State of Alaska
Department of Transportation and Public Facilities

GEOTECHNICAL REPORT

Engineering and Surveying Services for Various
Rural Southwest Alaska Airports

AKSAS Project No: 57281

Chefornak, Alaska

November 10, 2006

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1.0 INTRODUCTION

This report presents the results of subsurface investigations and laboratory testing for the evaluation of the new airport embankment at Chefornak, Alaska. Chefornak is located on the south bank of the Kinia River, approximately 8 air miles east of Etolin Strait of the Bering Sea. It lies at approximately 60°03' North Latitude and 164°12' West Longitude within the Bethel Recording District. The community is approximately 98 air miles southwest of Bethel, Alaska, as seen in Figure 1. A site map is presented on Figure 2. The purpose of the field exploration was to define the soil and groundwater conditions for use in the evaluation. The new airport embankment at Chefornak was constructed in the winter of 2000-2001 using frozen material and settlements were expected over time. The purpose of this project was to define the current progress of the embankment consolidation, and provide recommendations for completion of the embankment. A separate report addresses the engineering analyses and recommendations was developed for this project.

Ten (10) borings were advanced along the new embankment and thermistors were installed to monitor soil temperatures. An additional boring was advanced along the access road located northwest of the embankment near the stream crossing. Soil samples recovered from the borings were classified in the field and returned to our laboratory for testing and verification. The project investigation was performed in general accordance with the procedures outlined in the "Engineering Geology and Geotechnical Explorations Procedures Manual" (DOT&PF, 2003) and our proposal. Included in this report are a description of the site and project, subsurface explorations and laboratory test procedures, and our interpretation of the subsurface conditions.

The embankment of the new airport is approximately one mile south of the existing runway which is southwest of the village. The new airport includes a runway with a safety area, approximately 3,500 feet long and 120 feet wide, a crosswind runway with a safety area, a taxiway, a parking apron, and an access road connecting the new airport and the existing runway, Figure 3.

This report documents subsurface geotechnical conditions and provides analyses and interpretation of anticipated site conditions at the project. This report establishes a geotechnical baseline to be used in assessing the existence and scope of changed or differing site conditions. This report is intended for use by the project design engineering staff, construction personnel, bidders and contractors.

2.0 PREVIOUS REPORTS AND INVESTIGATIONS

The project began with the collection and compilation of existing data from previous studies in Chefornak and the surrounding area. A listing of sources with the relevant data is presented below.

School Site Investigation for Chefornak, Alaska
R&M Consultants, Inc., January 1979
The purpose of this study was to select a new high school site at Chefornak, Alaska and compile site specific information to be used as a design aid for architects and engineers. The school site selected and investigated is north of the new embankment area and east of the existing airport.

Geotechnical Report – Chefornak Airport
Alaska Department of Transportation and Public Facilities, 1999
This study is based on the geotechnical information gathered in 1997 and 1998 at the new runway embankment location. Thirty-six Test Holes (T.H.), TH-1 through TH-36, were advanced during this study. Test Holes 98-1 through 98-18 were located in the vicinity of the new airport site and access road and are shown on Figure 2. The soils were determined to be primarily silt and segregated ice to an approximate depth of 25 feet. The silt consisted of a measurable content of organic matter and was covered by an organic mat depth averaging approximately 2.5 feet. Potential borrow sites were investigated by advancing Test Holes 98-19 through 98-36 in four locations around Chefornak: 1) an area located west of the access road, 2) an area situated on a low hill approximately 1.5 miles south of the new airport site, 3) the northern slope of Tern Mountain located approximately 3.5 miles south of the new airport and, 4) a beach site located west of Tern Mountain and approximately 5.5 air miles southwest of the new airport. The most accessible source of borrow material is the site situated west of the access road, approximately ½ mile northwest of the new airport site. The site consists primarily of frozen silt with organics and segregated ice. Recommendations were provided for construction of the embankment, and included allowing for 50% shrink in volume of material after compaction, and about 3.5 ft of settlement.

3.0 PHYSICAL SETTING

3.1 Climate

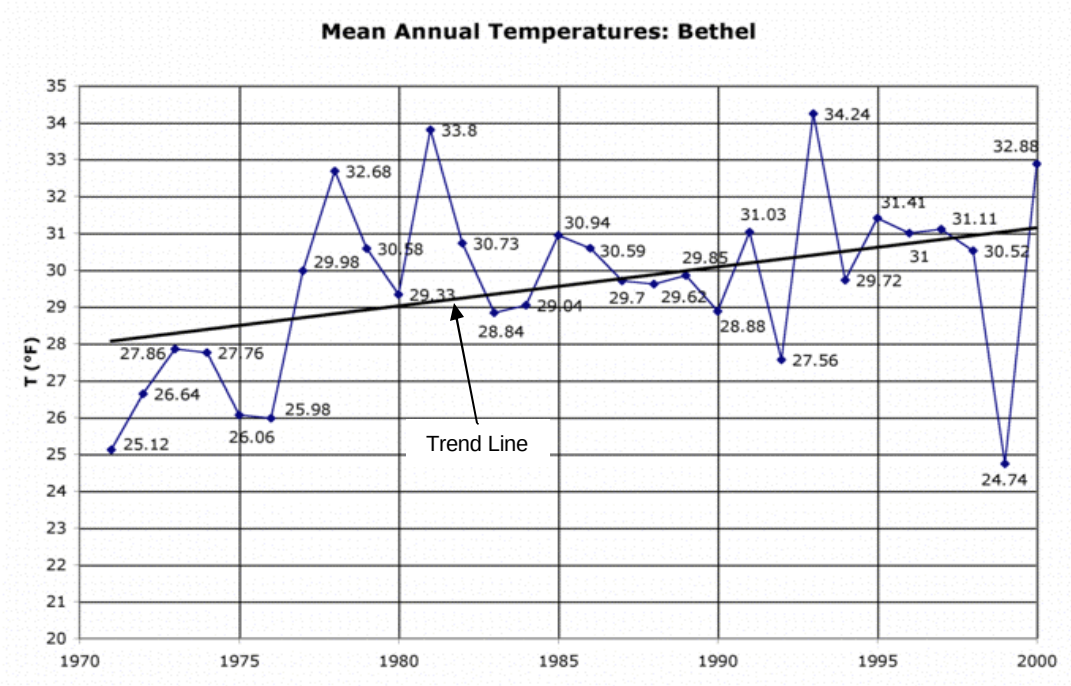
Chefornak is characterized as a transitional climate lying between the marine and continental zones. Precipitation averages 22 inches, with 43 inches of snowfall annually. Average summer temperatures range from 41 °F to 57 °F, average winter temperatures are 6 °F to 24 °F.

The *Environmental Atlas of Alaska (1978)* shows the following data for Chefornak:

Average Air Temperature	29 °F
Average Freezing Index	2800 °F-days
Design Freezing Index	3800 °F-days
Average Thawing Index	2000 °F-days
Design Thawing Index	3000 °F-days

Recent analysis of air temperature data for the nearest station, Bethel, shows that the area is experiencing a warming trend. The following graph from the Alaska Climate Research Center at the University of Alaska Fairbanks (2003 Data) shows the increase in the mean annual temperature from 1971 to 2000. In Bethel the trend is an increase of 3.08 °F or 0.106 °F per year for a 29 year period. See Figure 3.1.

Figure 3.1: Mean Annual Temperatures recorded in Bethel, Alaska from 1971 to 2000



It is unknown if this is due to global climate changes or if this is a climate cycle that affects Alaska for a short period of time, however, this increase in temperature should be considered when estimating the thaw consolidation of the airport embankment and future designs.

Average temperatures along with the increasing trend observed in the mean annual temperature was used in the thermal analysis model of the airport embankment. The results of the thermal analysis are presented in Section 6.0.

3.2 Topography, Drainage, & Vegetation

Chefornak is located in the coastal lowlands of the Yukon-Kuskokwim Delta along the Kinia River, approximately 8 air miles east of the Bering Sea. Numerous lakes, ponds, and sinuous streams of extremely low gradient occur throughout the region. The terrain in the vicinity is rolling to hummocky with small hills and ridges having an average relief of about 50 feet. Three extinct volcanoes are visible from town; Kinia Mountain (277 feet) located 5 miles north, Tern Mountain (443 feet) located 5 miles south, and Cheeching Mountain (310 feet) located 5 miles southeast of Chefornak.

Chefornak is on a broad, flat plain characterized by a marshy terrain of minimal relief with many small lakes and sloughs scattered throughout the area. The Kinia River which lies directly north of the village and flows generally south and west to the Bering Sea, is the primary drainage for the area. The river drains Dall Lake, located to the northeast of the village, and numerous smaller lakes in the village area. The town is located on a small rock outcropping and is 3 to 4 feet above flooding levels. Occurrences of flooding in the area are minimal and flooding levels should remain relatively constant.

The new embankment is situated at a site approximately one-half mile south of the community and Kinia River, and interferes very little with the many small lakes, sloughs, and drainage channels located throughout the area. The embankment surroundings occupy a vegetative community of wet to moist tundra. The dominate vegetation is tundra consisting of mosses, grasses, and low shrubs. An unnamed creek is located at the southern end of the access road.

3.3 Significant Features

The new embankment is surrounded on all sides by tundra vegetation. Several ponds and swamp areas are adjacent to the west side of the embankment. The placement of the embankment generally avoids most water bodies and drainage channels in the area and interferes very little with the site hydrology. The town and existing airport are located approximately 1 mile north of the embankment. An access road is constructed that extends between the existing airport and the new embankment. The access road travels generally north to south and borders a material site to the west approximately midway between the embankment area and the existing airport. A small, unnamed creek flows across the southeastern end of the access road. This creek will need to be crossed to access the new airport apron.

3.4 Regional Geology & Seismicity

The Yukon-Kuskokwim region is predominantly underlain by deltaic and aeolian deposits. Mafic lava flows and cinder cones crop out in the western part of the region. Sedimentary rocks of Cretaceous age occur on Nelson Island and possibly on Nunivak

Island. The higher portions of the Kusilvak Mountains on Nelson Island are composed of intrusive rocks and associated metamorphosed rocks of Cretaceous age.

The mafic volcanic rocks around Chefornak are part of a discontinuous belt extending from eastern Seward Peninsula southward along the Bering Sea to Nunivak Island and possibly the Pribilof Islands. The volcanics are older than the Pleistocene age silts that surround and partly bury them, and most likely younger than the late Tertiary. Figure 4 presents a regional geologic map.

Sediments are deltaic deposits of the Yukon and Kuskokwim Rivers and are composed of silts, sands, and bog deposits. The US Geologic Survey has also mapped undifferentiated surficial deposits of marine and river deposits. Soils are found on broad low plains and are poorly drained. Chefornak occurs in the discontinuous permafrost region of Alaska. Available reports on the area indicate similar soil conditions of silts and sands beneath a peaty surface mat. Permafrost varies in the community and is warming and degrading in many locations.

Chefornak is located in a region of low seismicity. Based on the Alaska Earthquake Information Center database there were 78 events above a magnitude of 4 in the region from 1898 to 2004. There were 12 events above a magnitude of 5 of which four were between magnitude 6 and 7. The largest earthquake in the region was a magnitude 6.9 near Aniak, while the other three greater than magnitude 6 were along the Farewell Fault near Dillingham in Bristol Bay. The 2000 International Building Code places the seismicity of the area in site class E.

3.5 Site Geology

The embankment is composed of silty sands to silts with gravel to boulder size rock pieces. The rock pieces are the local mafic volcanic rock that outcrops in the four extinct volcanoes that surround Chefornak.

The hills and ridges surrounding the embankment site are generally composed of organic material and silt overlying silty sand and sand of unknown thickness. Basalt bedrock occurs sporadically in Chefornak, and the occurrences are most likely old lava flows. The site is in a zone of discontinuous permafrost. Perennially frozen ground should be expected throughout the project area except immediately adjacent to bodies of water. Figure 5 shows a subsurface profile of the embankment.

4.0 FIELD INVESTIGATION

4.1 Exploration

The purpose of the field exploration was to define the subsurface soil conditions to assist in determining the thermal and geological condition of the embankment. In order to evaluate the embankment, the soil type, moisture content, consolidation characteristic, and ground temperatures were defined. This was accomplished by advancing ten borings, collecting soil samples for laboratory analyses, and installing thermistors in order to plot the ground temperature profiles of each boring. In addition to the explorations of the embankment, a boring was advanced at the site of the stream crossing of the access road. HDL submitted a work plan to Alaska DOT & PF in September 2004. The accepted work plan proposed advancing the borings and addressed equipment to be used, the methods for obtaining samples, and schedule for field work.

4.2 Drilling & Sampling

Eleven borings, designated B-1 through B-11, were advanced at the site on September 15th - 18th, 2004. Borings B-1 through B-10 were advanced along the new embankment. Boring B-11 was advanced at the location of the stream crossing of the access road. The borings were advanced to depths of 15 to 35 feet. Locations of the borings were based on existing topographical features and spaced approximately 200 to 600 feet apart with some variation due to topography and anticipated subsurface conditions. See Figures 2 & 3 for locations. GeoTek Alaska, Inc. of Anchorage, Alaska provided drilling services for this project using a Geoprobe 6610DT drill rig, mounted on tracks. The Geoprobe is a direct push machine that utilizes static weight and percussion to advance soil-coring rod. Continuous undisturbed core samples were collected in five-foot runs for the depth of the boreholes. A minimum of one representative sample was retained from each run. Additional samples were retained from each run if soil characteristics varied within the run. One to two additional samples were collected for consolidation testing from most embankment boreholes. The samples collected for consolidation tests were 2.36 inches in diameter. Sampling was conducted with a continuous Macro-Core barrel that houses a PVC liner. The samples were classified in the field and returned to our laboratory for analysis. An experienced engineer from our firm was present continuously during drilling to locate the borings, observe drilling action, collect samples, log subsurface conditions, and monitor groundwater encountered.

The soils were classified in the field according to the Unified Soil Classification System presented in Appendix A, Figure A1, and later verified from laboratory test results. The frozen soils classification presented in Appendix A, Figure A2, was used to describe the frozen state of the soils. This classification is the DOT&PF scheme. Figure A3 in Appendix A presents the frost classification. Detailed logs of the borings are presented

on the boring logs in Appendix A and are represented graphically in the generalized subsurface profile in Figures 5.

4.3 Instrumentation

A 1-inch diameter PVC tube was placed in each boring along the runway embankment to house thermistor strings for soil temperature monitoring. Thermistors were installed on November 4, 2004, in each of the ten runway embankment boreholes. Thermistors were vertically spaced every 2 feet to a depth of 12 feet in the shallowest borehole and spaced every 3 feet to a depth of 33 feet in the deeper boreholes. Thermistor strings were wired into data loggers for continuous hourly data collection. Every two borehole thermistor strings were wired into a single data logger. A total of five data loggers were installed to collect data from the 10 boreholes along the runway embankment. The data loggers are powered by 12-volt batteries with 10-watt solar panels replenishing the batteries. The batteries and data loggers were enclosed in weatherproof boxes and mounted above ground on posts. N-value instruments (thermistors) were installed and connected to the data loggers, for logging soil temperature data of the soil surface at three locations along the embankment. The n-value thermistors were placed about 0.4 to 1 inch below the ground surface. Air temperature probes were also installed and connected to the data loggers for monitoring baseline air temperature at two locations across the project site. The air temperature probes were placed about 3 feet above the ground surface.

Temperature data was continuously logged hourly throughout the project duration. Data was downloaded from the loggers approximately every two and a half months. Ground temperature profiles are plotted in Appendix B for selected days between November 4, 2004 and October 11, 2006. Ground temperatures for select days are also presented in Appendix B as a table. The graphs show the seasonal freeze-thaw cycle of the active layer for the embankment, which is approximately the upper 4 to 7 feet of soil. Below a depth of about 7 feet, the soil temperatures remain relatively constant throughout the data collection period. The soil temperatures range from about 30ºF to about 32.6ºF below the active layer. Additional discussions of ground temperatures are presented in Section 5.0.

4.4 Exploration Notes

The drilling and installation of the instrumentation along the embankment was accomplished according to the work plan.

4.5 Laboratory Testing

Laboratory tests were performed on selected samples recovered from the borings to verify field classifications and to determine the pertinent behavior characteristics of the typical materials encountered at the site. The laboratory testing was formulated with emphasis on determining the materials classification, moisture content, frost

characteristics, and consolidation potential. Laboratory results are shown in Appendix C. HDL's laboratory is certified by the Army Corps of Engineers and performed the testing.

4.5.1 Index Properties

A total of 59 water content tests were performed on samples from the eleven borings. These tests were conducted in accordance with procedures described in ASTM D-2216. The results of the water content measurements are presented on the boring logs, shown in Appendix A. The water contents are used to determine frost behavior and saturation conditions. Several of the water contents are above 100 percent. This indicates a large amount of organics and/or ice was present.

Grain size classification tests for this project consisted of two mechanical sieve tests and 10 short-time hydrometer tests. The results were used to estimate characteristics and the frost susceptibility of the soils. The short-time hydrometer tests were performed using a 15-minute time span to capture the amount of material smaller than 0.02 mm in diameter. The mechanical sieve tests were conducted according to procedures described in ASTM D-422. The short-time hydrometer tests were conducted as an abbreviated procedures described in ASTM D-1140. The results of the mechanical sieve and hydrometer tests are presented on the boring logs shown in Appendix A. The results of the mechanical sieves are also shown on the summary of laboratory results and the grain size curves located in Appendix C.

Atterberg Limits (liquid and plastic limits) were determined on one sample of fine-grained material. Liquid and plastic limits were determined in accordance with test procedures defined in ASTM D-423 and D-424, respectively. The results of this test are summarized on the boring log in Appendix A. Appendix C presents a summary of the result of the Atterberg Limit tests and indicates that the material was non-plastic to slightly plastic silts (ML).

Salinity contents were determined on three samples. These samples were analyzed to determine the freezing point depression. Salinity in the soils will cause the freezing point of water to fall below 32 °F. The results of these tests are shown on the boring logs in Appendix A and on the summary of laboratory results in Appendix C. HDL salinity values for the pore water ranged from 0.2 ppt to 7.9 ppt along the embankment. These values correspond to a freezing point depression of 0.02 °F to 0.45 °F.

4.5.2 Consolidation Tests

Consolidation tests help predict settlement rates in fine-grained soils. When fine-grain soil is subjected to an increase in load, a readjustment in the soil structure occurs as plastic deformation and is termed consolidation. In the case of Chefornak, the load (the embankment) has already been applied; however, the underlying frozen soils will not begin the consolidation process until thawing occurs. Once thawing occurs, pore water

is released and the settlement process begins. Also, the embankment may consolidate if the load is sufficiently large. Understanding the consolidation behavior of both the underlying soils and the embankment is useful in predicting overall settlement rates.

Two consolidation tests were performed to determine the current degree of consolidation and to estimate the future settlements that may occur. These tests were conducted in accordance with the procedures defined in ASTM D-2435. Each of the tests was performed on an approximate 2.5-inch diameter, one-inch high specimen confined in a steel ring. The test consists of applying a load to the sample and allowing it to settle over time (consolidate). As the sample consolidates, water is squeezed out through the top of the sample and through porous stones. Compression of the sample can only occur in the vertical direction, since the confining ring prevents lateral movement. This condition approximates those in the field beneath the center of a large loaded area. Continuous time settlement curves were maintained for each load increment. When consolidation appeared complete, the load was doubled and process repeated. The void ratio (e) versus load (p) curves were plotted. The results of the consolidation tests are summarized in Appendix C.

5.0 STATION TO STATION DESCRIPTION

The subsurface conditions at the new embankment are depicted in the boring logs presented in Appendix A. A profile map was generated that shows interpretation of soil conditions between each boring for the length of the embankment, this is shown on Figure 5. The soils encountered were generally sands and silts with cobbles and boulders of basalt. The silts and sands are a direct result of fluvial and deltaic deposition. The intermixing of cobbles and boulders occurred during embankment construction. Frozen soils were encountered generally about 5 to 9 feet below the existing ground surface. The original ground surface was encountered in the borings ranging between 5 feet and 14 feet below the embankment surface. The original ground surface was indicated by a layer of organics and organic silt ranging in thickness from 1/2 to 3.2 feet. A layer of ice-rich silty sand to sandy silt below the organic layer was evident throughout the majority of the boreholes. All boreholes showed frozen material beneath the embankment with the exception of Borehole B-7 where the organic layer was thawed. The constructed embankment, due to variability in original ground surface, was about 10 to 15 feet thick. The original ground surface was encountered from 5 to 14 feet deep in the borings indicating wind erosion and/or settlement of the embankment soils. The following discussions of the geotechnical conditions for the embankment are organized by division of similar segments.

5.1 Cobbles and Boulders

Cobbles and boulders have lifted up above the original surface of the embankment since the original placement of material. Data from a survey conducted in June 2006 indicates

approximately 100-150 cobbles and boulders exist along the embankment relatively uniformly spaced, ranging in average size of 12 inches to 36 inches in diameter, and protruding from the engineered grade 12 to 24 inches vertically. Several boulders over 36 inches were also noted. Boulders approximately 36 inches in diameter would weigh about a ton.

5.2 Frozen Ground Conditions (entire length of project)

The frozen ground characteristics along the embankment ranged from unfrozen to poorly bonded permafrost, with no visible ice crystals, to well bonded permafrost, with random visible ice formations. The ground temperatures of the soils drop below 32 °F at a depth ranging from about 6 feet to 9 feet below the ground surface at the end of October. The ground temperatures in the remaining depth of the boreholes range from about 30.2 °F to about 31.7 °F, see Appendix B. The salinity test results indicate a freezing point depression of at most 31.6 °F.

5.3 Station 10+00 (Beginning of Project) to 17+00

Boreholes B-1 through B-3 were placed along this section. The boreholes encountered an embankment thickness ranging from 8.5 to 9.0 feet. The embankment consisted of sand and silty sands. Below the embankment was a layer of vegetation followed by layers of silty sands and sandy silts to the depth of the boreholes. All three boreholes showed an active layer of thawed sand and silty sand to depths of 5 to 8 feet from the embankment surface. Frozen silty sands were encountered beneath the active layer to the depth of the vegetation layer. The frozen vegetation layer ranged in thickness from 1/2 to 3.2 feet thick from 9 to 11.7 feet in depth. All boreholes encountered frozen silts and silty sands beneath the frozen vegetation mat to the depths of the borings. These silts and silty sands remained frozen throughout all borings. Borehole B-1 had a layer of ice with a thickness of 0.3 feet within the frozen vegetation layer. Borehole B-3 had a layer of ice-rich permafrost below the vegetation layer. This layer had an estimated 60 percent ice content and a thickness of 1.5 feet.

A grain size test on a sample from the embankment revealed a fines content of 10.4 percent. The fines beneath the new embankment ranged from 28.7 percent to 98.5 percent. Moisture contents of the material in the active layer of the embankment ranged from 7 percent to 23 percent. A single moisture content on the frozen portion of sands in the embankment indicated a moisture content of 28 percent. The frozen sands and silts below the embankment ranged in moisture content from 16 to 84 percent.

5.4 Station 17+00 to 42+50 (End of Project)

Borehole B-4 to Borehole B-10 were placed along this section. The boreholes encountered an embankment thickness ranging from 5 to 13.5 feet. The thinnest embankment section was located near Stations 32+00 and 38+00. The embankment

consisted of sand and silty sand. Each of the boreholes encountered a vegetation layer overlaying layers of sandy silts and silty sands to the depth of the boring. A layer of ice-rich silty sands occurred near the bottom of the vegetation layer. The boreholes showed an active layer of thawed sands to silty sands to depths of 5 to 9 feet from the embankment surface. Frozen sands and silty sands were encountered beneath the active layer to depth of the vegetation layer. The ice-rich permafrost layers ranged in thickness from 1/2 feet to 3.0 feet. Borehole B-7 contained a vegetation layer that was thawed. This is due to its shallow depth of 5 feet. This unfrozen vegetation layer is underlayed by a 3.5 foot layer of ice-rich permafrost and then sandy silts and silty sands to the depth of the boring. Borehole B-10 has a ½-foot thick ice lens at 22 feet followed by a layer of sandy silt.

Grain size analysis on samples from the embankment revealed fines content ranged from less then one percent to 14.7 percent with the remaining portion of the soil being sand. Borehole B-10 had a sandy silt layer with a fines content of 63.1 percent. The fines beneath the new embankment ranged from 63.1 percent to 96.7 percent. Moisture contents of the silts in the active layer of the embankment ranged from 4 percent to 71 percent. Moisture contents of the frozen portion of silts in the embankment ranged from 23 percent to over 100 percent. The frozen sandy silts and silty sands below the embankment ranged in moisture content from 18 percent to over 100 percent.

