATION  
AND SWITCH BOX DETAILS**  
  
SCALE AS SHOWN  
SOILS LABORATORY  
NEW ENGLAND DIVISION, BOSTON, MASS. AUGUST 1947