5.5 Stream Crossing

An unnamed stream crosses the access road embankment near the apron. A temporary span was constructed at the crossing and consists of two 8-foot by 20-foot steel cargo "flats" placed side by side on two 16-foot-long pieces of multiplate culvert cut in half longitudinally, reversed, and placed on each bank of the stream as temporary abutments.

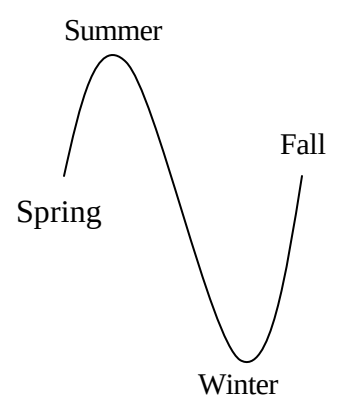
HDL collected data for four cross sections at the embankment crossing, and a cross section at a distance each upstream and downstream. The cross sections indicated the natural geometry of the stream is narrow and incised. The geometry at the embankment crossing is wider and deeper, indicating scour due to the temporary span of the makeshift bridge. HDL advanced one boring in the embankment at the stream crossing (B-11). The subsurface soils are generally soft silts to a depth of 20 feet below the stream bottom. Firmer silts with ice lenses are below the soft silts.

A steel multi-plate pipe is recommended at this location to convey the stream flows. The steel pipe should on the order of 10-foot diameter and convey a 10-year design flow of 46 cfs with a maximum velocity of 3.6 fps at mean annual flood to accommodate the design fish.

6.0 THERMAL ANALYSIS

A thermal analysis was conducted using TEMPW, a finite element program. The program generates a three dimensional (x, y, and time) thermal model based on the climate, soils, starting temperatures, thermal conductivity, heat capacity, and unfrozen water content. The cross-section shown in Appendix D, Figure D1, is based on the subsurface conditions encountered and represents the embankment along its entire length. The cross-section is divided into a series of elements and each corner (a node) of the element (typically a rectangle) is assigned an initial condition. Figure D1 shows the locations of the borings in the model. Nodes were assigned initial conditions based on the thermistor data collected in each boring.

TEMPW uses the fundamental laws of thermodynamics to predict ground temperature changes, and includes the effects from latent heat transfer during the phase change from ice to water. The program uses thermodynamic heat flux equations to calculate the heat transfer and distribution for each element. The governing equation states that the difference between the heat flux entering and leaving an elemental volume of soil at a point in time is equal to the change in the stored heat energy. The program was used to compute the distribution of subsurface temperatures over time and estimate the timing of when the embankment will be stable. In addition, the thermal model was used to analyze the changes in subsurface temperatures over time, which tells which ice-rich soil horizons will melt or freeze.



Sinusoidal Temperature Change

In order to determine how the subsurface temperatures change with time, a boundary function is applied at the model's ground surface. The boundary function uses the standard sinusoidal air temperature curve for a typical year. Four temperature points were inputted to simulate the first year and the sinusoidal temperature distribution. These four points are the average annual air temperature for "spring" and "fall" and the minimum average air temperature for "winter" and maximum average air temperature for "summer". The program interpolates between these four points to create a sinusoidal boundary function. See Section 3.1, Climate, for temperature information used in the model. The model is set to run in time steps up to the life of the project. Typically the temperature boundary function repeats itself however since there is a general warming trend observed in climate data for the region (See Section 3.1 Climate), the temperature boundary function for all models was increased at a rate of 0.106 °F per year. This temperature increase is consistent with climate data from Bethel, and can be assumed to pertain to most of the Yukon/Kuskokwim Delta. The rate of 0.106 °F is the average temperature increase for the region.

Three models were developed for analysis:

1) Model 1: Base model with the current average air temperatures observed in the Chefornak area as starting temperatures in the boundary function and a factor of 1.0 for the thermal conductivities.
2) Model 2: Base model with 6 inches of insulation and 12 inches of soil added to surface.
3) Model 3: Base model with 2 feet of insulation and 12 inches of soil added to surface.

Models 2 and 3 were developed since Model 1 did not stabilize. In other words, the 32 °F isotherm continued to move down the through the section over time. Model 2 stabilized for approximately 10-15 years. The 32 °F isotherm migrated down into the section after this stabilization period. Model 3 was then created, however eventually in about 20 years (model time) the 32 °F isotherm started to migrate down into the section.

6.1 Assumptions

The finite element base model created is shown in Appendix D, Figure D1. This model was based on the subsurface data gathered on September 15th through 18th, 2004 from the borings advanced along the embankment, and the temperature data. The base model used three material types: sandy silts, organic mat, and ice-rich sandy silts. In models 2 and 3, insulation was also used. Thermal conductivities and volumetric heat capacities were estimated for each material type.

Thermal conductivity values define how much heat is transferred from one soil type to the next. They are dependent upon the soil type (coarse grain, fine grain, or organic), unit weight, and moisture content of the material. The thermal conductivities chosen were based on average laboratory-measured soil contents, estimated unit weights and soil type. Since the soils varied in moisture contents, unit weights, and percentage of fine and coarse grain material, two sets of thermal conductivities were chosen. The higher the thermal conductivity, the higher the heat flow between the layers of material, and more likely the permafrost is to degrade. The following table presents the thermal conductivities used.

The temperature boundary function used in the base model had the first year temperatures set at 31 °F for Spring and Fall, 58 °F for Summer, and 20 °F for Winter (Appendix D, Figure D2). These temperatures were obtained from the Environmental Atlas of Alaska and the climate data presented in the geotechnical report. These temperatures were then increased for the next 40 years, at a rate of 0.106 °F per year, to simulate the increasing temperatures observed in the region over the past 29 years. A modifying function was applied to the boundary condition to simulate the presence of snow in the “winter” months (October through April) and grass in the warmer months (May through September).

Table 6.2: Thermal Conductivities Used in Modeling

Material	Model 1 & 2		Model 3 & 4	
	K_{frozen}	$K_{unfrozen}$	K_{frozen}	$K_{unfrozen}$
Sandy Silts	0.8	0.6	1.0	0.75
Organics	0.4	0.2	0.5	0.25
Ice-Rich Sandy Silts	0.9	0.4	1.2	0.5

Note: Thermal conductivity, K, units are BTU/ (hr-ft-°F)

The following basic assumptions are used in the modeling process:

1) Three soil types were used: sandy silts, ice-rich sandy silts, and organics/ vegetation.
2) Unfrozen water content and thermal conductivities were estimated based upon the laboratory test data.
3) The model does not collapse an ice lens when it melts. All materials are treated as solids.

6.2 Thermal Analysis

The results of the thermal analysis are presented in Appendix D, Figures D3(a) through D5(k).

Base Model

Appendix D, Figures D3(a) through D3(k), presents the 2-dimensional, temperature profiles for select Fall, from 2004 through 2044 for the base model. The profiles indicate that the embankment does not stabilize. The 32 °F isotherm remains in relatively the same location until year 2008. After this time the isotherm starts to migrate downward. The profile for 2019 (15 years) indicates the entire southern half of the embankment has experienced thawing of most to all of the vegetation/organic layer. In 2024, the 32 °F isotherm only occurs deep in the embankment on the northern side. This indicates that the embankment will undergo a long-term thawing process. If the embankment is left as is, from approximately 2008 until 2019, there will be thawing of the embankment and the vegetation/organic layer causing differential settlement to occur on the surface.

Model 2 - 6 Inches of Insulation

Appendix D, Figures D4(a) through D4(j), present the results for Model 2. This model was developed since Model 1 did not stabilize. This model stabilized for approximately 10 to 15 years and then after that time the 32 °F isotherm migrates downward. On the Fall 2024 profile (Figure D4(h)), the 32 °F isotherm has migrated below the vegetation/organic layer in the central and southern section of the embankment. This migration continues for the next 20 years. This indicates that one embankment will experience thawing and differential settlement.

Model 3 - 2 Feet of Insulation

Model 3 was developed since Model 2 was only stable for about 10 to 15 years. Model 3 is presented in Figures D5 (a) thru D5 (k). The 32 °F isotherm remains in the insulation or immediately below it until 2024 (Figure D5(a) thru D5 (h)). In the 2024 profile, Figure D5(i), the 32 °F isotherm has started to migrate downward. In 30 years, 2034, the 32 °F isotherm has migrated past the vegetation and organic layer.

6.3 Model Verification

For verifying the model, the base model was analyzed for a one year period. Outputs from the September 2005 to October 2006 time frame of the model were compared to collected thermistor data. Below about 7 feet, the model indicates that the temperatures are relatively consistent between about 31.2 and 31.8 F. The thermistor data however suggests that warmer zones still exist in this time period. This suggests that the model, while indicating colder temperatures within about 0.2 to 0.5 degrees of actual thermistor data, does not accurately reflect the warmer zones. In addition, the colder zones appear to be 0.1 to 0.3 degrees cooler in 2006 than in 2005 suggesting a smoothing of the temperatures over time as the model indicates. The model except for indicating colder temperatures than what is actually in the warmer zones of the embankment is producing temperatures within 0.5 degree of the actual temperatures, which is within acceptable limits.

7.0 CONSOLIDATION

The geotechnical analysis included conducting post-thaw consolidation tests to evaluate settlements. This soils information along with the thermal analysis was used to arrive at the conclusion presented in this report.

Settlement in the embankment is due to settlement from thawing of the soil horizons (thaw strain) and from settlement caused by loads placed on the already thawed soils (primary and secondary consolidation). Laboratory testing on already thawed sandy silts indicates that the sandy silts would rapidly settle (within a few days) on the order of 0.012 to 0.07 feet per foot of soil, if no ice lenses are present.

Additional settlements can be expected as a result of thawing ice-rich sandy silts and thaw compression of the original organic/vegetation layer. Ice-rich soil horizons with thin ice lenses of 2 to 4 inches thick occur throughout the embankment material. These soils if thawed would create differential settlement on the order of 2 to 4 inches. The organic/vegetation layer (original ground surface) varies between 2 feet to about 5 feet thick (near Boring B-9). The vegetation would experience settlement if thawed on the order of 1/2 to 2 feet depending upon the current thickness, ice content, and how much thaws.

8.0 LIMITATIONS

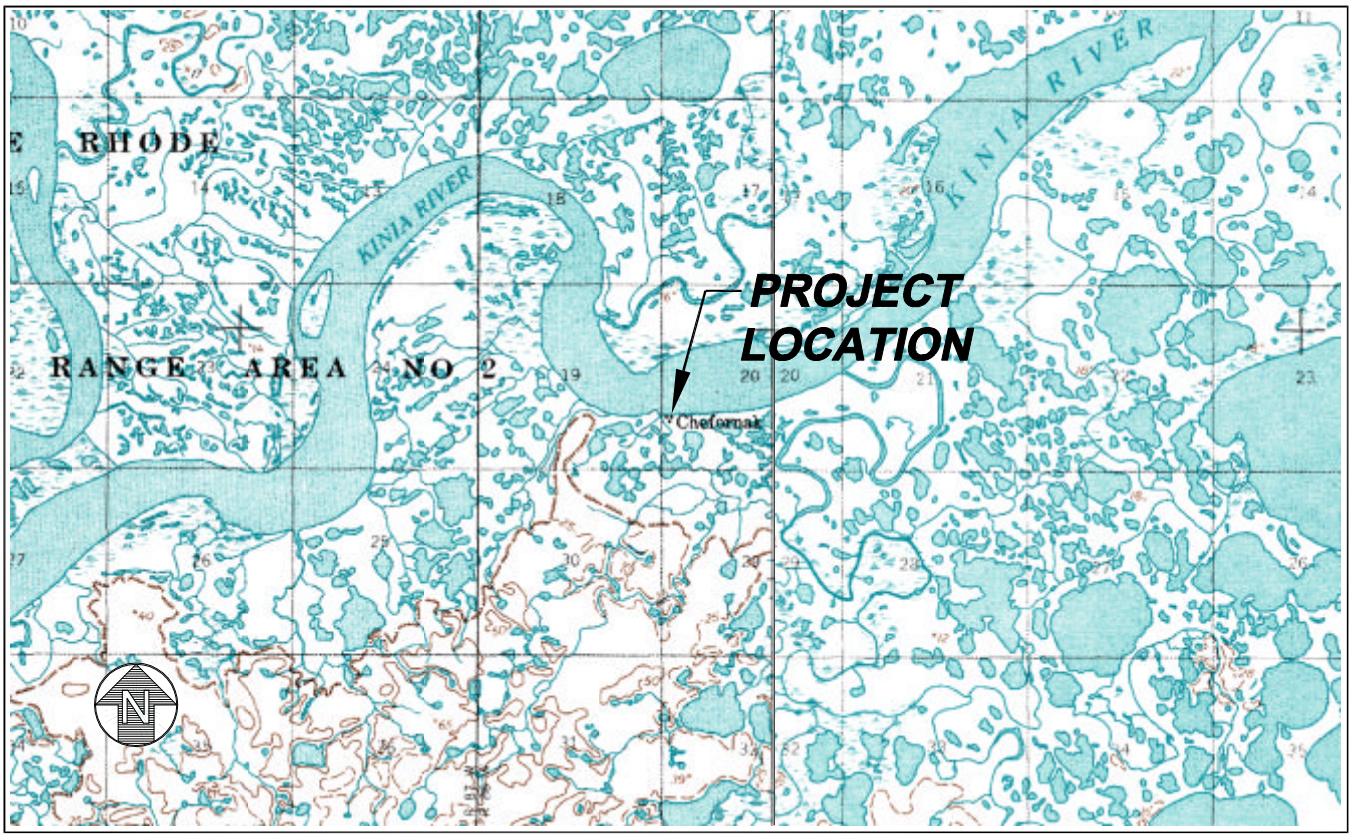
The analysis, conclusions, and recommendations contained in this report are based on site conditions as they presently exist and further assume that the 2-inch diameter exploratory borings spaced at approximately 400 feet over the approximate 720,000 square foot project area are representative of the subsurface conditions throughout the site. There is the likelihood of differing subsurface conditions from those encountered in the borings. Ice lenses, organic zones, or soft soils may be present between boreholes and may cause differential settlements not predicted in this report. If during construction, subsurface conditions different from those encountered in the exploratory borings are observed or appear to be present beneath excavations, advise us at once so we can review these conditions and reconsider our recommendations when necessary. The modeling was based upon estimated conditions as well as the borings and subsurface thermal data obtained for a limited period.

9.0 BIBLIOGRAPHY

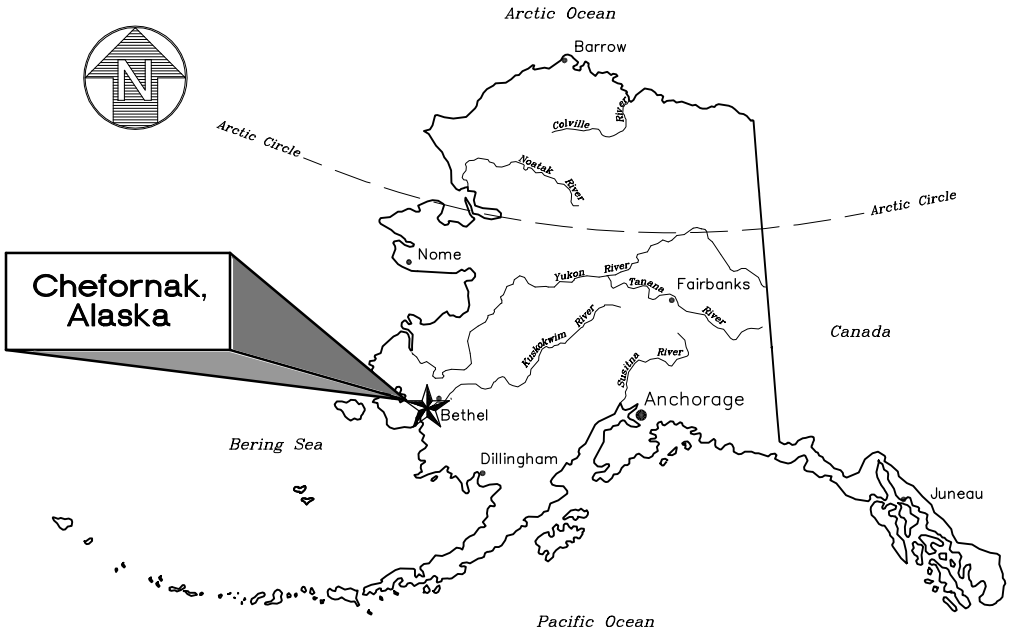
R&M Consultants, Inc., Lower Kuskokwim School District, School Site Investigation for Chefornak, Alaska, January 1979

Alaska Department of Transportation and Public Facilities, Geotechnical Report, Chefornak Airport, July 1999.

The Alaskan Communities Flood Hazard Data, 2000 Publication by the US Army Corps of Engineers for Chefornak.



AREA LOCATION MAP



LOCATION MAP

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CHEFORNAK AIRPORT
VICINITY MAP
ALASKA DOT & PF
CHEFORNAK, ALASKA

DATE: 11/10/06	DRAWN BY:	SHEET: FIGURE 1
SCALE: NTS	CHECKED BY:	JOB NO.: 04-108

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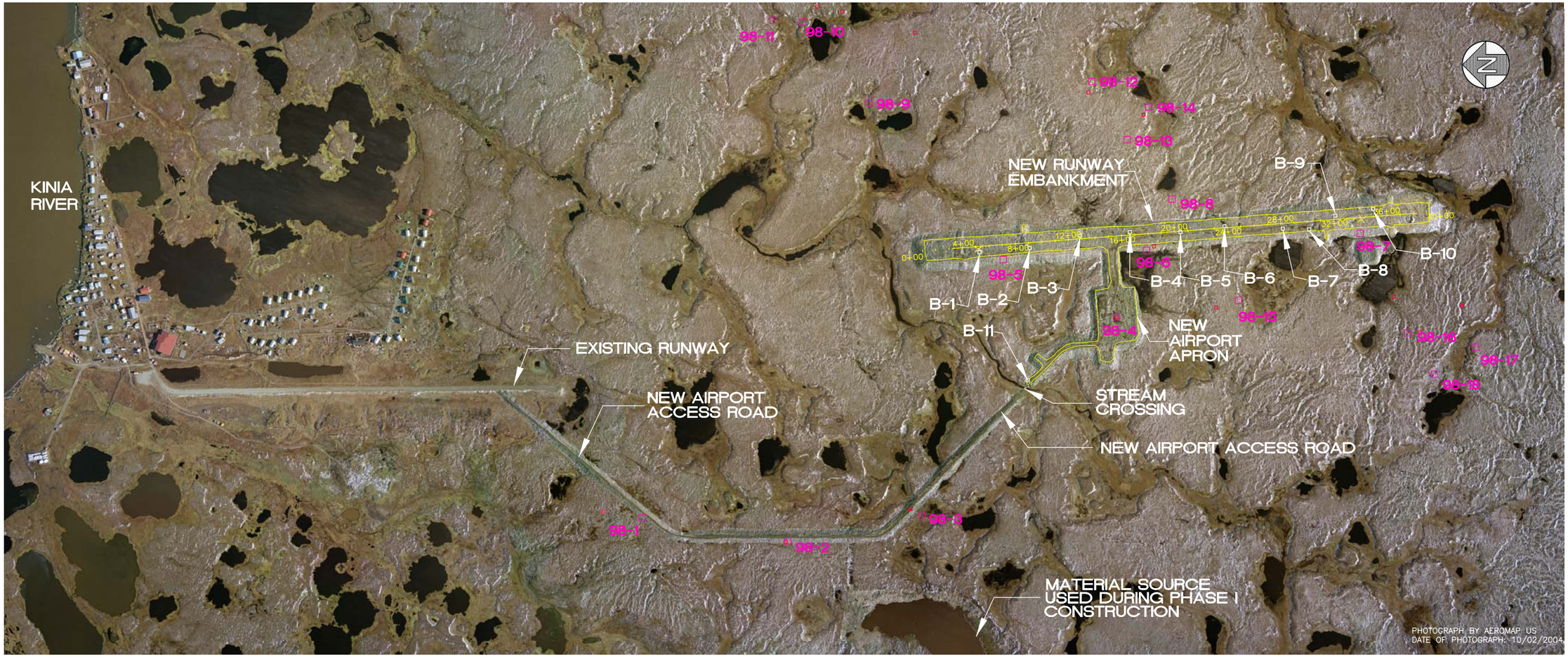

LEGEND

B-2	HDL 2004 BORINGS
98-3	DOT & PF 1998 BORINGS

REVISIONS

MARK	DATE	DESCRIPTION
1		
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NOT FOR CONSTRUCTION

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CHEFORNAK AIRPORT EMBANKMENT

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CHEFORNAK, ALASKA

SHEET TITLE
SITE MAP

SHEET
FIGURE 2

DRAWN BY: JSD
CHECKED BY: SLH
DATE: 11/10/06
SCALE: 1" = 400'
JOB NUMBER: 04-108

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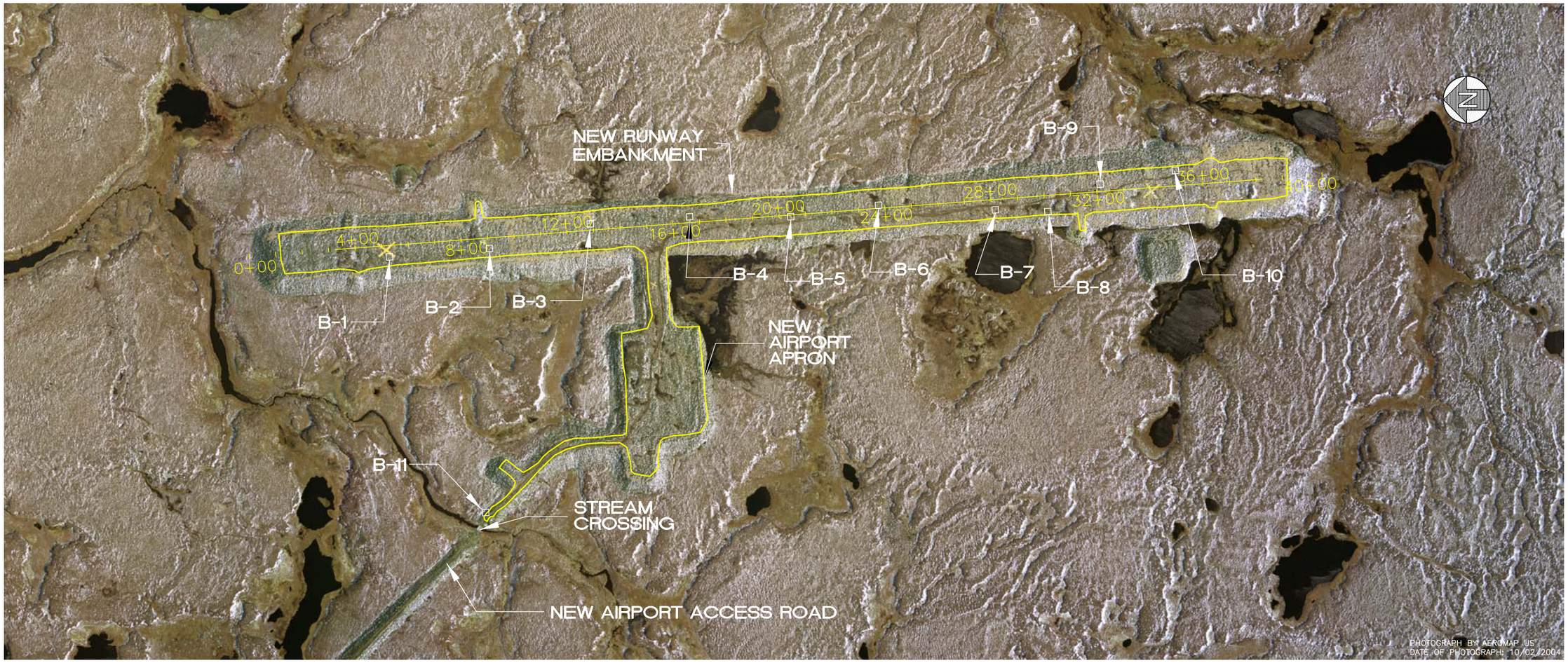

0 100 200
SCALE IN FEET

ONE INCH

REVISIONS		
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CHEFORNAK, ALASKA

SHEET TITLE: PROPOSED AIRPORT LAYOUT

SHEET: FIGURE 3

DRAWN BY: JSD	CHECKED BY: SLH
DATE: 11/10/06	SCALE: 1" = 400'

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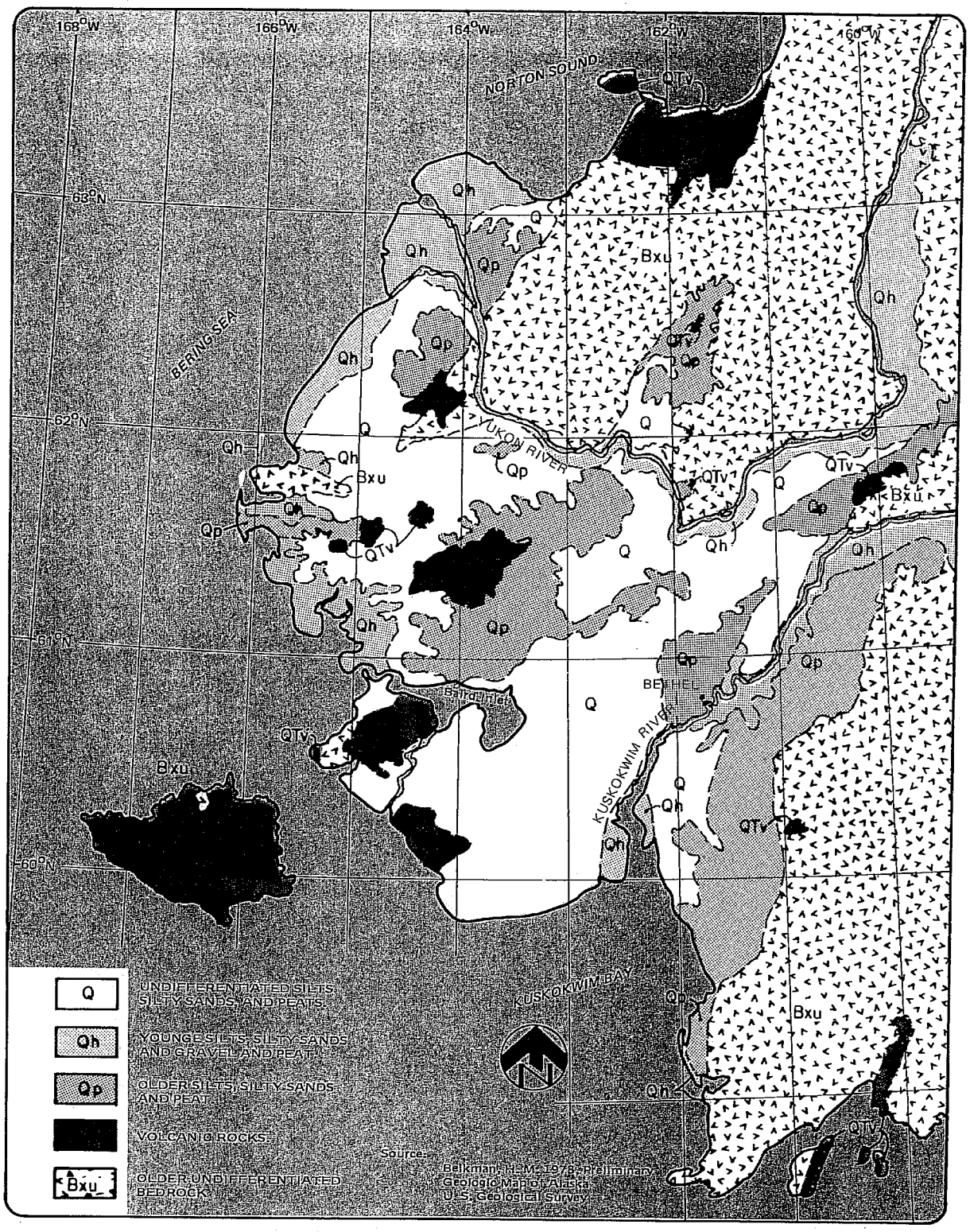
LAYOUT: Layout1 (2)



REGIONAL GEOLOGY

YUKON - KUSKOKWIM DELTA REGION

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CHEFORNAK AIRPORT EMBANKMENT
REGIONAL GEOLOGY

CHEFORNAK, ALASKA

DATE: 11/10/2006	DRAWN BY: KK	SHEET: FIGURE 4
SCALE: NTS	CHECKED BY: LH	JOB NO.: 04-108

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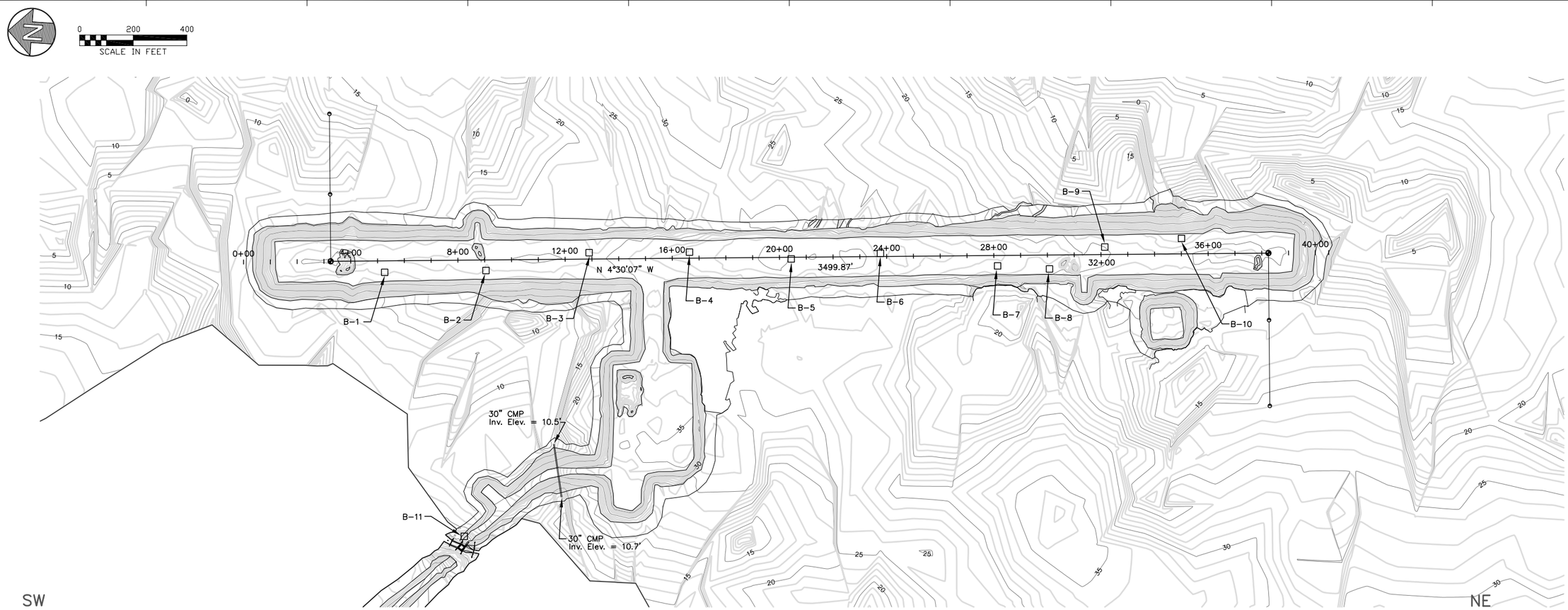
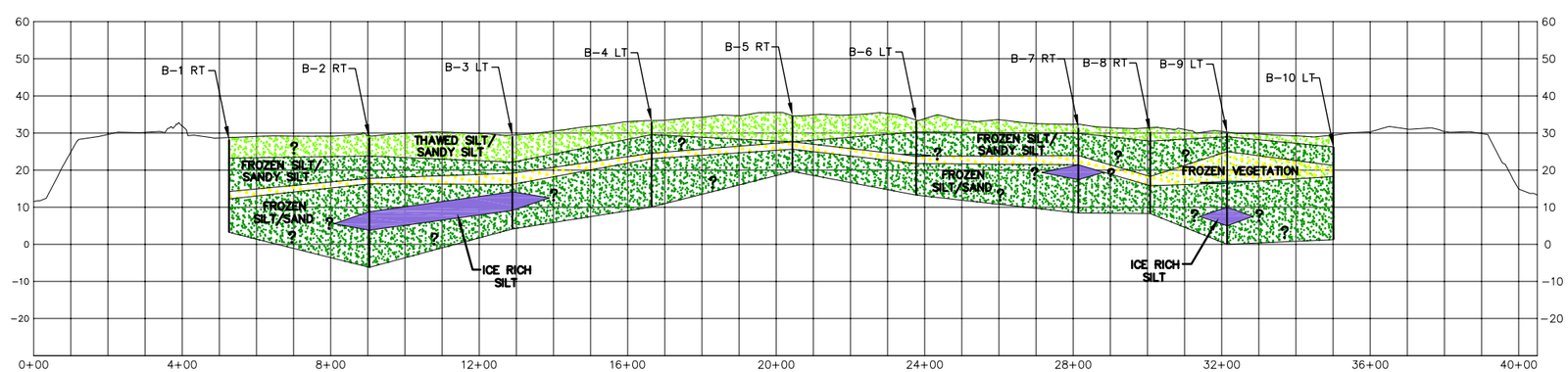
LAYOUT: FIGURE 2





SUBSURFACE PROFILE

SCALE: 1" = 200'

NOTE:
DATUM BASED ON 2004 SURVEY OPUS VALUES.

THAWED SILT/ SANDY SILT

FROZEN SILT/ SANDY SILT

ICE RICH SILT

FROZEN VEGETATION

REVISIONS		
MARK	DATE	DESCRIPTION
1		
2		
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CHEFORNAK AIRPORT SUBSURFACE PROFILE
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SHEET TITLE
SUBSURFACE PROFILE

SHEET
FIGURE 5

DRAWN BY:	CHECKED BY:
MLM	LMD
DATE: 11/10/06	SCALE: AS NOTED

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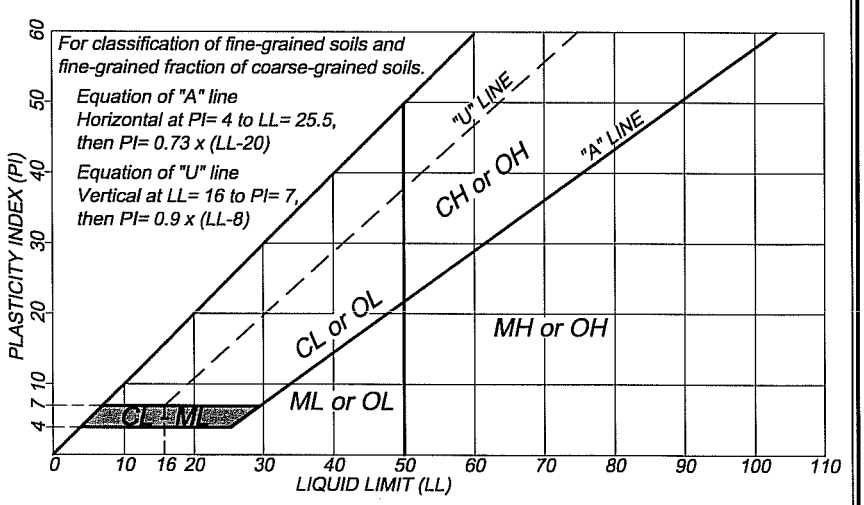
LAYOUT: Layout1

APPENDIX A

Unified Soil Classification
Frozen Soil Classification
Boring Logs

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Names			Soil Classification Generalized Group Descriptions	
COARSE-GRAINED SOILS More than 50% retained on No. 200 sieve	GRAVELS 50% or more of coarse fraction retained on No. 4 sieve	CLEAN GRAVELS Less than 5% fines	GW	Well-graded Gravels
			GP	Poorly-graded Gravels
		GRAVELS with fines More than 12% fines	GM	Gravel & Silt Mixtures
			GC	Gravel & Clay Mixtures
	SANDS More than 50% of coarse fraction passes No. 4 sieve	CLEAN SANDS Less than 5% fines	SW	Well-graded Sands
			SP	Poorly Graded Sands
		SANDS with FINES More than 12% fines	SM	Sand & Silt Mixtures
			SC	Sand & Clay Mixtures
FINE-GRAINED SOILS 50% or more passes the No. 200 sieve	SILTS AND CLAYS Liquid limit 50% or less	INORGANIC	ML	Non-plastic & Low Plasticity Silts
			CL	Low-plasticity Clays
		ORGANIC	OL	Non-plastic and Low Plasticity Organic Clays Non-plastic and Low Plasticity Organic Silts
	SILTS AND CLAYS Liquid limit greater than 50%	INORGANIC	CH	High-plasticity Clays
			MH	High-plasticity Silts
		ORGANIC	OH	High plasticity Organic Clays High Plasticity Organic Silts
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat



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CHEFORNAK AIRPORT EMBANKMENT
UNIFIED SOIL CLASSIFICATION
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DATE: 1/27/2006	DRAWN BY:	SHEET: FIGURE A1
SCALE: NTS	CHECKED BY:	JOB NO.: 04-108

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LAYOUT: Layout1

Figure 5
Description and Classification of Frozen Soils
(After ASTM D4083)

DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS

Part I Description of Soil Phase (a) (Independent of Frozen State)	Major Group		Sub-Group		Field identification (6)				Pertinent Properties of Frozen Materials which may be measured by physical tests to supplement field identification. (7)	Guide for Construction on Soils Subject to Freezing and Thawing	
	Description (2)	Description (3)	Description (4)	Description (5)						Thaw Characteristics (8)	Criteria (9)
Part II Description of Frozen Soil	Segregated ice is not visible by eye (b)	N	Poorly Bonded or Friable	Nf	Identify by visual examination. To determine presence of excess ice, use procedure under note (c) below and hand magnifying lens as necessary. For soils not fully saturation: Medium, Low. Note presence of crystals, or of ice coatings around larger particles.				In-Place Temperature Density and Void Ratio a) In Frozen State b) After Thawing in Place Water Content (Total H20, Including ice)a) Average b) Distribution Strength a) Compressive b) Tensile c) Shear d) Adfreeze Elastic Properties Plastic Properties Thermal Properties Ice Crystal Structure (using optional instruments.) a) Orientation of Axes b) Crystal Size c) Crystal Shape d) Pattern of Arrangement	Usually Thaw-Stable	The potential intensity of ice segragation in a soil is dependant to a large degree on its void sizes and may be expressed as an empirical function of grain size as follows: Most inorganic soils containing 3 percent or more of grains finer than 0.02 mm. in diameter by weight are frost-susceptible Gravels, well-graded sands and silty sands, especially those approaching the theoretical maximum density curve, which contail 1.5 to 3 percent finer than 0.02 mm. by weight without being frost-susceptible. However, their tendency to occur interbedded with other soils usually makes it impractical to consider them separately. Soils classed as frost-susceptible under the above criteria are likely to develop significant ice segregation and frost heave if frozen at normal rates with free water readily available. Soils so frozen will fall into the thaw-unstable category. However, they may also be classed as thaw-stable if frozen with insufficient water to permit ice segregation. Soils classed as no-frost-susceptible (*NFS) under the above criteria usually occur without significant ice segregation and are not exact and may be inadequate for some structure applications: exceptions may also result from minor soil variations. In permafrost areas, ice wedges, pockets, veins, or other ice bodies may be found whose mode of origin is different from that described above. Such ice may be the result of long-time surface expansion and contraction phenomena or may be glacial or other ice which has been buried under a protective earth cover.
			No excess ice Well Bonded Excess ice	Nb (n, e)	For ice phase, record the following as applicable: Location, Size, Orientation, Shape, Spacing, Thickness, Length, Pattern of arrangement Hardness, Structure, Color } per part III Below Estimate volume of visible segregated ice present as percent of total sample volume.					Usually Thaw-Unstable	
	Segregated ice is visible by eye (Ice 1 inch or less in thickness) (b)	V	Individual ice crystals or inclusions	Vx							
			Ice coatings on particles	Vc							
			Random or irregularly oriented ice formations	Vr							
			Stratified or distinctly oriented ice formations	Vs							
Part III Description of Substantial Ice Strata	Ice (Greater than 1 inch in thickness)	Ice	Ice with soil inclusions	Ice + soil Type	Designate material as ICE (d) and use descriptive terms as follows, usually one item from each group, as applicable.				Same as Part II above, as applicable, with special emphasis on Ice Crystal Structure.		
			Ice without soil inclusions	Ice	Hardness: Hard, Soft (mass, not indi-crystals)	Structure: Clear, Cloudy, Porous, Candled, Granular, Stratified	Color: e.g.: Color-less, Gray, Blue	Admixtures: e.g.: Contains Thin Silt Inclus-oins			

DEFINITIONS:

Ice Coatings on Particles are descernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are sometimes associated with hoarfrost crystals, which have grown into voids produced by the freezing action.
Ice Crystals is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in a combination with other ice formations.
Clear Ice is transparent and contains only a moderate number of air bubbles. (e)
Cloudy Ice is translucent, but essentially sound and non-pervious.
Porous Ice contains numerous voids, usually interconnected and usually resulting from melting at air bubbles or along crystal interfaces from presence of salt or other materials in the water, or from the freezing of saturated snow. Though porous, the mass retains its structural unity.
Candled Ice is ice which has rotted or otherwise formed into long columnar crystals, very loosely bonded together.
Granular Ice is composed of coarse, more or less equidimensional, ice crystals weakly bonded together.
Ice Lenses are lenticular ice formations in soil occuring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.
Ice Segregation is the growth of ice as distinct lenses, layers, viens and masses in soils, commonly but not always oriented normal to direction of heat loss:

Well-bonded signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.
Poorly-bonded signifies that the soil particles are weakly held together by the ice and that the frozen soil consequently has poor resistance to chipping and breaking.
Friable denotes a condition in which material is easily broken up under light to moderate pressure.
Thaw-Stable frozen soils do not, on thawing, show loss of strength below normal, long-time thawed values nor produce detrimental settlement.
Thaw-Unstable frozen soils show on thawing, significant loss of strength below normal, long-time thawed values and/or significant settlement, as a direct result of the melting of the excess ice in the soil.

Modified from: Linell, K. A. and Kaplar, C. W., 1966, Description and Classification of Frozen soils, Proc. International Conference on Permafrost (1963), Lafayette, IN, U.S. National Academy of Sciences, Publ. 1287, pp 481-478.

NOTES:

(a) When rock is encountered, standard rock classification terminology should be used.
(b) Frozen soils in the N group may on closed examination indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. However, the impression to the unaided eye is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group.
(c) When visual methods may be inadequate, a simple field test to aid evaluation of volume of excess ice can be made by placing some frozen soil in a small jar, allowing it to melt and observing the quantity of supernatant water as a percent of total volume.

(d) Where special forms of ice, such as hoarfrost, can be distinguished, more explicit description should be given.
(e) Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

OBTAINED FROM ALASKA DEPARTMENT OF TRANSPORTATION AND PUBLIC FACILITIES "ALASKA GEOTECHNICAL PROCEDURES MANUAL".

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GEOTECHNICAL REPORT
DESCRIPTION AND CLASSIFICATIONS OF FROZEN SOILS
ALASKA DOT & PF
CHEFORNAK, ALASKA

DATE: 1/27/2006	DRAWN BY:	SHEET: FIGURE A2
SCALE: NTS	CHECKED BY:	JOB NO.: 04-108

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LAYOUT: Layout1

FROST DESIGN SOIL CLASSIFICATION
(Modeled after U.S. Army Corps of Engineers Standards)

GROUP	KIND OF SOIL	P200	TYPICAL SOILS
NFS	Sand or Gravel	0 to 6	SW, SP GW, GP
F1	Gravelly Soils	6 to 10	GM, GW-GM, GP-GM SW, SP, SM, SW-SM, SP-SM
F2	Gravelly Soils Sands	10-20 6-15	GM, GW-GM, GP-GM SW, SP, SM, SW-SM, SP-SM
F3	Gravelly Soils Sands, except very fine silty sands Clays PI > 12	Over 20 Over 15	GM, GC SM, SC CL, CH CL, CH
F4	All Silts Very fine silty sands Clays, PI < 12 Varved clays and other fine-grained, banded sediments	Over 15	ML, MH SM CL, CL-ML CL and ML CL, ML, and SM; CL, CH, and ML; CL, CH, ML, and SM

P200 = percent passing the number 200 sieve

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CHEFORNAK AIRPORT EMBANKMENT
FROST DESIGN SOIL CLASSIFICATION
ALASKA DOT & PF
CHEFORNAK, ALASKA

DATE: 1/27/2006	DRAWN BY:	SHEET: FIGURE A3
SCALE: NTS	CHECKED BY:	JOB NO.: 04-108

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LAYOUT: Layout1

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10 20 30 40 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown silt, moist (no sample recovered 0' to 5')		
5						Frozen, gray, SILT; Vr (2" layer organics at 6')		5.0
						(3" ice lens at 7') Frozen, gray, SILT (ML); Vs, F4		7.5
10		□	■		ML	grain size: 0.3% gravel, 1.7% sand, 97.9% fines	SV	
			>>□					
15			>>□			Frozen, brown ORGANICS (vegetation mat); Vs		14.0
						Frozen, brown, SILT (ML) w/ trace sand; Vs, F4		16.0
					ML	grain size: 0.0% gravel, 3.1% sand, 96.9% fines	SV	
20			>>□			Frozen, gray, SILT; Vs		20.0
25			>>□			BORING completed at 25.0 ft. (closed PVC installed to 25')		25.0
30								
35								

Unconfined Compressive Strength (tsf): 1 2 3 4 5

■ Undisturbed Sample

SOIL DESCRIPTION

TEST KEY
SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

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Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-01
LOGGED BY: T. Strait
DATE DRILLED: October 3, 2004

SHEET TITLE: A- 4
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10 20 30 40 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown SILT, w/ trace sand, wet		
						(no sample recovered 2' to 5')		
5						Frozen, gray, slightly sandy SILT (ML); Vs, F4		5.0
					ML			
			>>			P200: 90.1% fines	P200	
10								
						Frozen, brown ORGANICS (vegetation mat); Vr		11.0
			>>			Frozen, brown, sandy SILT; Vr		12.5
						(no sample attempted 13' to 15')		
15						Frozen, brown SILT, w/ trace sand; Vs		15.0
			>>			(ice rich permafrost at 20')		
20								
25			>>			Frozen, gray SILT, w/ trace sand; Vs		25.0
30								
35						BORING completed at 35.0 ft. (closed PVC installed to 35')		35.0

1 2 3 4 5

Unconfined Compressive Strength (tsf)

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY

P200: Percent passing #200 Sieve

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment

Alaska DOT&PF

Chefornak, Alaska

LOG OF BORING B-02

LOGGED BY: T. Strait

DATE DRILLED: October 3, 2004

SHEET TITLE: A- 5

SHEET: 1 of 1

JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10 20 30 40 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown, sandy SILT, moist		0.5
						Soft, gray, sandy SILT, moist		
						(no sample recovered 3' to 7')		
5								
						Frozen, gray SILT, w/ trace sand; Vr		7.0
10						Frozen, gray, sandy SILT; Vr		10.0
			>>					
						Frozen, brown, ORGANICS (vegetation mat)		13.0
			>>					
15						Frozen, gray SILT (ML); Vs- ice rich, F4		15.0
					ML			
						grain size: 0.0% gravel, 1.1% sand, 98.9% fines	SV	
20						Frozen, gray SILT, w/ trace sand; Vr- very well bonded		20.0
25						BORING completed at 25.0 ft. (closed PVC installed to 25')		25.0
30								
35								

Unconfined Compressive Strength (tsf): 1 2 3 4 5

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY
SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-03
LOGGED BY: T. Strait
DATE DRILLED: October 2, 2004

SHEET TITLE: A- 6
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10, 20, 30, 40, 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown SILT, w/ trace sand, moist		
						Soft, gray SILT, w/ organics and trace sand, moist		2.5
						Frozen, gray SILT w/ trace sand; Nbe (no sample recovered 4' to 5')		3.5
5					ML	Frozen, gray, slightly sandy, gravelly SILT (ML); Vs- ice rich, F4 grain size: 14.5% gravel, 6.5% sand, 79.0% fines	SV	5.0
						ICE w/ 5% silt		8.0
						Frozen, brown SILT w/ organics; Vr		8.5
			>>			Frozen, brown ORGANICS (vegetation mat)		9.0
10						Frozen, brown SILT w/ trace sand; Vr		10.0
			>>			Frozen, gray SILT w/ trace sand; vs		11.5
15						Frozen, gray SILT; Vr		15.0
20						Frozen, gray SILT, w/ trace sand; Vr		20.0
						BORING completed at 23.0 ft. (refusal at 23') (closed PVC installed to 23')		23.0
25								
30								
35								

1 2 3 4 5

Unconfined Compressive Strength (tsf)

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY

SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment

Alaska DOT&PF

Chefornak, Alaska

LOG OF BORING B-04

LOGGED BY: T. Strait

DATE DRILLED: October 1, 2004

SHEET TITLE: A- 7

SHEET: 1 of 1

JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10 20 30 40 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown SILT, moist (no sample recovered 0' to 6')		
5								
		□	■			Soft, gray, silty SAND, w/ cobbles, moist; F3	P200	6.0
						P200: 29.1% fines		7.0
						Frozen, brown, sandy SILT w/ organics; Vr		
			>>□ ■			Frozen, gray, sandy SILT (ML); Vr, F4	SV	9.0
10						grain size: 0.0% gravel, 27.4% sand, 72.6% fines		
			■		ML			
15						BORING completed at 15.0 ft. (refusal at 15') (closed PVC installed to 15')		15.0
20								
25								
30								
35								

Unconfined Compressive Strength (tsf): 1 2 3 4 5

■ Undisturbed Sample

SOIL DESCRIPTION

TEST KEY
P200: Percent passing #200 Sieve
SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-05
LOGGED BY: T. Strait
DATE DRILLED: October 1, 2004

SHEET TITLE: A- 8
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10, 20, 30, 40, 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown SILT w/ trace sand, wet		
						Soft, brown SILT w/ cobbles and trace sand, moist		2.5
						Frozen, brown SILT w/ cobbles and trace sand; nbn		3.0
5						Frozen, brown SILT w/ trace sand; Vr-Vs		5.0
						ICE		9.0
10						Frozen, brown ORGANICS (vegetation mat)		9.5
			>>					
						COBBLES		11.5
						Frozen, gray SILT (ML) w/ trace sand; Nf, F4		12.0
					ML	grain size: 0.0% gravel, 3.1% sand, 96.9% fines	SV	
15						Frozen, gray SILT w/ cobbles and trace sand; Nf		15.0
20						BORING completed at 20.0 ft. (closed PVC installed to 20')		20.0
25								
30								
35								

Unconfined Compressive Strength (tsf): 1, 2, 3, 4, 5

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY
SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-06
LOGGED BY: T. Strait
DATE DRILLED: October 2, 2004

SHEET TITLE: A- 9
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10, 20, 30, 40, 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown SILT, w/ trace sand and organics		
			>>			Frozen, brown SILT w/ trace sand and organics; Nbe (no sample recovered 2.5' to 5')		1.5
5					ML	Frozen, gray, slightly gravelly SILT (ML) w/ trace sand; Vs, F4 (4" ice lens at 7')	SV	5.0
						grain size: 5.4% gravel, 3.3% sand, 91.3% fines		7.5
			>>			Frozen, brown ORGANICS (vegetation mat)		
10					ML	Frozen, gray, slightly sandy SILT (ML), w/ trace sand; Vs- ice rich, F4 grain size: 0.0% gravel, 7.0% sand, 93.0% fines		10.0
15						Frozen, gray, slightly sandy SILT; Vs	SV	15.0
			>>					
20						Frozen, gray, slightly sandy SILT; Nf (layer of cobbles at 21.5')		20.0
						BORING completed at 23.0 ft. (refusal at 23') (closed PVC installed to 23')		23.0
25								
30								
35								

Unconfined Compressive Strength (tsf): 1, 2, 3, 4, 5

Undisturbed Sample

TEST KEY
SV: Grain Size

SOIL DESCRIPTION

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-07
LOGGED BY: T. Strait
DATE DRILLED: October 2, 2004

SHEET TITLE: A- 10
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10, 20, 30, 40, 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown, sandy SILT, wet		
						Frozen, brown, sandy SILT; Nbe (no sample recovered 2.5' to 5')		2.5
5						Frozen, gray SILT, w/ trace sand; Nbe (4" layer of organics at 6')		5.0
						COBBLES		8.0
			>>			Frozen, gray, silty SAND; Nbe, F3		8.5
10						P200: 29.9% fines	P200	
						Frozen, brown ORGANICS (vegetation mat)		12.0
			>>					
15						Frozen, brown SILT w/ trace sand and random cobble layers; Nbe		14.5
20						Frozen, gray SILT w/ trace sand and cobbles; Nbe		20.0
						BORING completed at 22.0 ft. (refusal at 22') (closed PVC installed to 22')		22.0
25								
30								
35								

Unconfined Compressive Strength (tsf): 1, 2, 3, 4, 5

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY

P200: Percent passing #200 Sieve

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment

Alaska DOT&PF

Chefornak, Alaska

LOG OF BORING B-08

LOGGED BY: T. Strait

DATE DRILLED: October 2, 2004

SHEET TITLE: A- 11

SHEET: 1 of 1

JOB NUMBER: 04-108

CONTRACTOR: GeoTek Alaska, Inc.
EQUIPMENT: Geoprobe 6610DT
LOCATION:
ELEVATION:

PL MC LL

N VALUE, blows/ft

DEPTH (ft)	SOIL DESCRIPTION	USCS	TESTS	LAYER DEPTHS (ft)
	Soft, gray SILT w/ trace sand, wet			
	Frozen, gray SILT w/ trace sand; Vs			1.0
	(no sample recovered 2' to 5')			
5	Frozen, gray SILT w/ trace sand; vr			5.0
	(no sample attempted 8' to 10')			
10	Frozen, gray SILT (ML) w/ organics; Vr, F4	ML		11.0
	grain size: 0.0% gravel, 2.4% sand, 97.6% fines		SV	13.0
	ICE			13.5
	Frozen, brown ORGANICS (vegetation mat)			
15	Frozen, gray SILT w/ trace sand; Vs			16.0
20	Frozen, gray SILT w/ trace sand; Vs- ice rich			20.0
	(2" ice lens at 21.5')			
	(cobbles at 23')			
25	Frozen, gray, sandy SILT; Vs			25.0
	(cobbles at 28')			
30	BORING completed at 30.0 ft. (closed PVC installed to 30')			30.0
35				

Unconfined Compressive Strength (tsf): 1 2 3 4 5

Undisturbed Sample

TEST KEY
SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-09
LOGGED BY: T. Strait
DATE DRILLED: October 2, 2004

SHEET TITLE: A- 12
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10, 20, 30, 40, 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown SILT w/ trace sand, wet		
						Frozen, gray SILT w/ trace sand; Nbe		2.0
						(no sample recovered 3' to 5')		
5						Frozen, brown, slightly sandy SILT (ML) w/ organics; Nbe, F4		5.0
			>>		ML	grain size: 0.0% gravel, 8.4% sand, 91.6% fines	SV	
						Frozen, gray, sandy SILT; Vs		8.0
10								
15						Frozen, gray SILT (ML); Nbe-Nf, F4		15.0
					ML	grain size: 0.0% gravel, 2.0% sand, 98.0% fines	SV	
20						Frozen, gray, sandy SILT; Vs		20.0
						(6" cobble layer at 23')		
			>>					
25						BORING completed at 25.0 ft. (closed PVC installed to 25')		25.0
30								
35								

Unconfined Compressive Strength (tsf): 1, 2, 3, 4, 5

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY
SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment
Alaska DOT&PF
Chefornak, Alaska

LOG OF BORING B-10
LOGGED BY: T. Strait
DATE DRILLED: October 2, 2004

SHEET TITLE: A- 13
SHEET: 1 of 1
JOB NUMBER: 04-108

DEPTH (ft)	PL / MC / LL	N VALUE, blows/ft (10 20 30 40 50)	SAMPLES	GRAPHIC LOG	USCS	CONTRACTOR: GeoTek Alaska, Inc. EQUIPMENT: Geoprobe 6610DT LOCATION: ELEVATION:	TESTS	LAYER DEPTHS (ft)
						Soft, brown, sandy SILT, moist		0.5
						Soft, gray, sandy SILT, moist		1.8
						3" ICE lens		2.0
						Frozen, brown ORGANICS		2.5
						Soft, brown SILT, w/ trace sand, moist		
						(no sample recovered 3' - 5')		
5						Soft, brown, SILT (ML) w/ trace sand, moist; F4		5.0
					ML			
						grain size: 0.0% gravel, 4.3% sand, 95.7% fines	SV	
10						Soft/ firm, brown SILT, moist		10.0
15								
						4" ICE lens		16.0
						Firm, gray SILT, wet		16.3
						6" ICE lens		18.0
						Firm, gray SILT, wet		18.5
20						BORING completed at 20.0 ft.		20.0
25								
30								
35								

1 2 3 4 5

Unconfined Compressive Strength (tsf)

Undisturbed Sample

SOIL DESCRIPTION

TEST KEY

SV: Grain Size

LOG OF BORING 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 14:54

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Chefornak Airport Embankment

Alaska DOT&PF

Chefornak, Alaska

LOG OF BORING B-11

LOGGED BY: T. Strait

DATE DRILLED: October 3, 2004

SHEET TITLE: A- 14

SHEET: 1 of 1

JOB NUMBER: 04-108

APPENDIX B

Ground Temperature Data

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Borehole B-1

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface (feet)											
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft	20.3 ft	22.3 ft
11-Dec-04	1500	28.7	32.7	31.5	31.6	31.6	31.5	31.5	31.5	31.3	31.3	30.9	30.8
28-Dec-04	1500	24.8	32.5	31.5	31.8	31.6	31.5	31.5	31.3	31.3	31.3	30.9	30.7
11-Jan-05	1500	16.3	32.3	31.6	32.1	31.6	31.6	31.6	31.4	31.4	31.2	30.8	30.8
28-Jan-05	1500	15.0	31.6	31.6	32.3	31.7	31.6	31.6	31.4	31.4	31.4	30.8	30.8
11-Feb-05	1500	15.1	27.9	31.4	32.5	31.6	31.4	31.4	31.3	31.3	31.3	30.9	31.1
28-Feb-05	1500	21.1	30.5	31.4	32.6	31.8	31.4	31.4	31.2	31.2	31.2	30.9	30.9
11-Mar-05	1500	26.9	30.0	31.4	32.8	31.9	31.4	31.6	31.4	31.2	31.2	30.9	30.9
28-Mar-05	1500	22.9	29.5	31.3	32.9	32.0	31.3	31.7	31.3	31.3	31.3	30.8	30.8
11-Apr-05	1500	21.5	26.9	31.2	32.8	31.9	31.4	31.7	31.4	31.2	31.4	30.9	30.9
28-Apr-05	1500	32.0	30.0	31.1	32.7	31.8	31.3	31.8	31.5	31.1	31.5	30.9	30.9
11-May-05	1500	34.4	31.2	31.2	32.6	31.9	31.3	31.7	31.3	31.2	31.5	31.7	30.8
28-May-05	1500	41.9	31.3	31.3	32.4	31.9	31.3	31.7	31.5	31.1	31.5	32.2	31.0
11-Jun-05	1500	45.2	31.6	31.4	32.3	31.8	31.4	31.6	31.4	31.2	31.8	32.1	31.0
28-Jun-05	1500	61.4	32.7	31.4	32.1	31.8	31.3	31.6	31.4	31.3	31.8	32.1	31.1
11-Jul-05	1500	50.2	34.2	31.3	32.0	31.8	31.3	31.6	31.4	31.3	31.8	32.1	31.1
28-Jul-05	1500	55.6	38.9	31.4	31.9	31.7	31.4	31.6	31.4	31.2	31.9	32.1	31.0
11-Aug-05	1500	57.1	40.0	31.5	31.8	31.6	31.3	31.5	31.3	31.3	32.0	32.2	31.1
28-Aug-05	1500	49.9	41.0	31.8	31.7	31.7	31.3	31.3	31.3	31.1	31.8	32.0	30.9
11-Sep-05	1500	51.5	40.8	33.8	31.7	31.6	31.4	31.4	31.2	31.2	31.9	32.1	31.0
28-Sep-05	1500	47.9	40.6	34.6	31.7	31.7	31.3	31.3	31.3	31.1	32.0	32.0	31.1
11-Oct-05	1500	37.5	36.4	33.6	31.7	31.5	31.3	31.3	31.3	31.1	32.0	32.0	31.0
28-Oct-05	1500	23.9	33.0	32.3	31.6	31.6	31.4	31.2	31.2	31.2	32.0	32.1	31.1
11-Nov-05	1500	18.6	31.8	31.6	31.6	31.5	31.5	31.3	31.3	31.3	32.2	32.2	31.1
28-Nov-05	1200	27.3	31.4	31.4	31.5	31.4	31.4	31.2	31.2	31.2	32.1	32.1	31.0
11-Dec-05	1200	18.8	31.2	31.4	31.4	31.4	31.2	31.2	31.0	31.2	31.9	32.1	31.0
28-Dec-05	1200	21.8	30.8	31.5	31.5	31.5	31.3	31.3	31.1	31.3	32.0	32.2	30.9
11-Jan-06	1200	17.6	29.8	31.4	31.4	31.4	31.4	31.2	31.1	31.2	32.0	32.1	31.1
28-Jan-06	1200	3.5	23.1	31.3	31.5	31.3	31.3	31.3	31.1	31.1	32.0	32.0	30.9
11-Feb-06	1200	25.9	28.3	31.2	31.4	31.4	31.4	31.2	31.0	31.2	31.9	32.1	30.8
28-Feb-06	1200	16.7	29.1	31.3	31.3	31.3	31.3	31.2	31.0	31.2	31.9	32.0	31.0
11-Mar-06	1200	22.3	26.4	31.1	31.3	31.3	31.3	31.3	30.9	31.1	31.8	32.0	30.9
28-Mar-06	1200	19.4	25.1	30.8	31.2	31.4	31.2	31.2	31.0	31.0	31.7	31.9	31.0
11-Apr-06	1200	27.0	29.0	30.8	31.2	31.3	31.2	31.2	31.0	31.2	31.7	32.0	31.0
28-Apr-06	1200	23.2	27.0	30.6	31.3	31.3	31.3	31.1	31.0	31.1	31.9	32.0	31.0
11-May-06	1200	32.3	30.3	30.9	31.2	31.2	31.2	31.2	30.9	31.0	31.6	31.9	30.9
28-May-06	1200	53.7	31.0	31.0	31.1	31.3	31.3	31.1	31.0	31.1	31.7	31.9	31.0
11-Jun-06	1200	47.0	31.5	31.1	31.3	31.3	31.3	31.3	30.9	31.1	31.7	31.8	30.9
28-Jun-06	1200	46.2	33.2	30.9	31.1	31.3	31.1	31.1	30.8	31.1	31.5	31.6	30.9
11-Jul-06	1200	59.7	37.0	31.0	31.0	31.2	31.2	31.0	30.8	31.0	31.6	31.6	30.8
28-Jul-06	1200	50.2	38.7	31.1	31.1	31.3	31.1	31.1	30.8	31.1	31.5	31.7	30.9
11-Aug-06	1200	54.6	39.0	31.2	31.2	31.2	31.2	31.2	30.8	31.2	31.5	31.5	30.8
28-Aug-06	1200	53.1	38.7	31.3	30.9	31.1	31.1	31.1	30.8	31.1	31.5	31.5	30.8
11-Sep-06	1200	55.5	40.4	32.0	31.1	31.3	31.3	31.1	30.7	31.1	31.4	31.6	30.9
28-Sep-06	1200	41.0	36.9	32.8	31.1	31.2	31.1	31.1	30.7	31.1	31.4	31.4	30.9
11-Oct-06	1200	39.5	34.3	32.8	31.1	31.2	31.1	31.1	30.7	31.1	31.4	31.4	30.9

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Borehole B-2

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface (feet)											
		0.3 ft	3.3 ft	6.3 ft	9.3 ft	12.3 ft	15.3 ft	18.3 ft	21.3 ft	24.3 ft	27.3 ft	30.3 ft	33.3 ft
11-Dec-04	1500	29.9	31.5	31.8	31.6	31.5	31.6	31.1	30.8	31.3	30.9	30.9	30.9
28-Dec-04	1500	26.2	31.5	31.8	31.6	31.5	31.6	31.3	30.7	31.3	30.9	30.9	30.9
11-Jan-05	1500	14.5	31.6	31.7	31.7	31.4	31.6	31.2	30.8	31.2	31.0	30.8	31.0
28-Jan-05	1500	13.2	31.4	31.7	31.7	31.4	31.6	31.2	30.8	31.2	31.0	30.8	31.0
11-Feb-05	1500	15.4	31.1	31.8	31.6	31.4	31.8	31.1	30.7	31.1	30.9	30.9	30.9
28-Feb-05	1500	23.7	31.2	31.8	31.6	31.4	31.9	31.0	30.7	31.0	30.9	30.9	30.9
11-Mar-05	1500	28.5	31.0	31.7	31.6	31.4	31.9	31.2	30.7	31.0	30.9	30.9	31.0
28-Mar-05	1500	24.2	30.9	31.7	31.7	31.3	31.8	31.1	30.8	31.1	30.9	30.8	31.1
11-Apr-05	1500	22.6	29.8	31.7	31.6	31.4	31.9	31.2	30.7	31.0	30.9	30.9	31.2
28-Apr-05	1500	32.3	30.4	31.6	31.6	31.3	31.6	31.1	30.6	31.1	30.9	30.7	31.3
11-May-05	1500		30.8	31.5	31.5		31.5	28.6	30.6	31.0			31.3
28-May-05	1500		31.0	31.7	31.5		31.5	30.8	30.6	31.0			31.5
11-Jun-05	1500		31.0	31.6	31.6		31.4	29.2	30.7	31.0			31.6
28-Jun-05	1500		31.1	31.6	31.6		31.3	25.6	30.7	31.1			31.4
11-Jul-05	1500		31.4	31.6	31.6		31.3	25.2	30.7	31.1			31.4
28-Jul-05	1500		33.3	31.6	31.6		31.2	9.9	30.7	31.0			31.4
11-Aug-05	1500		34.9	31.6	31.6		31.3	15.2	30.7	31.1			31.5
28-Aug-05	1500		37.1	31.7	31.5		31.1	14.0	30.6	31.1			31.3
11-Sep-05	1500		37.5	31.6	31.6		31.0	16.4	30.7	31.0			31.2
28-Sep-05	1500		37.4	31.7	31.7		31.1	16.5	30.8	31.1			31.3
11-Oct-05	1500		34.9	31.7	31.7		31.1	15.5	30.8	31.1			31.1
28-Oct-05	1500		32.6	31.6	31.6		31.1	11.9	30.7	31.1			31.8
11-Nov-05	1500		31.6	31.8	31.6		31.1	13.1	30.8	31.1			31.8
28-Nov-05	1200		31.4	31.7	31.5		31.0	13.5	30.7	31.0			31.7
11-Dec-05	1200		31.2	31.6	31.6		31.0	15.1	30.7	31.0			31.6
28-Dec-05	1200		31.3	31.6	31.6		31.1	11.4	30.8	31.1			31.5
11-Jan-06	1200		31.1	31.8	31.6		31.1	13.0	30.7	31.2			31.4
28-Jan-06	1200		28.3	31.6	31.6		30.9	12.2	30.7	31.1			31.5
11-Feb-06	1200		29.2	31.7	31.6		31.0	14.0	30.7	31.2			31.4
28-Feb-06	1200		30.2	31.7	31.5		31.0	11.4	30.6	31.2			31.3
11-Mar-06	1200		28.3	31.6	31.6		30.9	13.3	30.6	31.1			31.3
28-Mar-06	1200		27.7	31.5	31.5		31.0	8.3	30.5	31.0			31.2
11-Apr-06	1200		29.1	31.5	31.5		31.0	12.6	30.6	31.0			31.2
28-Apr-06	1200		28.6	31.7	31.5		31.0	11.5	30.6	31.1			31.1
11-May-06	1200		30.1	31.6	31.6		30.9	7.1	30.7	31.0			31.0
28-May-06	1200		30.6	31.5	31.5		31.0	10.7	30.6	31.0			31.1
11-Jun-06	1200		30.9	31.7	31.5		30.9	10.0	30.6	31.1			31.1
28-Jun-06	1200		30.9	31.5	31.5		30.9	10.9	30.4	30.9			31.1
11-Jul-06	1200		31.2	31.6	31.4		30.8	8.1	30.5	30.8			31.0
28-Jul-06	1200		32.2	31.5	31.5		30.9	6.7	30.4	30.9			30.9
11-Aug-06	1200		33.4	31.5	31.3		30.8	8.0	30.4	31.0			31.0
28-Aug-06	1200		34.2	31.5	31.3		30.8	8.6	30.4	30.9			30.9
11-Sep-06	1200		35.3	31.6	31.4		30.9	8.5	30.6	30.9			30.9
28-Sep-06	1200		34.7	31.6	31.4		30.9	8.1	30.3	30.9			30.9
11-Oct-06	1200		33.3	31.6	31.4		30.9	5.9	30.5	30.9			30.9

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Borehole B-3

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface											
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft	20.3 ft	22.3 ft
11-Dec-04	1500	30.3	31.9	32.0	31.9	31.5	31.5	32.0	31.7	31.9	31.5	31.3	31.5
28-Dec-04	1500	27.8	31.7	32.0	31.8	31.5	31.5	32.0	31.7	31.8	31.5	31.3	31.5
11-Jan-05	1500	18.6	31.6	31.9	31.8	31.4	31.4	31.9	31.6	31.8	31.6	31.2	31.4
28-Jan-05	1500	22.2	31.6	31.9	31.9	31.6	31.6	31.9	31.8	31.8	31.6	31.4	31.6
11-Feb-05	1500	17.7	30.1	32.0	31.9	31.5	31.5	32.0	31.7	31.9	31.5	31.3	31.5
28-Feb-05	1500	23.0	31.0	31.9	31.9	31.5	31.5	32.0	31.7	31.7	31.5	31.3	31.3
11-Mar-05	1500	27.4	30.4	31.8	31.8	31.4	31.4	32.0	31.6	31.8	31.4	31.3	31.4
28-Mar-05	1500	24.1	30.3	31.9	31.8	31.6	31.6	31.9	31.6	31.8	31.6	31.2	31.4
11-Apr-05	1500	22.3	28.2	31.9	31.7	31.5	31.5	31.9	31.5	31.7	31.5	31.3	31.3
28-Apr-05	1500	31.2	30.3	31.9	31.7	31.6	31.6	31.9	31.6	31.7	31.6	31.2	31.4
11-May-05	1500	35.8	31.1	31.8	31.8	31.6	31.4	31.9	31.6	31.8	31.6	31.2	31.4
28-May-05	1500	43.3	31.2	31.8	31.8	31.4	31.4	31.9	31.6	31.8	31.6	31.2	31.4
11-Jun-05	1500	46.5	31.4	31.8	31.8	31.4	31.4	31.9	31.6	31.8	31.6	31.2	31.4
28-Jun-05	1500	60.0	32.0	31.7	31.7	31.3	31.3	31.8	31.5	31.7	31.5	31.1	31.3
11-Jul-05	1500	50.5	34.0	31.8	31.8	31.4	31.6	31.9	31.6	31.8	31.6	31.2	31.4
28-Jul-05	1500	56.0	37.7	31.8	31.6	31.4	31.4	31.8	31.6	31.6	31.4	31.2	31.2
11-Aug-05	1500	56.7	38.6	31.8	31.6	31.4	31.3	31.8	31.4	31.6	31.4	31.1	31.3
28-Aug-05	1500	50.4	39.7	32.2	31.6	31.5	31.5	31.8	31.5	31.6	31.5	31.3	31.3
11-Sep-05	1500	51.0	39.7	33.2	31.7	31.3	31.3	31.9	31.5	31.7	31.5	31.2	31.3
28-Sep-05	1500	46.9	39.4	33.6	31.7	31.4	31.4	31.7	31.6	31.6	31.4	31.2	31.2
11-Oct-05	1500	36.1	35.9	33.1	31.7	31.3	31.3	31.9	31.5	31.7	31.5	31.2	31.2
28-Oct-05	1500	28.9	32.8	32.5	31.8	31.5	31.5	31.8	31.6	31.8	31.5	31.3	31.3
11-Nov-05	1500	24.0	31.8	32.0	31.6	31.5	31.5	31.8	31.6	31.6	31.5	31.3	31.3
27-Nov-05	1200	27.8	31.5	31.8	31.6	31.3	31.3	31.8	31.5	31.6	31.5	31.1	31.3
11-Dec-05	1200	23.7	31.6	31.9	31.7	31.4	31.4	31.9	31.6	31.7	31.6	31.2	31.2
28-Dec-05	1200	27.2	31.6	32.0	31.8	31.6	31.4	32.0	31.6	31.8	31.6	31.3	31.4
11-Jan-06	1200	24.2	31.3	31.8	31.8	31.5	31.5	32.0	31.7	31.8	31.5	31.1	31.3
28-Jan-06	1200	13.7	29.0	31.9	31.7	31.6	31.4	31.9	31.6	31.7	31.6	31.2	31.4
11-Feb-06	1200	28.0	30.0	32.0	31.8	31.5	31.5	32.0	31.6	31.8	31.6	31.3	31.3
28-Feb-06	1200	20.7	30.6	31.8	31.7	31.5	31.5	31.8	31.7	31.7	31.5	31.3	31.3
11-Mar-06	1200	21.2	28.0	31.8	31.6	31.5	31.5	31.8	31.6	31.6	31.5	31.3	31.3
28-Mar-06	1200	20.9	27.9	31.8	31.8	31.4	31.4	31.8	31.6	31.8	31.6	31.2	31.2
11-Apr-06	1200	28.5	30.0	31.8	31.8	31.4	31.4	32.0	31.6	31.8	31.6	31.2	31.2
28-Apr-06	1200	25.2	28.7	31.6	31.6	31.3	31.3	31.8	31.5	31.6	31.5	31.1	31.3
11-May-06	1200	31.9	30.6	31.7	31.7	31.3	31.3	31.9	31.5	31.7	31.5	31.2	31.3
28-May-06	1200	46.4	31.0	31.7	31.5	31.3	31.3	31.7	31.5	31.7	31.3	31.2	31.2
11-Jun-06	1200	47.0	31.4	31.7	31.6	31.4	31.4	31.7	31.6	31.7	31.4	31.2	31.2
28-Jun-06	1200	47.4	32.4	31.7	31.7	31.3	31.3	31.8	31.5	31.7	31.5	31.1	31.1
11-Jul-06	1200	64.7	34.9	31.5	31.5	31.3	31.2	31.7	31.5	31.5	31.3	31.0	31.2
28-Jul-06	1200	52.1	37.5	31.7	31.7	31.5	31.3	31.9	31.5	31.7	31.5	31.1	31.1
11-Aug-06	1200	54.0	37.8	31.8	31.6	31.4	31.2	31.8	31.4	31.6	31.4	31.2	31.2
28-Aug-06	1200	51.7	37.9	31.9	31.7	31.3	31.3	31.9	31.5	31.7	31.5	31.1	31.1
11-Sep-06	1200	54.8	39.3	32.0	31.7	31.3	31.3	31.7	31.5	31.7	31.5	31.1	31.1
28-Sep-06	1200	41.2	37.7	34.1	31.7	31.4	31.4	31.9	31.5	31.7	31.5	31.2	31.2
11-Oct-06	1200	40.0	35.2	33.7	31.8	31.3	31.3	31.8	31.5	31.6	31.5	31.1	31.1

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Borehole B-4

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface										
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft	20.3 ft
11-Dec-04	1500	30.1	32.0	32.0	31.7	31.5	31.9	31.5	31.5	36.4	31.3	31.5
28-Dec-04	1500	27.0	31.8	31.8	31.5	31.5	31.8	31.7	31.5	35.7	31.3	31.5
11-Jan-05	1500	17.8	31.6	31.9	31.8	31.4	32.3	32.1	31.8	36.4	31.4	31.6
28-Jan-05	1500	24.9	31.6	32.1	31.8	31.4	32.3	33.0	32.3	36.6	31.4	31.6
11-Feb-05	1500	18.0	30.2	32.6	31.7	31.5	33.1	33.9	32.2	36.5	31.3	31.7
28-Feb-05	1500	23.0	30.8	33.6	31.7	31.3	35.2	33.9	32.2	36.8	31.3	31.7
11-Mar-05	1500	27.2	30.2	34.2	31.8	31.3	35.3	33.9	32.1	37.1	31.3	31.6
28-Mar-05	1500	26.0	30.0	34.2	32.1	31.4	35.5	33.7	32.6	37.6	31.4	31.6
11-Apr-05	1500	23.6	27.4	34.1	32.4	31.5	34.9	33.4	33.6	37.9	31.7	31.5
28-Apr-05	1500	32.2	29.7	33.9	32.8	31.6	34.9	33.3	33.9	39.0	31.9	31.6
11-May-05	1500	39.7	30.9	33.5	33.0	31.6	35.0	33.5	33.8	39.7	31.9	31.4
28-May-05	1500	50.1	31.2	33.5	33.1	31.6	34.8	33.3	33.7	40.3	32.3	31.4
11-Jun-05	1500	51.7	31.6	33.3	33.5	31.8	34.8	33.3	33.7	40.6	32.3	31.4
28-Jun-05	1500	66.5	33.7	33.1	33.4	31.5	34.6	33.1	33.4	40.8	32.2	31.1
11-Jul-05	1500	53.9	36.1	33.1	33.5	31.6	34.5	33.5	33.3	41.0	32.3	31.2
28-Jul-05	1500	56.1	39.8	33.0	33.3	31.6	34.2	33.5	32.1	41.2	32.1	31.1
11-Aug-05	1500	57.3	40.7	33.5	33.5	31.4	34.2	33.5	32.1	41.2	32.0	31.1
28-Aug-05	1500	49.5	40.9	35.0	33.4	31.5	34.0	33.7	32.0	40.9	32.0	31.1
11-Sep-05	1500	48.3	40.3	35.6	33.2	31.5	34.1	33.6	32.0	40.5	32.0	31.2
28-Sep-05	1500	46.2	39.9	35.8	33.1	31.4	34.0	33.6	31.9	40.6	31.9	31.2
11-Oct-05	1500	32.2	36.4	34.9	33.1	31.3	33.9	33.6	31.7	40.5	31.9	31.2
28-Oct-05	1500	25.8	33.4	33.7	33.0	31.3	33.9	33.7	31.8	40.6	31.8	31.3
11-Nov-05	1500	19.8	32.2	32.9	32.9	31.3	33.7	33.5	32.7	39.0	31.8	31.1
28-Nov-05	1200	26.8	31.8	32.7	32.7	31.1	33.7	33.6	32.2	38.5	31.6	31.1
11-Dec-05	1200	24.1	31.9	32.8	32.6	31.2	34.0	33.6	32.3	40.1	31.7	31.0
28-Dec-05	1200	26.4	31.8	32.8	32.7	31.3	34.0	33.5	32.3	41.5	31.8	31.3
11-Jan-06	1200	25.8	31.5	32.9	32.7	31.1	34.1	33.2	32.2	41.2	31.7	31.1
28-Jan-06	1200	15.0	28.2	32.9	32.4	31.2	34.1	33.6	32.3	40.8	31.7	31.2
11-Feb-06	1200	28.0	30.0	32.9	32.5	31.5	34.1	33.7	32.2	40.6	31.6	31.1
28-Feb-06	1200	23.1	30.8	33.1	32.4	31.5	34.1	33.7	32.2	40.4	31.7	31.1
11-Mar-06	1200	22.3	28.6	33.4	32.5	31.6	34.2	33.7	32.2	40.2	31.6	31.1
28-Mar-06	1200	21.8	28.3	33.3	32.5	31.6	34.2	33.7	32.1	40.0	31.6	31.0
11-Apr-06	1200	28.1	30.2	33.5	32.3	31.6	34.2	33.9	32.1	39.6	31.6	31.1
28-Apr-06	1200	24.6	28.9	33.9	32.3	31.5	34.2	33.7	32.1	39.6	31.5	30.9
11-May-06	1200	31.7	31.0	33.4	32.2	31.5	34.2	33.8	32.2	39.4	31.5	31.0
28-May-06	1200	49.9	31.3	35.6	32.2	31.5	34.3	33.6	32.2	39.2	31.3	31.0
11-Jun-06	1200	49.4	31.6	36.4	32.3	31.6	34.3	33.8	32.3	39.4	31.4	31.0
28-Jun-06	1200	47.5	32.2	36.7	32.4	31.5	34.2	33.7	32.4	39.3	31.3	30.9
11-Jul-06	1200	58.8	33.9	39.3	32.7	31.5	34.3	33.8	32.2	39.2	31.3	30.8
28-Jul-06	1200	51.8	35.9	37.8	33.1	31.7	34.4	33.9	32.4	39.1	31.5	31.0
11-Aug-06	1200	56.0	36.7	36.7	33.1	31.6	34.0	33.8	32.3	39.1	31.4	30.9
28-Aug-06	1200	54.3	37.0	37.3	32.6	31.7	34.1	33.9	32.4	39.0	31.3	31.0
11-Sep-06	1200	56.9	38.5	37.6	32.9	31.5	33.9	33.7	32.6	39.0	31.3	30.8
28-Sep-06	1200	42.8	35.8	39.2	32.9	31.7	33.9	33.6	32.7	39.0	31.4	30.8
11-Oct-06	1200	34.5	33.7	38.0	33.2	31.6	33.9	33.5	32.7	39.0	31.5	30.7

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Borehole B-5

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface						
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft
11-Dec-04	1500	29.1	31.7	31.8	32.0	31.7	32.5	32.4
28-Dec-04	1500	28.1	31.6	31.6	32.0	31.6	32.5	32.4
11-Jan-05	1500	16.2	31.6	31.8	32.1	31.6	32.5	32.5
28-Jan-05	1500	20.3	31.2	31.8	32.5	31.6	33.0	32.6
11-Feb-05	1500	16.3	28.6	31.7	32.7	31.7	34.1	33.8
28-Feb-05	1500	23.3	30.6	31.6	33.0	31.6	34.2	33.6
11-Mar-05	1500	27.3	30.0	31.6	32.9	31.6	34.1	33.4
28-Mar-05	1500	24.2	29.9	31.7	32.9	31.7	33.6	33.3
11-Apr-05	1500	22.2	27.5	31.5	32.7	31.6	33.2	33.2
28-Apr-05	1500	31.3	30.2	31.5	32.7	31.5	33.1	33.1
11-May-05	1500	39.9	31.4	31.6	32.8	31.6	33.1	33.1
28-May-05	1500	48.5	31.6	31.7	32.4	31.6	33.0	33.0
11-Jun-05	1500	48.8	32.0	31.9	32.4	31.7	32.9	33.1
28-Jun-05	1500	66.5	35.5	31.8	32.2	31.6	32.9	32.9
11-Jul-05	1500	52.6	37.4	31.9	32.0	31.7	32.7	32.7
28-Jul-05	1500	56.9	41.9	31.9	31.9	31.6	32.6	32.6
11-Aug-05	1500	58.1	42.5	32.3	32.1	31.4	32.5	32.5
28-Aug-05	1500	50.7	43.1	34.5	31.9	31.5	32.0	32.4
11-Sep-05	1500	52.6	41.9	34.6	32.0	31.3	32.4	32.4
28-Sep-05	1500	49.2	41.0	34.9	32.0	31.5	32.4	32.4
11-Oct-05	1500	38.0	36.3	33.8	31.9	31.6	32.3	32.4
28-Oct-05	1500	23.6	32.6	32.6	32.1	31.5	32.4	32.4
11-Nov-05	1500	17.8	31.5	31.9	32.2	31.5	32.4	32.4
28-Nov-05	1200	28.6	31.0	31.7	31.9	31.4	32.1	32.3
11-Dec-05	1200	12.4	31.0	31.9	31.7	31.5	32.2	32.4
28-Dec-05	1200	22.2	30.6	31.9	31.7	31.5	32.2	32.4
11-Jan-06	1200	15.8	30.1	31.7	31.7	31.5	32.2	32.2
28-Jan-06	1200	1.5	25.0	31.7	31.5	31.5	32.2	32.2
11-Feb-06	1200	26.5	29.1	31.6	31.6	31.6	32.3	32.3
28-Feb-06	1200	14.8	29.5	31.6	31.7	31.6	32.3	32.3
11-Mar-06	1200	23.3	26.2	31.5	31.7	31.7	32.2	32.4
28-Mar-06	1200	20.9	26.8	31.2	31.5	31.5	32.2	32.2
11-Apr-06	1200	26.6	29.3	31.2	31.5	31.5	32.2	32.2
28-Apr-06	1200	23.6	28.0	31.0	31.5	31.7	32.2	32.4
11-May-06	1200	34.2	30.5	31.1	31.4	31.6	32.1	32.3
28-May-06	1200	56.2	31.1	31.2	31.4	31.6	32.1	32.3
11-Jun-06	1200	48.0	32.4	31.2	31.6	31.6	32.1	32.3
28-Jun-06	1200	47.0	36.7	31.3	31.5	31.5	32.2	32.4
11-Jul-06	1200	74.5	42.5	31.4	31.6	31.6	32.1	32.3

HATTENBURG DILLEY & LINNELL
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Borehole B-6

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface									
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft
11-Dec-04	1500	30.0	31.8	31.7	31.5	31.8	31.5	31.7	31.7	31.8	31.7
28-Dec-04	1500	29.1	31.6	31.6	31.5	31.6	31.5	31.6	31.5	31.6	31.6
11-Jan-05	1500	18.9	31.6	31.8	31.4	31.8	31.4	31.8	31.6	31.8	31.6
28-Jan-05	1500	22.8	31.4	31.8	31.4	31.8	31.4	31.8	31.8	31.6	31.6
11-Feb-05	1500	17.6	28.9	31.7	31.3	31.7	31.5	31.7	32.0	31.7	31.7
28-Feb-05	1500	22.4	30.4	31.6	31.3	31.6	31.5	31.6	32.4	31.6	31.6
11-Mar-05	1500	27.2	29.8	31.6	31.5	31.6	31.5	31.6	32.5	31.6	31.6
28-Mar-05	1500	24.2	29.7	31.7	31.5	31.7	31.5	31.7	32.6	31.9	31.7
11-Apr-05	1500	22.2	27.3	31.6	31.5	31.6	31.5	31.6	32.5	31.8	31.6
28-Apr-05	1500	30.4	29.9	31.7	31.5	31.8	31.5	31.7	32.6	32.0	31.7
11-May-05	1500	34.8	30.9	31.6	31.4	31.7	31.4	31.7	32.6	32.3	31.7
28-May-05	1500	44.4	31.2	31.6	31.4	31.7	31.4	31.7	32.4	32.3	31.9
11-Jun-05	1500	47.9	31.5	31.5	31.5	31.9	31.5	31.7	32.6	32.2	32.0
28-Jun-05	1500	67.3	35.4	31.6	31.5	31.6	31.5	31.6	32.5	32.2	32.0
11-Jul-05	1500	51.6	37.8	31.7	31.5	31.7	31.5	31.7	32.4	32.2	32.0
28-Jul-05	1500	56.9	43.7	31.6	31.4	31.6	31.4	31.6	32.2	32.1	31.9
11-Aug-05	1500	57.7	44.3	33.4	31.4	31.6	31.3	31.6	32.3	32.0	32.0
28-Aug-05	1500	50.4	44.8	35.6	31.3	31.7	31.3	31.5	32.4	31.9	31.9
11-Sep-05	1500	53.9	43.1	35.8	31.3	31.7	31.3	31.5	32.0	31.9	31.9
28-Sep-05	1500	49.1	42.0	36.1	31.5	31.7	31.3	31.7	32.0	31.9	31.9
11-Oct-05	1500	32.1	37.3	34.5	31.4	31.7	31.4	31.6	32.1	31.7	31.9
28-Oct-05	1500	22.5	32.8	32.8	31.5	31.7	31.4	31.7	32.1	31.7	31.9
11-Nov-05	1500	17.3	31.7	31.9	31.5	31.7	31.3	31.7	32.0	31.7	31.9
28-Nov-05	1200	27.7	29.9	31.6	31.4	31.7	31.2	31.6	31.9	31.6	31.7
11-Dec-05	1200	11.8	30.3	31.5	31.5	31.7	31.4	31.5	31.9	31.5	31.7
28-Dec-05	1200	19.3	28.7	31.5	31.5	31.7	31.5	31.5	31.9	31.5	31.7
11-Jan-06	1200	8.2	27.2	31.5	31.3	31.7	31.5	31.5	31.9	31.5	31.7
28-Jan-06	1200	-1.9	19.1	31.4	31.4	32.4	31.9	31.5	31.9	31.5	31.7
11-Feb-06	1200	25.5	27.1	30.9	31.3	33.0	32.3	31.6	31.8	31.6	31.8
28-Feb-06	1200	11.0	28.4	31.7	31.4	33.6	33.6	31.6	31.7	31.7	31.7
11-Mar-06	1200	22.2	25.4	31.5	31.9	33.8	34.1	31.7	31.7	31.7	31.7
28-Mar-06	1200	19.8	25.4	31.2	32.2	34.0	34.5	31.5	31.5	31.5	31.7
11-Apr-06	1200	27.0	28.6	31.4	32.4	34.0	34.8	31.5	31.7	31.5	31.7
28-Apr-06	1200	25.2	27.8	31.0	32.8	33.8	35.0	31.7	31.5	31.7	31.7
11-May-06	1200	32.7	30.2	31.2	32.7	33.5	35.0	31.6	31.6	31.6	31.8
28-May-06	1200	58.1	30.9	31.4	32.5	33.4	35.0	31.6	31.4	31.4	31.8
11-Jun-06	1200	48.8	32.1	31.4	32.4	33.3	35.0	31.7	31.6	31.6	31.7
28-Jun-06	1200	47.0	37.3	31.5	32.6	33.1	34.9	31.7	31.5	31.5	31.7
11-Jul-06	1200	66.6	44.7	31.6	32.5	33.0	34.8	31.7	31.6	31.4	31.7

HATTENBURG DILLEY & LINNELL
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Borehole B-7

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface										
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft	20.3 ft
11-Dec-04	1500	28.7	31.5	31.5	31.5	31.3	31.3	31.3	31.1	31.1	31.1	30.9
28-Dec-04	1500	25.6	31.3	31.5	31.6	31.3	31.3	31.3	31.1	31.1	31.1	30.9
11-Jan-05	1500	16.6	31.2	31.4	31.6	31.2	31.4	31.2	31.0	31.2	31.0	30.9
28-Jan-05	1500	16.6	30.7	31.4	31.6	31.2	31.2	31.2	31.2	31.2	31.0	30.9
11-Feb-05	1500	13.0	26.6	31.2	31.4	31.2	31.2	31.2	31.1	31.1	31.1	30.9
28-Feb-05	1500	19.7	29.2	31.2	31.4	31.2	31.2	31.2	31.1	31.1	31.1	30.9
11-Mar-05	1500	25.7	28.7	31.2	31.4	31.2	31.2	31.2	31.0	31.0	31.0	30.9
28-Mar-05	1500	22.7	28.5	31.1	31.5	31.1	31.3	31.1	31.1	31.1	30.9	30.7
11-Apr-05	1500	20.1	24.9	30.5	31.4	31.2	31.2	31.2	31.0	31.0	30.8	30.7
28-Apr-05	1500	30.5	28.5	29.8	31.4	31.1	31.1	31.3	31.1	31.1	30.9	30.7
11-May-05	1500	35.1	30.1	30.4	31.3	31.0	31.1	31.1	31.0	31.0	31.0	30.8
28-May-05	1500	40.5	30.6	30.6	31.3	31.1	31.1	31.1	31.0	31.0	31.0	30.8
11-Jun-05	1500	43.7	30.8	30.8	31.3	31.1	31.1	31.1	31.1	31.1	30.9	30.8
28-Jun-05	1500	57.2	31.9	30.8	31.4	31.2	31.2	31.2	31.0	31.0	31.0	30.8
11-Jul-05	1500	48.8	33.0	30.9	31.3	31.1	31.1	31.1	30.9	30.9	30.9	30.8
28-Jul-05	1500	53.6	37.3	31.0	31.3	31.1	31.1	31.3	31.1	31.1	31.0	30.8
11-Aug-05	1500	54.5	38.7	31.1	31.3	31.1	31.1	31.1	31.0	31.0	31.0	30.8
28-Aug-05	1500	49.4	39.7	31.5	31.3	31.1	31.1	31.1	31.1	31.1	30.9	30.8
11-Sep-05	1500	49.8	39.0	31.8	31.3	31.1	31.1	31.1	30.9	30.9	30.9	30.8
28-Sep-05	1500	45.9	38.7	32.2	31.5	31.1	31.3	31.3	31.1	31.1	31.1	30.9
11-Oct-05	1500	35.8	34.8	31.9	31.4	31.2	31.2	31.2	31.0	31.2	31.0	30.9
28-Oct-05	1500	26.4	32.0	31.5	31.3	31.1	31.1	31.1	30.9	30.9	30.9	30.8
11-Nov-05	1500	20.9	31.3	31.5	31.5	31.3	31.3	31.5	31.1	31.1	31.1	30.9
28-Nov-05	1200	26.7	30.8	31.4	31.5	31.2	31.2	31.2	31.2	31.2	31.0	31.0
11-Dec-05	1200	19.3	30.7	31.2	31.4	31.1	31.1	31.2	31.1	31.1	30.9	30.9
28-Dec-05	1200	22.3	30.0	31.5	31.5	31.1	31.3	31.3	31.1	31.1	31.1	30.9
11-Jan-06	1200	20.1	28.9	31.3	31.3	31.2	31.2	31.2	31.2	31.2	31.0	30.8
28-Jan-06	1200	4.4	23.0	31.2	31.4	31.2	31.2	31.2	31.0	31.0	31.0	30.9
11-Feb-06	1200	26.3	27.6	31.2	31.3	31.2	31.2	31.3	31.2	31.2	31.0	30.8
28-Feb-06	1200	19.1	28.8	31.2	31.3	31.2	31.2	31.2	31.2	31.2	31.0	30.8
11-Mar-06	1200	21.0	25.7	30.8	31.3	31.2	31.2	31.2	31.0	31.2	31.0	30.8
28-Mar-06	1200	18.9	24.8	30.4	31.3	31.1	31.1	31.1	31.1	31.1	30.9	30.9
11-Apr-06	1200	27.3	28.2	30.3	31.3	31.2	31.2	31.3	31.2	31.2	31.0	30.8
28-Apr-06	1200	23.6	26.4	29.5	31.3	30.9	31.1	31.1	31.1	30.9	30.9	30.8
11-May-06	1200	31.5	29.5	29.8	31.3	31.1	31.1	31.3	31.1	30.9	30.9	30.7
28-May-06	1200	45.2	30.2	30.4	31.1	30.9	30.9	31.1	30.9	30.9	30.9	30.8
11-Jun-06	1200	44.5	30.9	30.7	31.2	31.0	31.2	31.2	31.0	31.0	31.0	30.9
28-Jun-06	1200	45.3	31.8	30.7	31.1	31.1	31.1	31.1	30.9	31.1	30.9	30.7
11-Jul-06	1200	61.4	35.0	30.7	31.2	31.0	31.0	31.2	31.0	31.0	30.9	30.7
28-Jul-06	1200	50.3	37.7	30.9	31.3	31.1	31.1	31.3	31.1	31.1	30.9	30.9
11-Aug-06	1200	53.3	38.5	31.1	31.3	31.1	31.1	31.3	31.1	31.1	30.9	30.9
28-Aug-06	1200	51.6	38.5	31.3	31.3	31.1	31.1	31.1	31.1	31.1	30.9	30.9
11-Sep-06	1200	54.4	39.9	31.8	31.1	31.1	31.1	31.1	30.9	30.9	30.9	30.8
28-Sep-06	1200	41.1	37.5	32.6	31.2	31.0	31.0	31.0	31.0	31.0	30.9	30.9
11-Oct-06	1200	38.2	34.8	32.4	31.4	31.2	31.0	31.2	31.0	31.0	30.9	30.9

HATTENBURG DILLEY & LINNELL
Engineering Consultants

Borehole B-8

Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface										
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft	20.3 ft
11-Dec-04	1500	16.0	31.5	31.7	31.7	31.5	31.5	31.3	31.7	31.5	31.7	31.7
28-Dec-04	1500	11.9	31.5	31.6	31.6	31.5	31.6	31.5	31.6	31.5	31.6	31.6
11-Jan-05	1500	2.0	31.4	31.6	31.6	31.4	31.6	31.4	31.6	31.6	31.7	31.6
28-Jan-05	1500	1.6	30.9	31.6	31.6	31.4	31.6	31.4	31.6	31.6	31.7	31.7
11-Feb-05	1500	19.7	27.0	31.6	31.6	31.4	31.6	31.4	31.6	31.4	31.6	31.6
28-Feb-05	1500	16.1	29.6	31.6	31.6	31.4	31.6	31.2	31.6	31.4	31.6	31.6
11-Mar-05	1500	42.0	29.0	31.6	31.4	31.4	31.4	31.2	31.6	31.4	31.6	31.6
28-Mar-05	1500	17.9	28.9	31.5	31.5	31.3	31.5	31.3	31.5	31.5	31.6	31.6
11-Apr-05	1500	38.4	26.1	31.2	31.4	31.4	31.4	31.2	31.4	31.4	31.6	31.6
28-Apr-05	1500	59.3	29.3	31.3	31.4	31.3	31.4	31.3	31.4	31.4	31.6	31.8
11-May-05	1500	74.4	30.4	31.3	31.3	31.3	31.3	31.1	31.5	31.3	31.5	32.0
28-May-05	1500	74.7	30.8	31.3	31.3	31.3	31.3	31.1	31.5	31.3	31.5	32.2
11-Jun-05	1500	58.4	31.3	31.3	31.5	31.3	31.5	31.3	31.5	31.3	31.5	32.3
28-Jun-05	1500	81.1	33.5	31.4	31.4	31.4	31.6	31.4	31.6	31.4	31.7	32.3
11-Jul-05	1500	56.0	35.7	31.3	31.3	31.3	31.5	31.3	31.5	31.3	31.5	32.2
28-Jul-05	1500	60.5	40.3	31.5	31.5	31.3	31.5	31.3	31.5	31.5	31.5	32.2
11-Aug-05	1500	60.6	40.9	31.5	31.3	31.3	31.5	31.3	31.5	31.3	31.5	32.0
28-Aug-05	1500	50.8	41.8	32.2	31.5	31.3	31.5	31.3	31.5	31.5	31.5	32.0
11-Sep-05	1500	56.6	40.9	33.0	31.3	31.3	31.5	31.3	31.5	31.3	31.5	32.0
28-Sep-05	1500	51.4	40.3	33.7	31.5	31.5	31.5	31.3	31.6	31.5	31.6	32.0
11-Oct-05	1500	41.1	36.1	33.0	31.4	31.4	31.6	31.4	31.6	31.4	31.6	31.9
28-Oct-05	1500	22.5	32.4	32.0	31.3	31.3	31.5	31.1	31.5	31.3	31.7	31.8
11-Nov-05	1500	16.2	31.5	31.8	31.5	31.5	31.7	31.3	31.7	31.5	32.0	32.0
28-Nov-05	1200	30.5	31.0	31.5	31.4	31.4	31.5	31.4	31.5	31.4	32.1	31.9
11-Dec-05	1200	8.4	31.1	31.6	31.2	31.2	31.4	31.2	31.4	31.4	31.9	31.8
28-Dec-05	1200	17.0	30.4	31.7	31.5	31.5	31.5	31.3	31.5	31.5	32.4	31.8
11-Jan-06	1200		29.3	31.5	31.3	31.3	31.5	31.3	31.5	31.3	32.4	31.9
28-Jan-06	1200		26.3	31.6	31.4	31.4	31.6	31.2	31.6	31.4	32.4	31.7
11-Feb-06	1200	23.4	28.8	31.5	31.3	31.3	31.5	31.3	31.5	31.3	32.4	31.7
28-Feb-06	1200	12.0	29.7	31.3	31.3	31.3	31.5	31.2	31.5	31.3	32.4	31.7
11-Mar-06	1200	28.6	26.7	31.3	31.2	31.3	31.5	31.2	31.5	31.3	32.4	31.7
28-Mar-06	1200	33.4	26.0	31.3	31.3	31.3	31.5	31.3	31.5	31.3	32.4	31.7
11-Apr-06	1200	33.6	29.2	31.2	31.3	31.3	31.5	31.3	31.5	31.3	32.4	31.7
28-Apr-06	1200	24.8	28.6	30.9	31.1	31.3	31.3	31.1	31.3	31.3	32.2	31.7
11-May-06	1200	41.9	30.2	31.1	31.3	31.3	31.5	31.3	31.5	31.3	32.2	31.6
28-May-06	1200	67.1	30.8	31.1	31.1	31.1	31.3	31.1	31.3	31.1	32.0	
11-Jun-06	1200	47.6	31.6	31.2	31.2	31.4	31.6	31.2	31.4	31.4	32.1	31.6
28-Jun-06	1200	49.9	34.7	31.3	31.1	31.3	31.4	31.1	31.4	31.4	32.0	31.4
11-Jul-06	1200	76.8	40.2	31.4	31.2	31.4	31.4	31.2	31.4	31.6	31.9	31.6
28-Jul-06	1200	55.4	42.0	31.6	31.1	31.3	31.5	31.3	31.5	31.6	32.0	31.5
11-Aug-06	1200	62.8	41.9	32.0	31.3	31.3	31.5	31.3	31.5	31.8	32.0	31.6
28-Aug-06	1200	56.5	41.0	33.2	31.1	31.3	31.5	31.1	31.5	31.8	31.8	31.6
11-Sep-06	1200	65.1	42.0	35.0	31.1	31.3	31.5	31.1	31.3	31.8	31.8	31.6
28-Sep-06	1200	50.0	39.1	35.6	31.2	31.2	31.4	31.0	31.4	31.7	31.7	31.6
11-Oct-06	1200	58.6	35.5	34.5	31.2	31.4	31.4	31.2	31.4	31.9	31.7	31.6

HATTENBURG DILLEY & LINNELL
Engineering Consultants

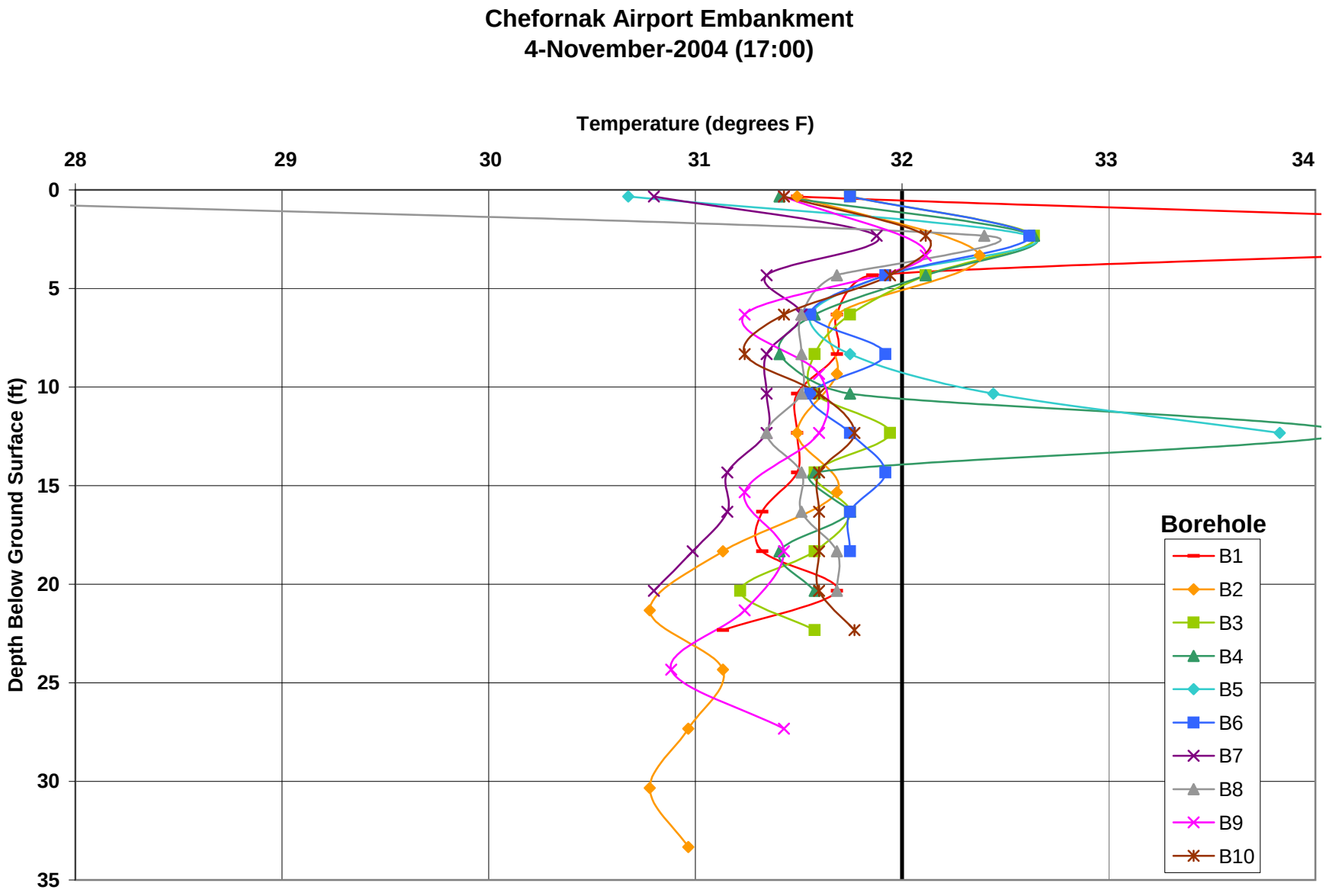
Borehole B-9

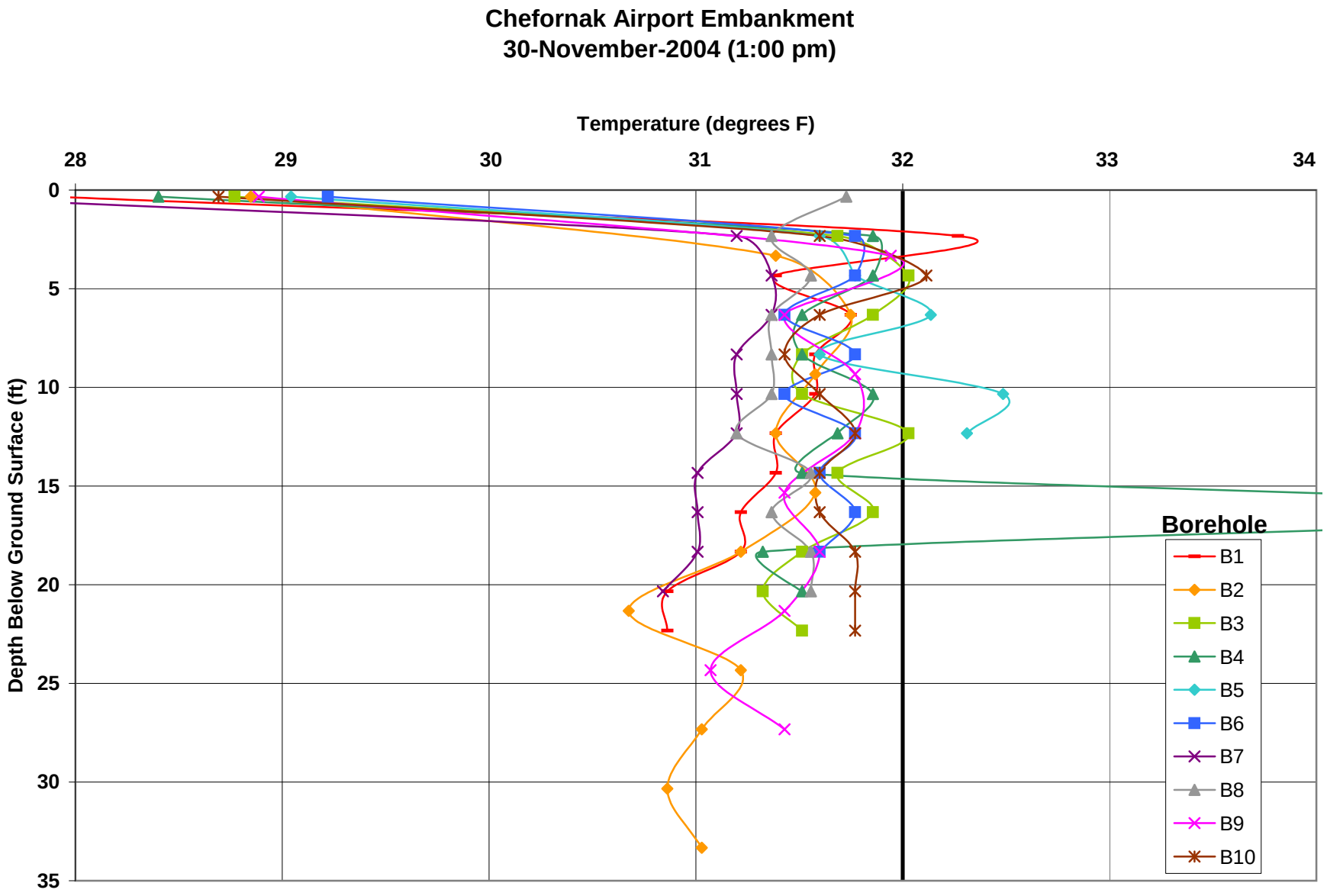
Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface									
		0.3 ft	3.3 ft	6.3 ft	9.3 ft	12.3 ft	15.3 ft	18.3 ft	21.3 ft	24.3 ft	27.3 ft
11-Dec-04	1500	29.7	31.8	31.3	31.6	31.8	31.3	31.5	31.3	30.9	31.5
28-Dec-04	1500	25.9	31.9	31.3	31.7	31.7	31.3	31.5	31.3	31.0	31.5
11-Jan-05	1500	16.2	31.8	31.3	31.6	31.6	31.3	31.4	31.3	30.9	31.4
28-Jan-05	1500	16.5	31.8	31.3	31.6	31.6	31.3	31.4	31.3	30.9	31.4
11-Feb-05	1500	15.2	31.6	31.4	31.6	31.7	31.2	31.4	31.2	30.9	31.4
28-Feb-05	1500	18.2	31.6	31.3	31.6	31.6	31.3	31.5	31.3	30.9	31.5
11-Mar-05	1500	27.4	31.4	31.4	31.6	31.6	31.2	31.4	31.2	30.9	31.4
28-Mar-05	1500	23.0	31.3	31.3	31.7	31.7	31.3	31.5	31.3	31.0	31.3
11-Apr-05	1500	21.6	29.8	31.4	31.6	31.7	31.4	31.6	31.4	31.0	31.4
28-Apr-05	1500	31.5	30.4	31.3	31.5	31.6	31.3	31.5	31.3	30.9	31.3
11-May-05	1500	37.9	31.2	31.3	31.5	31.7	31.3	31.5	31.3	31.0	31.3
28-May-05	1500	44.6	31.3	31.3	31.5	31.7	31.3	31.5	31.3	31.0	31.3
11-Jun-05	1500	46.6	31.5	31.3	31.5	31.7	31.3	31.3	31.3	30.9	31.3
28-Jun-05	1500	63.0	31.5	31.4	31.5	31.7	31.2	31.4	31.4	31.0	31.4
11-Jul-05	1500	50.7	31.7	31.3	31.5	31.7	31.3	31.5	31.3	30.9	31.3
28-Jul-05	1500	55.5	32.2	31.2	31.5	31.5	31.2	31.3	31.3	31.0	31.3
11-Aug-05	1500	56.8	33.6	31.2	31.6	31.6	31.2	31.4	31.2	30.9	31.4
28-Aug-05	1500	50.3	35.5	31.3	31.5	31.7	31.3	31.5	31.3	30.9	31.5
11-Sep-05	1500	51.1	35.7	31.3	31.5	31.7	31.3	31.5	31.3	30.9	31.5
28-Sep-05	1500	47.4	35.9	31.4	31.6	31.7	31.2	31.4	31.4	31.0	31.4
11-Oct-05	1500	36.1	34.1	31.4	31.6	31.8	31.2	31.4	31.4	31.1	31.4
28-Oct-05	1500	26.3	32.6	31.4	31.5	31.7	31.4	31.5	31.4	31.0	31.5
11-Nov-05	1500	21.3	31.9	31.3	31.5	31.7	31.3	31.5	31.3	31.0	31.3
28-Nov-05	1200	28.7	31.9	31.4	31.6	31.7	31.2	31.4	31.4	31.0	31.4
11-Dec-05	1200	20.3	31.8	31.3	31.5	31.6	31.3	31.5	31.3	30.9	31.5
28-Dec-05	1200	25.3	31.7	31.3	31.5	31.7	31.2	31.3	31.3	31.0	31.3
11-Jan-06	1200	25.7	31.7	31.2	31.6	31.6	31.2	31.4	31.2	30.8	31.4
28-Jan-06	1200	16.1	31.7	31.4	31.5	31.7	31.4	31.4	31.4	31.0	31.4
11-Feb-06	1200	20.7	31.6	31.2	31.4	31.6	31.2	31.4	31.2	30.9	31.4
28-Feb-06	1200	20.7	31.6	31.2	31.4	31.6	31.2	31.4	31.2	30.9	31.4
11-Mar-06	1200	23.1	31.2	31.2	31.4	31.6	31.2	31.4	31.2	30.9	31.4
28-Mar-06	1200	21.1	30.6	31.2	31.5	31.5	31.2	31.3	31.3	31.0	31.3
11-Apr-06	1200	28.2	31.0	31.2	31.4	31.5	31.2	31.4	31.2	31.0	31.4
28-Apr-06	1200	25.7	30.6	31.3	31.5	31.7	31.3	31.3	31.3	31.0	31.3
11-May-06	1200	32.6	31.2	31.4	31.6	31.8	31.2	31.4	31.4	31.1	31.4
28-May-06	1200	51.6	31.5	31.3	31.5	31.7	31.3	31.3	31.3	30.9	31.3
11-Jun-06	1200	47.6	31.5	31.3	31.5	31.6	31.3	31.3	31.3	30.9	31.3
28-Jun-06	1200	47.2	31.6	31.3	31.5	31.6	31.3	31.5	31.3	30.9	31.3
11-Jul-06	1200	62.4	32.0	31.3	31.5	31.7	31.3	31.5	31.3	31.0	31.3
28-Jul-06	1200	51.5	33.4	31.2	31.6	31.7	31.2	31.4	31.4	31.0	31.4
11-Aug-06	1200	56.4	35.0	31.3	31.5	31.7	31.3	31.5	31.3	30.9	31.3
28-Aug-06	1200	52.8	37.0	31.4	31.6	31.7	31.2	31.4	31.2	31.0	31.4
11-Sep-06	1200	55.3	38.5	31.3	31.5	31.6	31.3	31.5	31.3	30.9	31.3
28-Sep-06	1200	41.1	37.8	31.2	31.4	31.6	31.2	31.4	31.2	30.9	31.2
11-Oct-06	1200	40.1	35.6	31.4	31.6	31.6	31.2	31.4	31.2	30.9	31.2

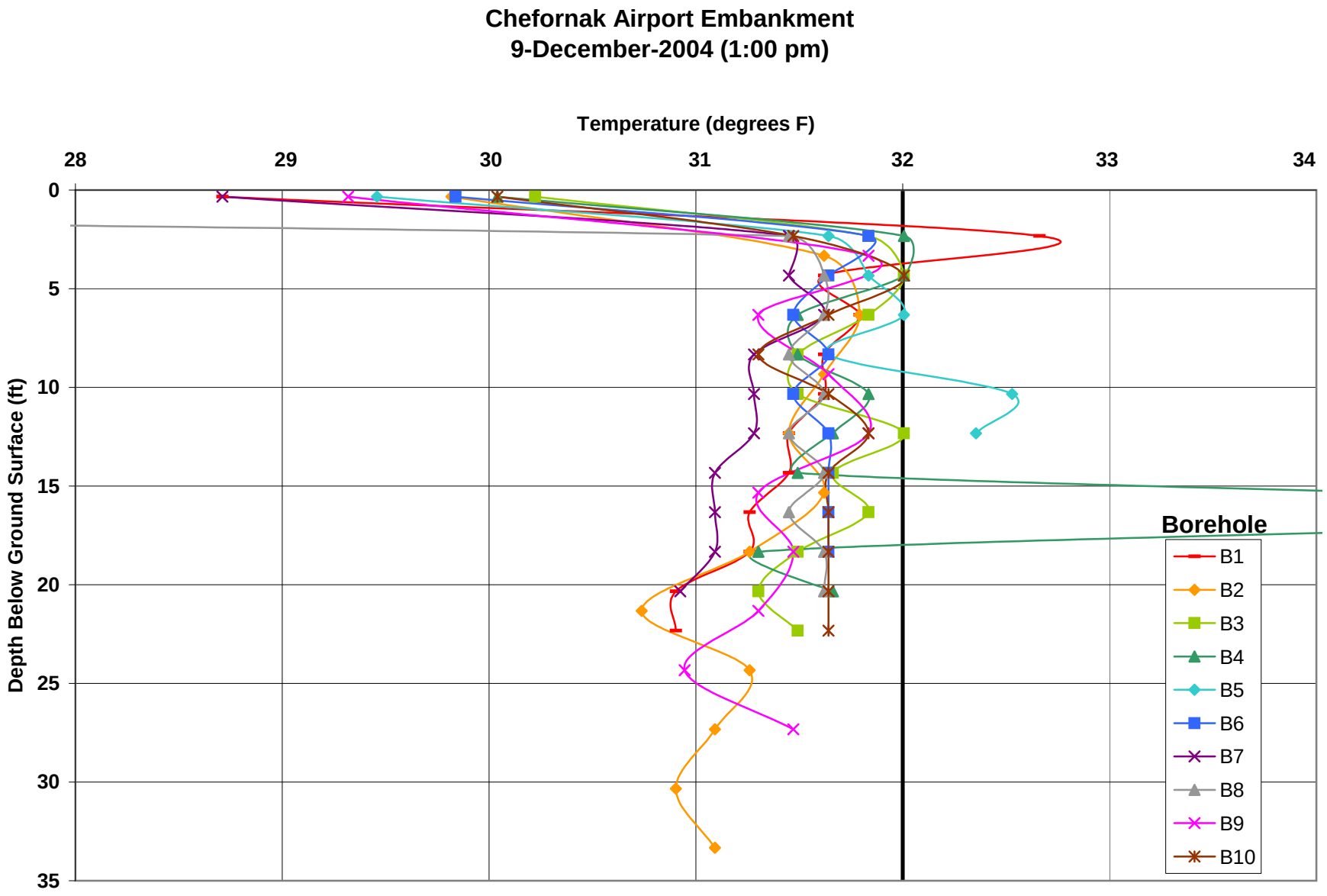
HATTENBURG DILLEY & LINNELL
Engineering Consultants

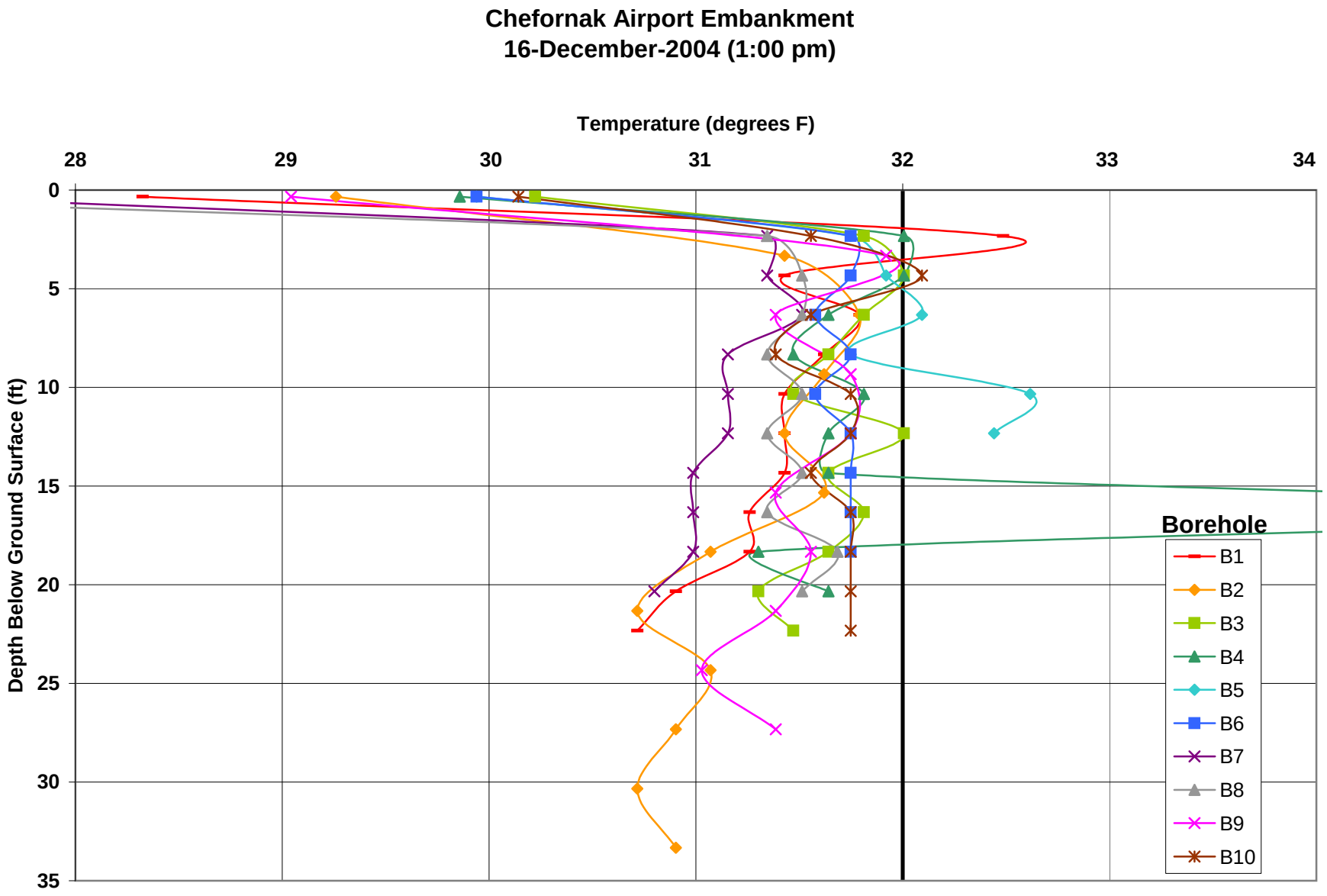
Borehole B-10

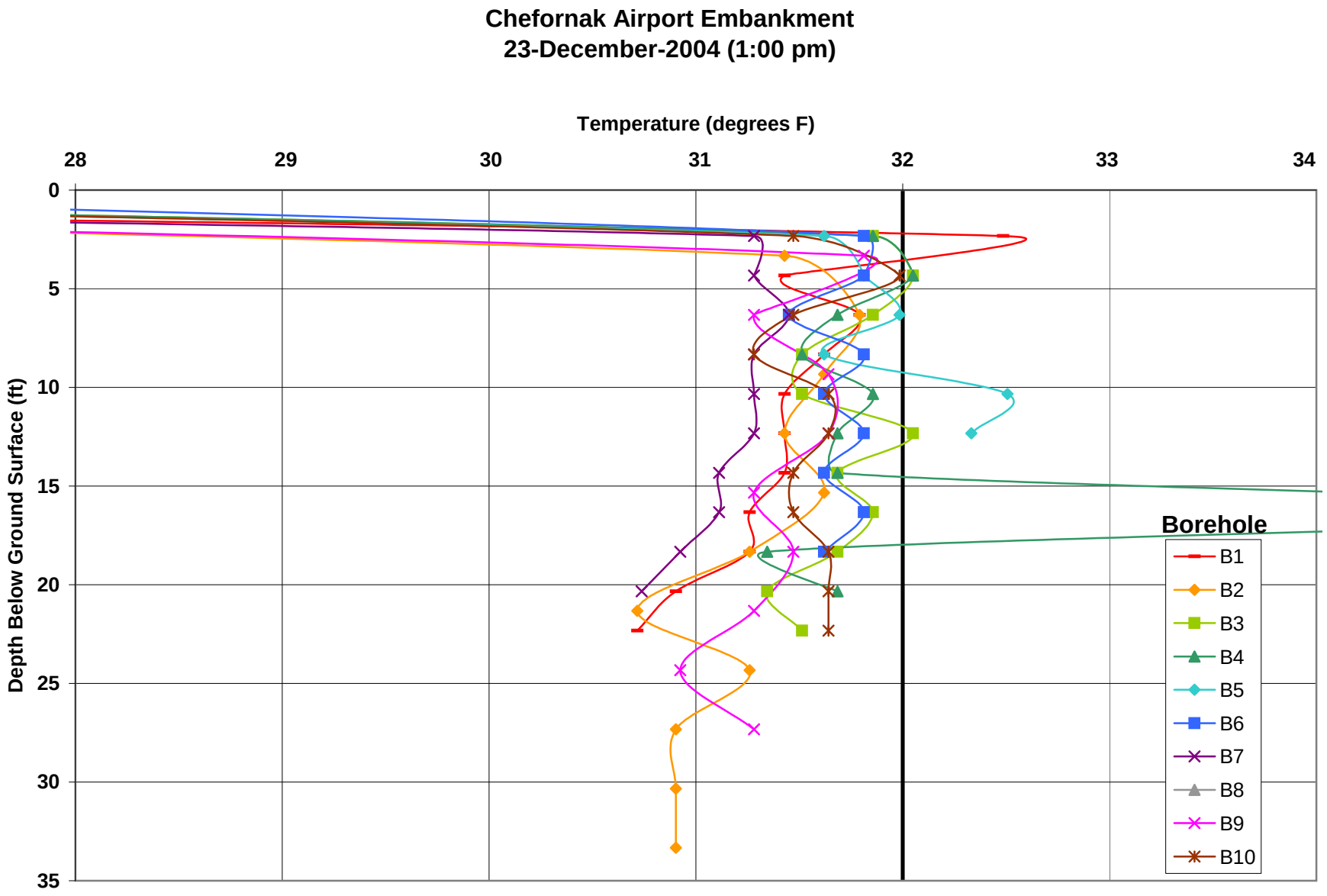
Day	Time	Ground Temperature (°F) at Predetermined Depths Below Ground Surface											
		0.3 ft	2.3 ft	4.3 ft	6.3 ft	8.3 ft	10.3 ft	12.3 ft	14.3 ft	16.3 ft	18.3 ft	20.3 ft	22.3 ft
11-Dec-04	1500	30.0	31.5	32.0	31.6	31.3	31.6	31.8	31.6	31.6	31.6	31.6	31.6
28-Dec-04	1500	28.0	31.5	32.0	31.5	31.3	31.7	31.7	31.7	31.7	31.7	31.7	31.7
11-Jan-05	1500	17.5	31.3	32.0	31.4	31.3	31.6	31.6	31.4	31.6	31.6	31.6	31.6
28-Jan-05	1500	26.2	31.3	32.0	31.6	31.3	31.6	31.6	31.6	31.6	31.6	31.6	31.6
11-Feb-05	1500	19.3	30.0	31.9	31.6	31.2	31.6	31.7	31.6	31.6	31.6	31.6	31.6
28-Feb-05	1500	24.4	30.8	32.0	31.6	31.3	31.6	31.6	31.5	31.6	31.6	31.6	31.6
11-Mar-05	1500	27.6	30.2	31.9	31.6	31.2	31.6	31.8	31.6	31.6	31.6	31.6	31.6
28-Mar-05	1500	24.7	29.9	32.0	31.7	31.3	31.7	31.7	31.5	31.7	31.7	31.7	31.7
11-Apr-05	1500	23.1	28.1	31.9	31.6	31.4	31.7	31.7	31.6	31.7	31.7	31.7	31.7
28-Apr-05	1500	31.1	29.8	31.8	31.5	31.3	31.6	31.6	31.5	31.5	31.6	31.6	31.6
11-May-05	1500	38.5	30.8	31.9	31.5	31.3	31.7	31.7	31.5	31.7	31.7	31.7	31.9
28-May-05	1500	47.0	31.0	31.9	31.5	31.3	31.7	31.7	31.5	31.5	31.7	31.7	31.7
11-Jun-05	1500	49.1	31.5	31.8	31.5	31.3	31.7	31.7	31.5	31.5	31.7	31.7	31.7
28-Jun-05	1500	66.4	35.1	31.9	31.5	31.2	31.7	31.7	31.5	31.5	31.7	31.7	31.7
11-Jul-05	1500	51.8	37.3	31.8	31.5	31.3	31.7	31.7	31.5	31.7	31.7	31.7	31.7
28-Jul-05	1500	57.2	42.3	32.0	31.5	31.3	31.5	31.7	31.5	31.5	31.7	31.5	31.7
11-Aug-05	1500	56.8	43.1	32.6	31.6	31.4	31.6	31.8	31.6	31.6	31.6	31.6	31.8
28-Aug-05	1500	50.8	43.1	33.9	31.7	31.5	31.7	31.8	31.7	31.7	31.7	31.7	31.7
11-Sep-05	1500	54.7	41.7	34.2	31.7	31.3	31.7	31.8	31.5	31.7	31.7	31.7	31.7
28-Sep-05	1500	49.6	40.8	34.6	31.6	31.4	31.7	31.7	31.6	31.6	31.7	31.6	31.6
11-Oct-05	1500	37.7	36.4	33.6	31.6	31.4	31.6	31.8	31.6	31.6	31.8	31.6	31.6
28-Oct-05	1500	26.7	32.6	32.6	31.7	31.4	31.7	31.7	31.5	31.5	31.7	31.7	31.5
11-Nov-05	1500	22.8	31.5	32.0	31.7	31.3	31.7	31.7	31.5	31.5	31.7	31.7	31.5
28-Nov-05	1200	28.7	30.7	31.9	31.6	31.4	31.6	31.7	31.6	31.6	31.7	31.6	31.6
11-Dec-05	1200	16.3	30.9	32.0	31.6	31.3	31.6	31.6	31.5	31.5	31.6	31.6	31.5
28-Dec-05	1200	24.9	30.6	31.9	31.5	31.3	31.5	31.7	31.5	31.5	31.7	31.5	31.5
11-Jan-06	1200	23.3	30.3	31.9	31.6	31.2	31.6	31.6	31.4	31.6	31.6	31.6	31.4
28-Jan-06	1200	11.0	26.9	31.9	31.7	31.4	31.7	31.7	31.5	31.5	31.7	31.5	31.5
11-Feb-06	1200	28.1	29.2	31.9	31.5	31.4	31.5	31.7	31.5	31.5	31.5	31.5	31.5
28-Feb-06	1200	17.9	30.1	31.9	31.6	31.2	31.6	31.7	31.6	31.6	31.6	31.6	31.6
11-Mar-06	1200	23.3	27.8	31.8	31.6	31.2	31.6	31.6	31.4	31.6	31.6	31.6	31.6
28-Mar-06	1200	22.2	27.5	31.7	31.5	31.3	31.5	31.7	31.5	31.5	31.7	31.5	31.5
11-Apr-06	1200	28.1	29.6	31.7	31.5	31.4	31.5	31.7	31.5	31.5	31.5	31.5	31.5
28-Apr-06	1200	25.1	28.6	31.7	31.7	31.5	31.7	31.7	31.5	31.5	31.5	31.5	31.5
11-May-06	1200	33.1	30.5	31.8	31.8	31.4	31.8	31.8	31.6	31.6	31.8	31.6	31.6
28-May-06	1200	60.3	31.1	31.8	31.7	31.3	31.7	31.7	31.5	31.5	31.7	31.7	31.5
11-Jun-06	1200	48.1	32.3	31.8	31.6	31.3	31.6	31.6	31.5	31.5	31.6	31.6	31.5
28-Jun-06	1200	47.5	36.4	31.8	31.6	31.5	31.6	31.6	31.5	31.6	31.6	31.6	31.5
11-Jul-06	1200	73.1	42.7	31.9	31.7	31.3	31.7	31.7	31.5	31.7	31.7	31.7	31.5
28-Jul-06	1200	51.9	42.4	32.2	31.6	31.4	31.7	31.7	31.6	31.6	31.7	31.6	31.4
11-Aug-06	1200	55.8	42.0	32.9	31.7	31.3	31.7	31.7	31.5	31.5	31.7	31.7	31.5
28-Aug-06	1200	53.0	41.6	35.9	31.7	31.4	31.7	31.7	31.6	31.6	31.7	31.6	31.4
11-Sep-06	1200	56.5	43.1	36.6	31.8	31.5	31.6	31.8	31.6	31.6	31.6	31.6	31.5
28-Sep-06	1200	41.4	38.4	36.6	31.8	31.2	31.6	31.6	31.4	31.6	31.6	31.6	31.4
11-Oct-06	1200	44.7	35.0	35.0	31.8	31.4	31.6	31.8	31.6	31.6	31.6	31.6	31.4

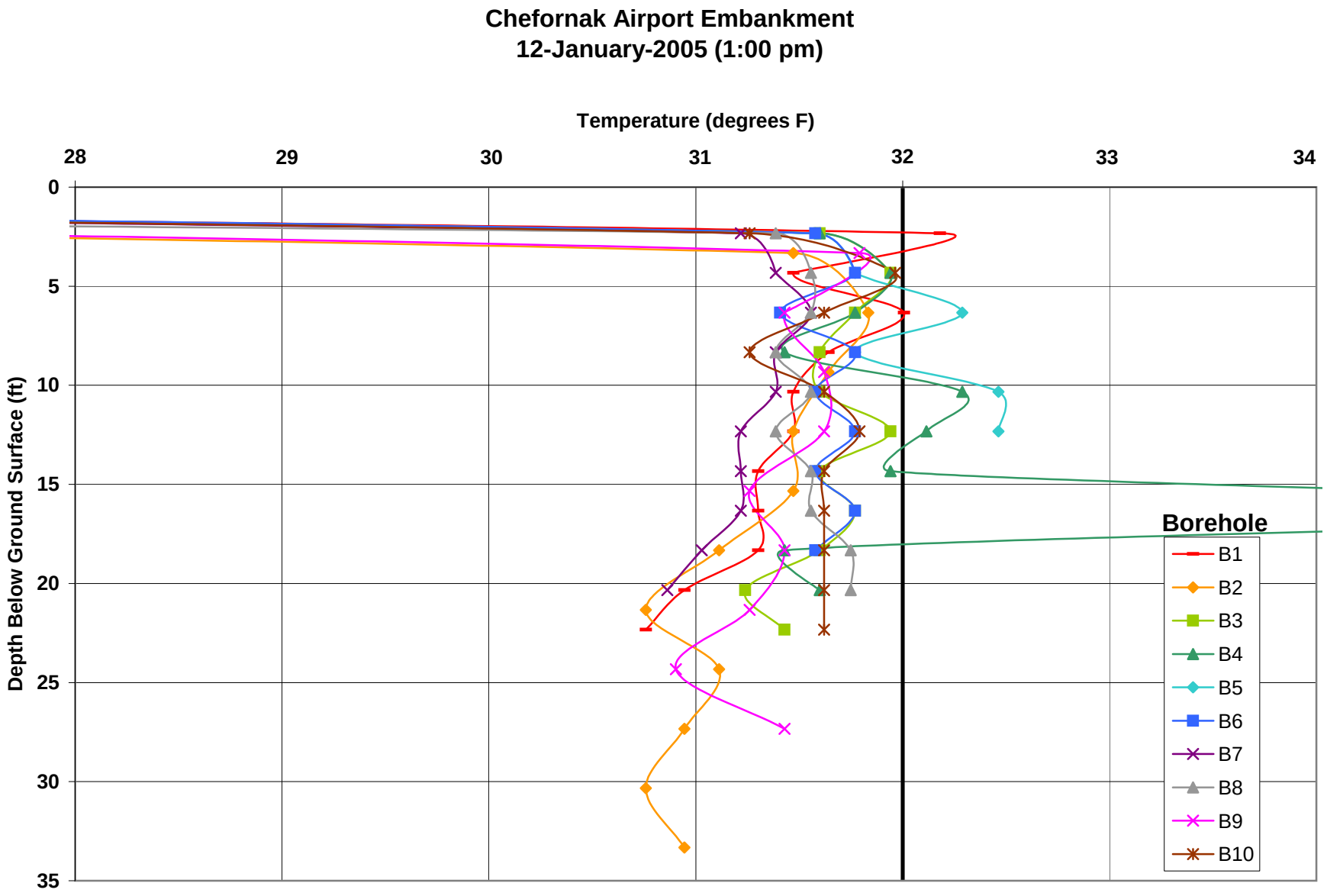

Chefornak Airport Embankment
4-November-2004 (17:00)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

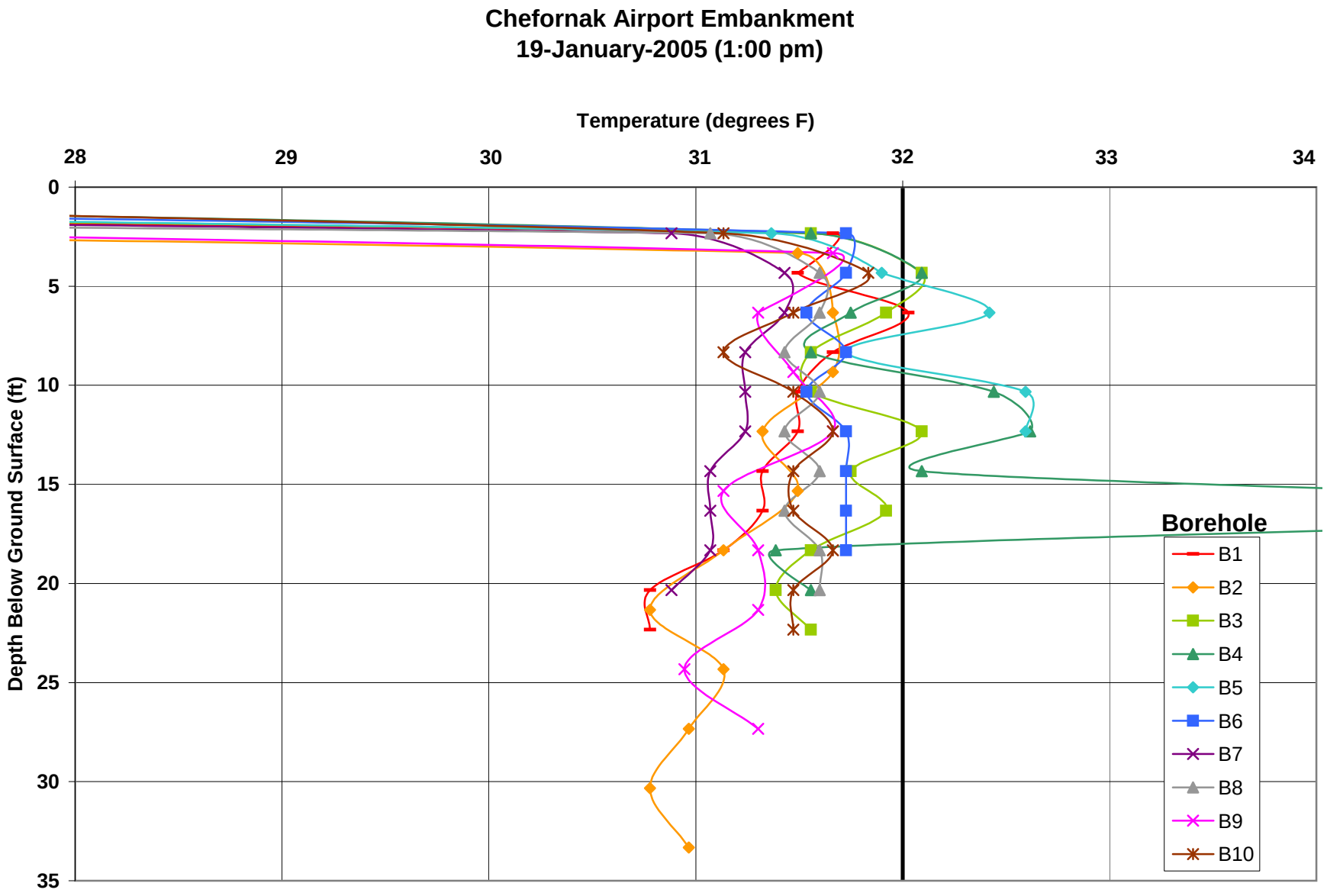

Chefornak Airport Embankment
30-November-2004 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

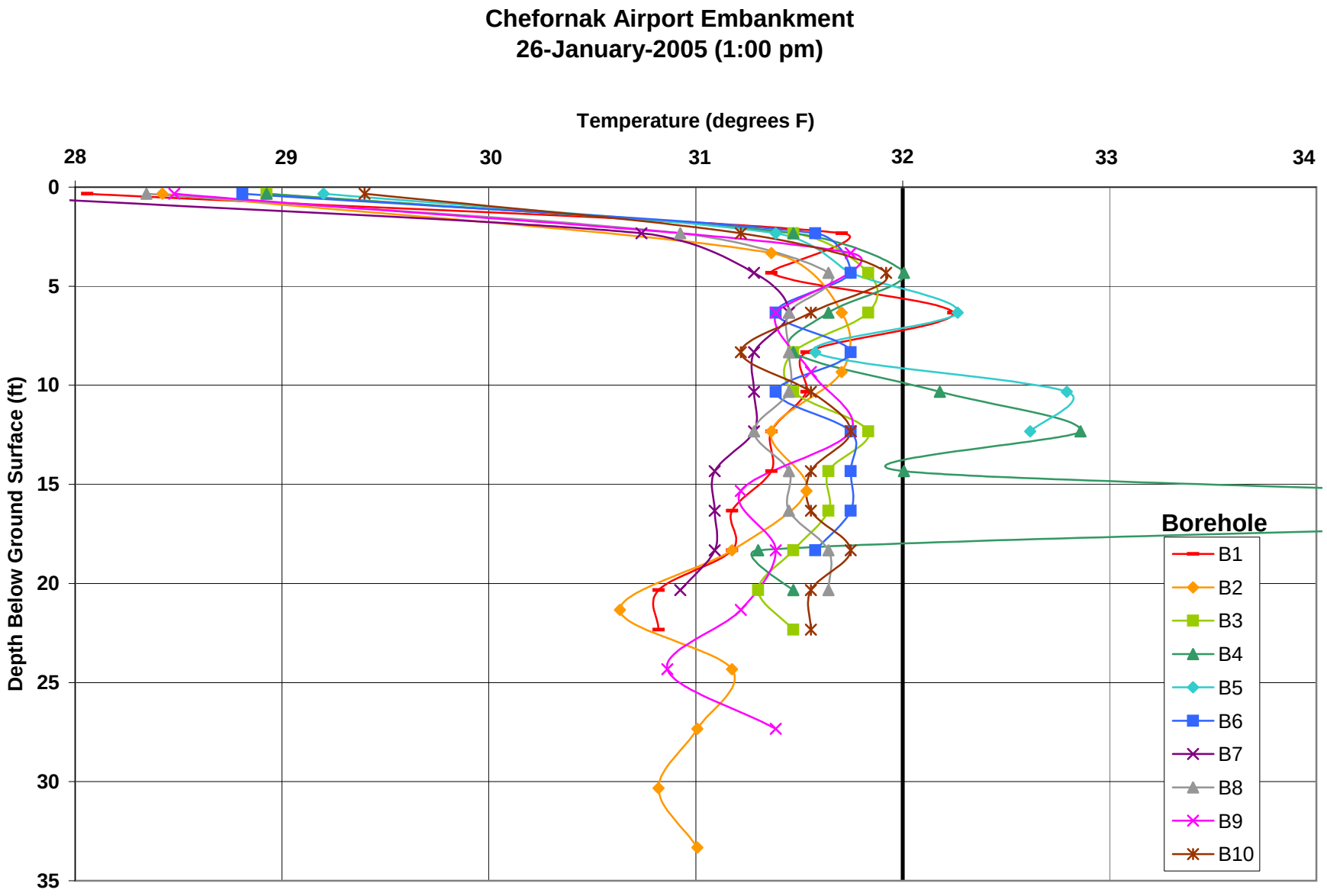

Chefornak Airport Embankment
9-December-2004 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

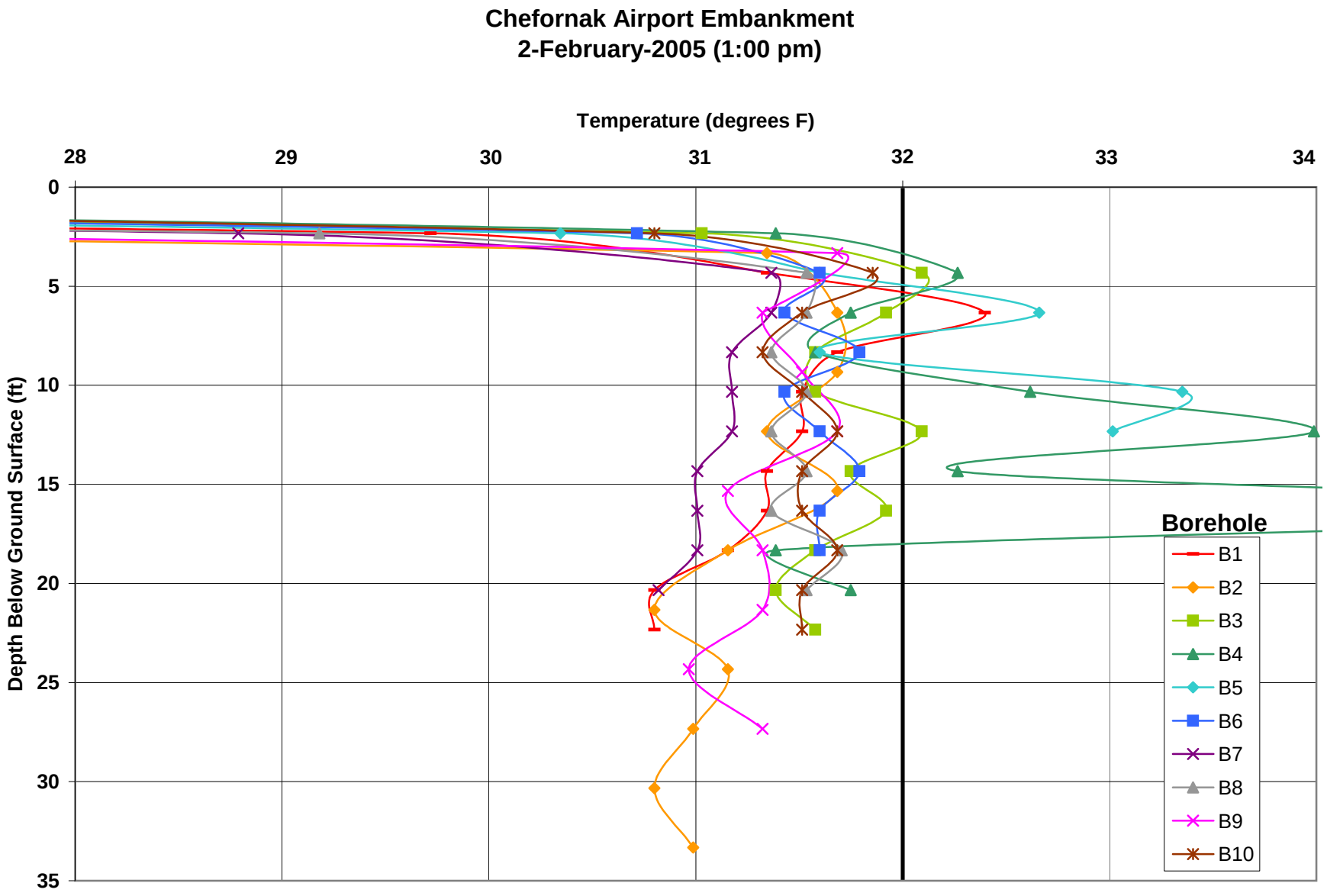

Chefornak Airport Embankment
16-December-2004 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

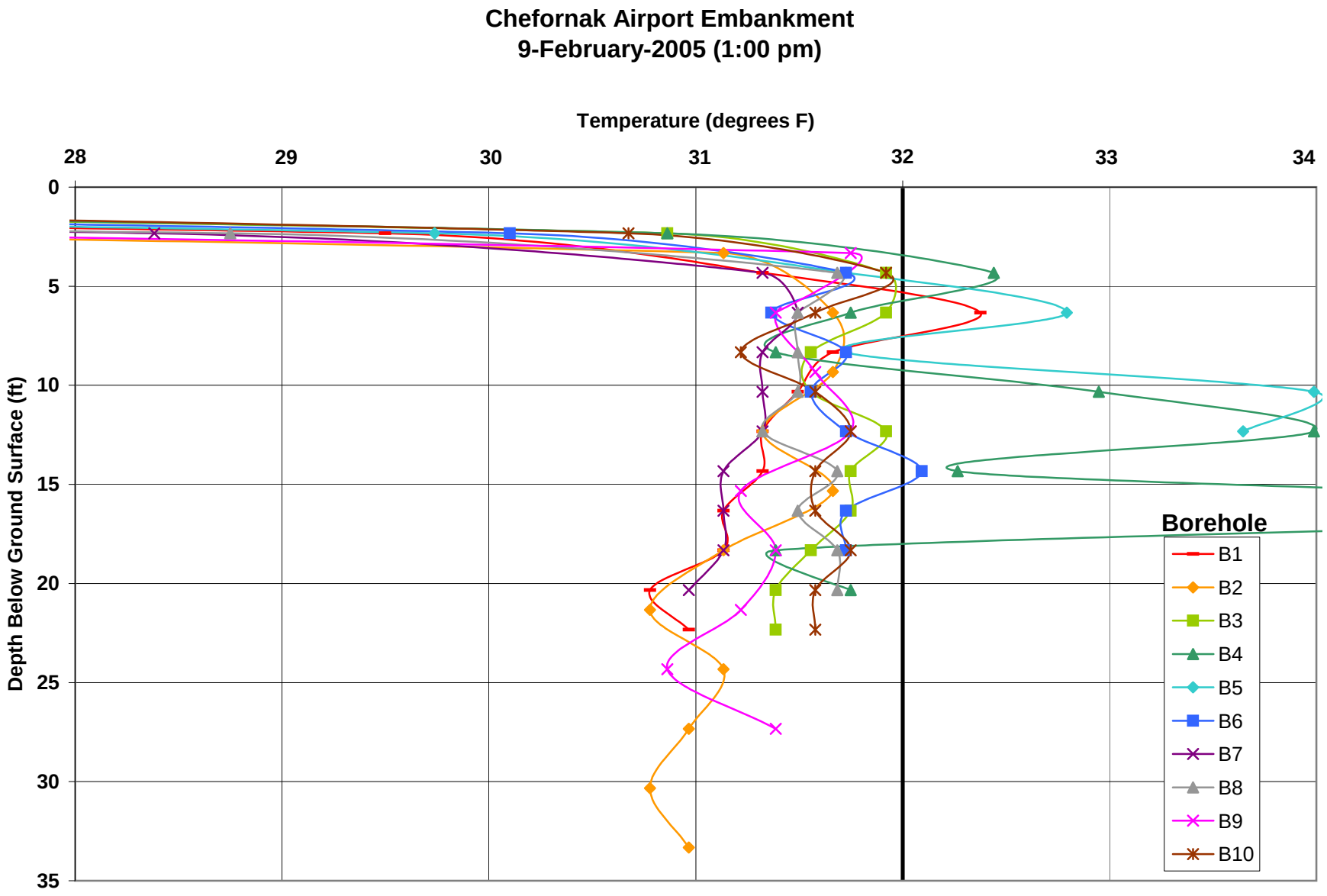

Chefornak Airport Embankment
23-December-2004 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

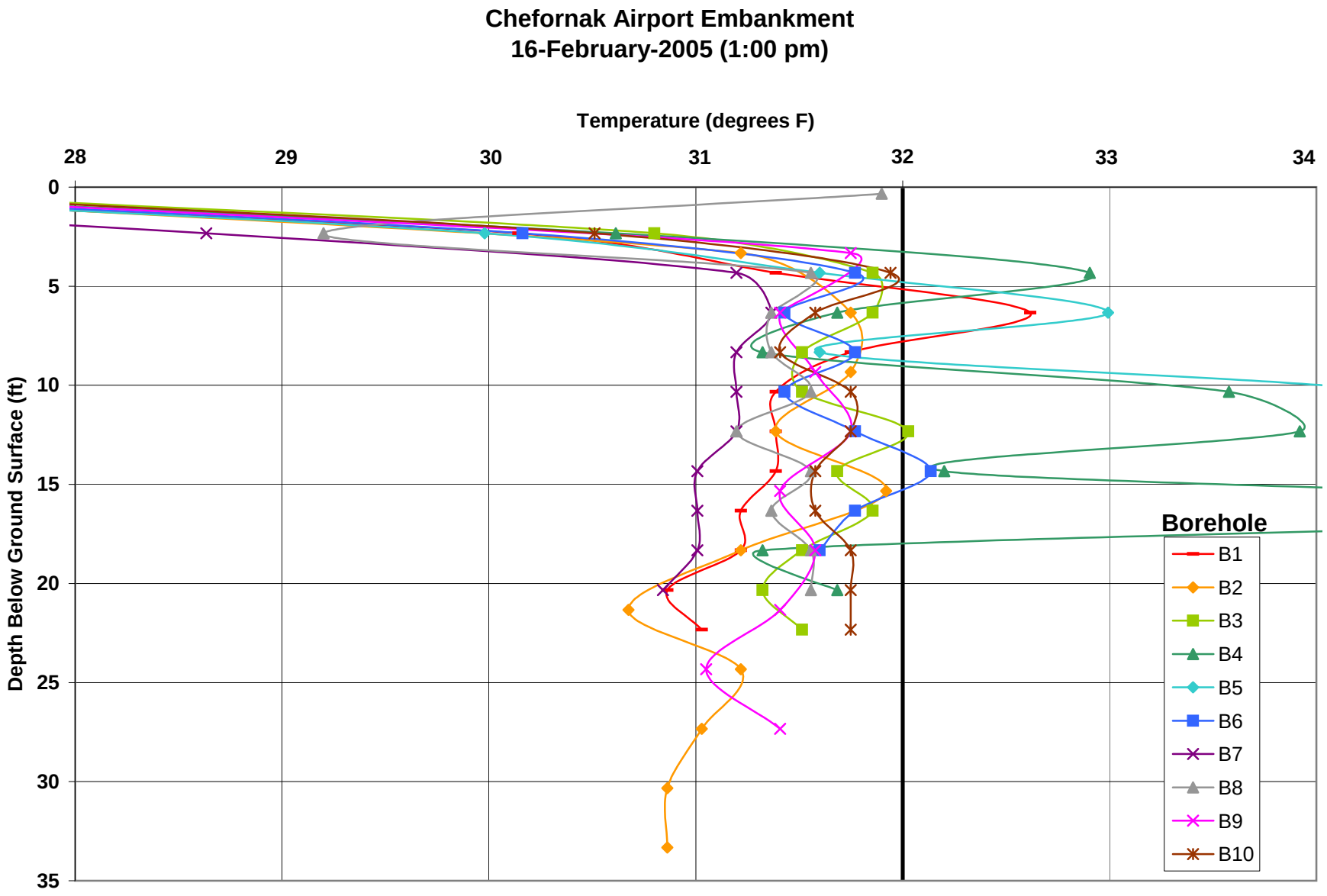

Chefornak Airport Embankment
12-January-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

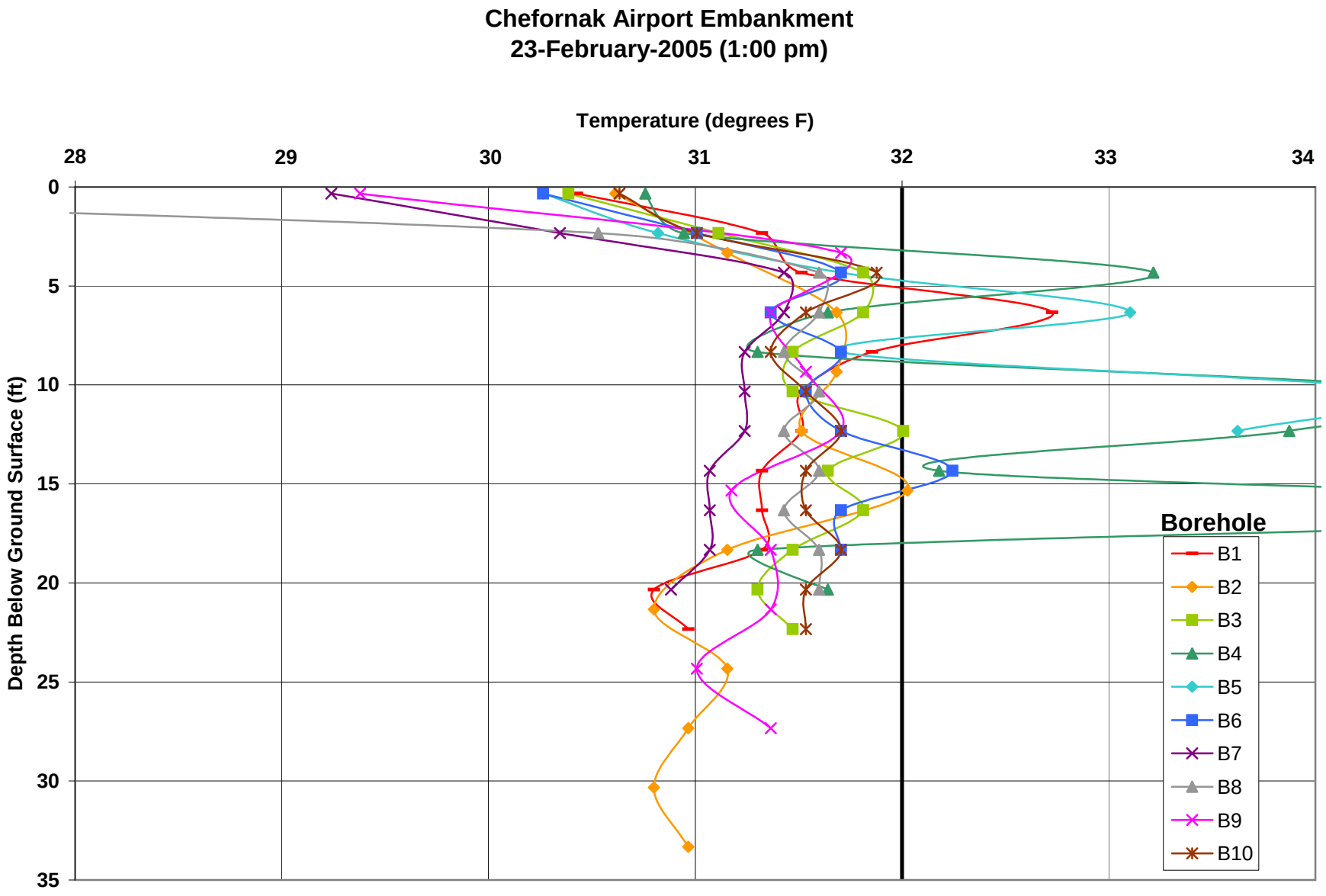

Chefornak Airport Embankment
19-January-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

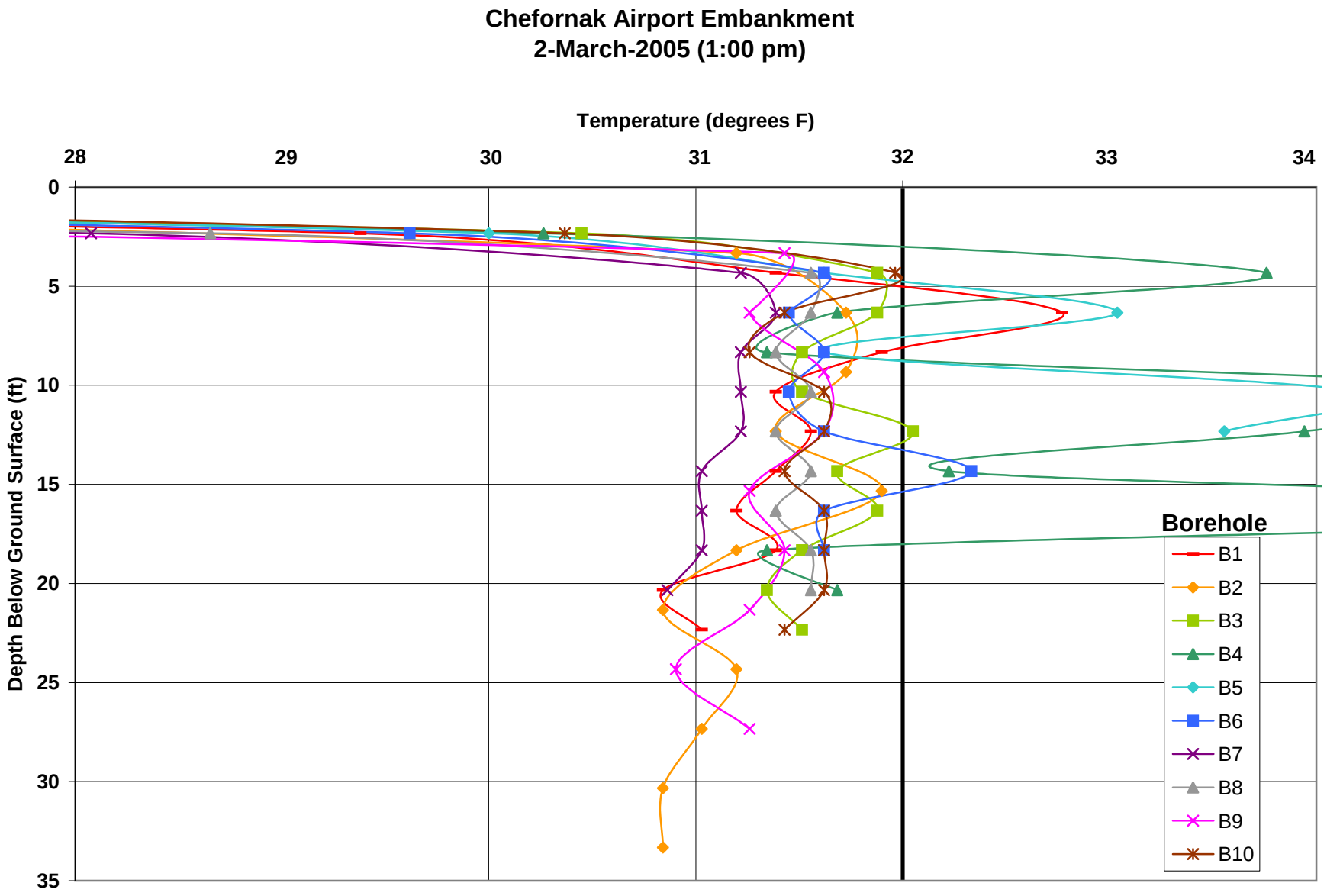

Chefornak Airport Embankment
26-January-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10

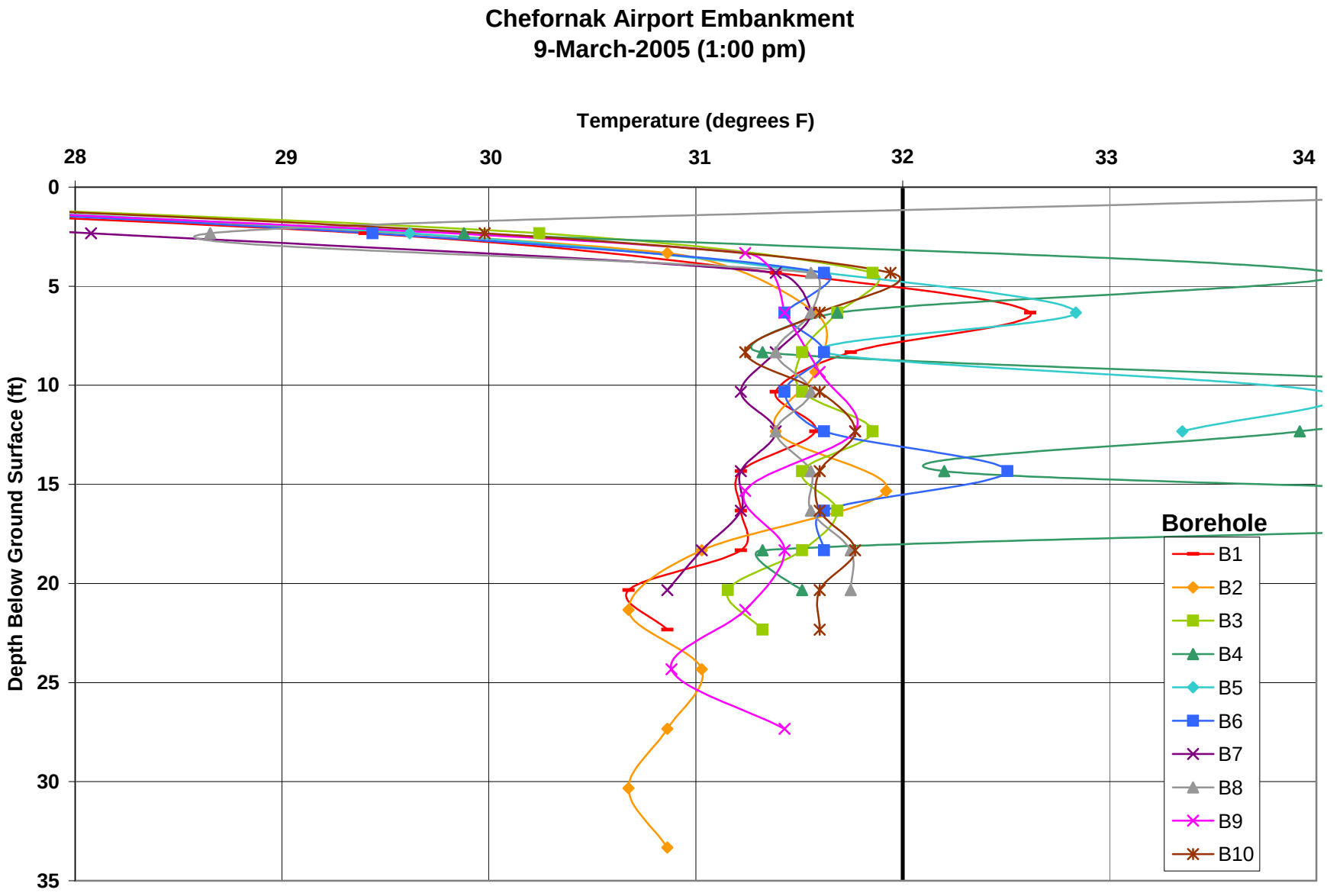

Chefornak Airport Embankment
2-February-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
9-February-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
16-February-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
23-February-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
2-March-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
9-March-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
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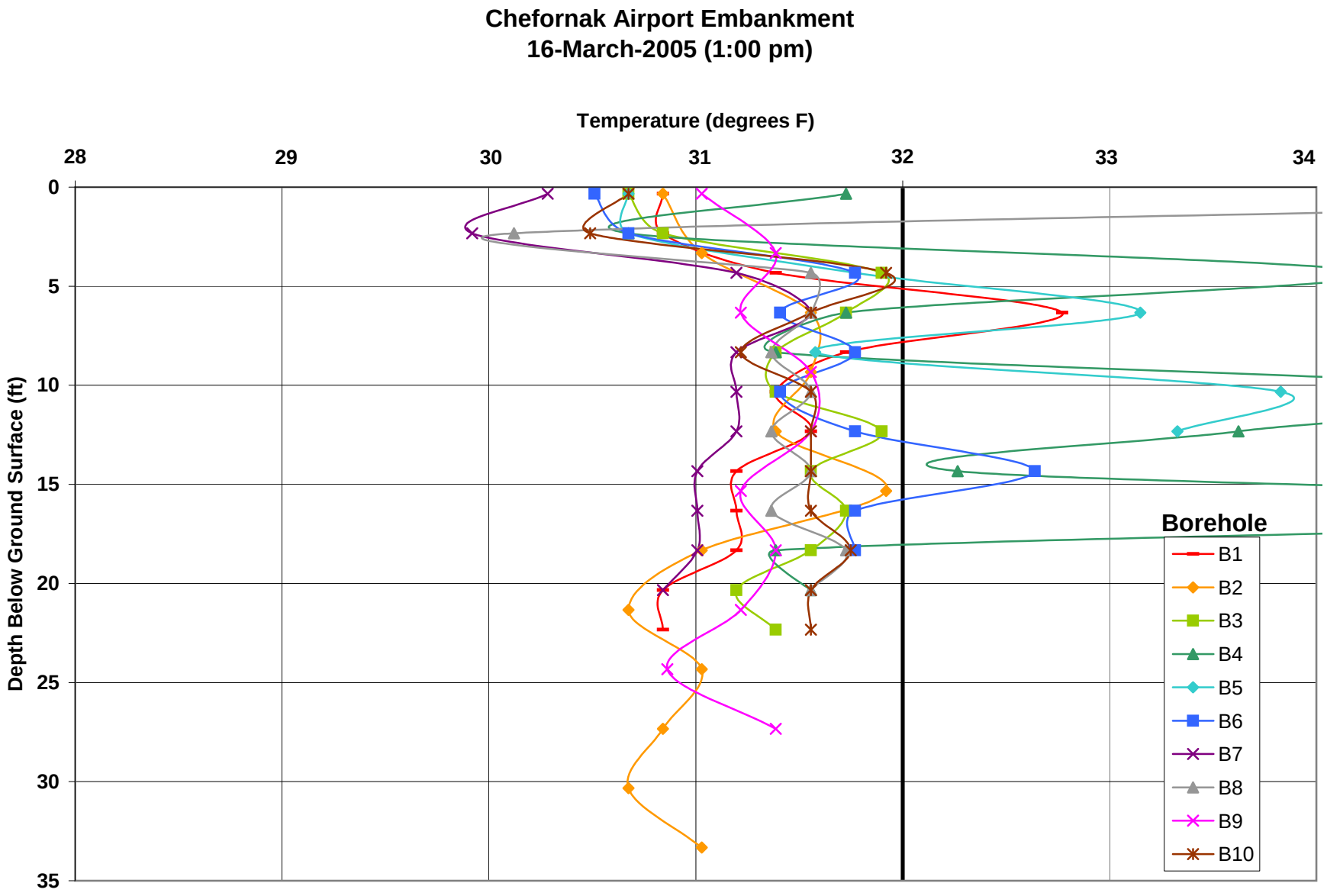
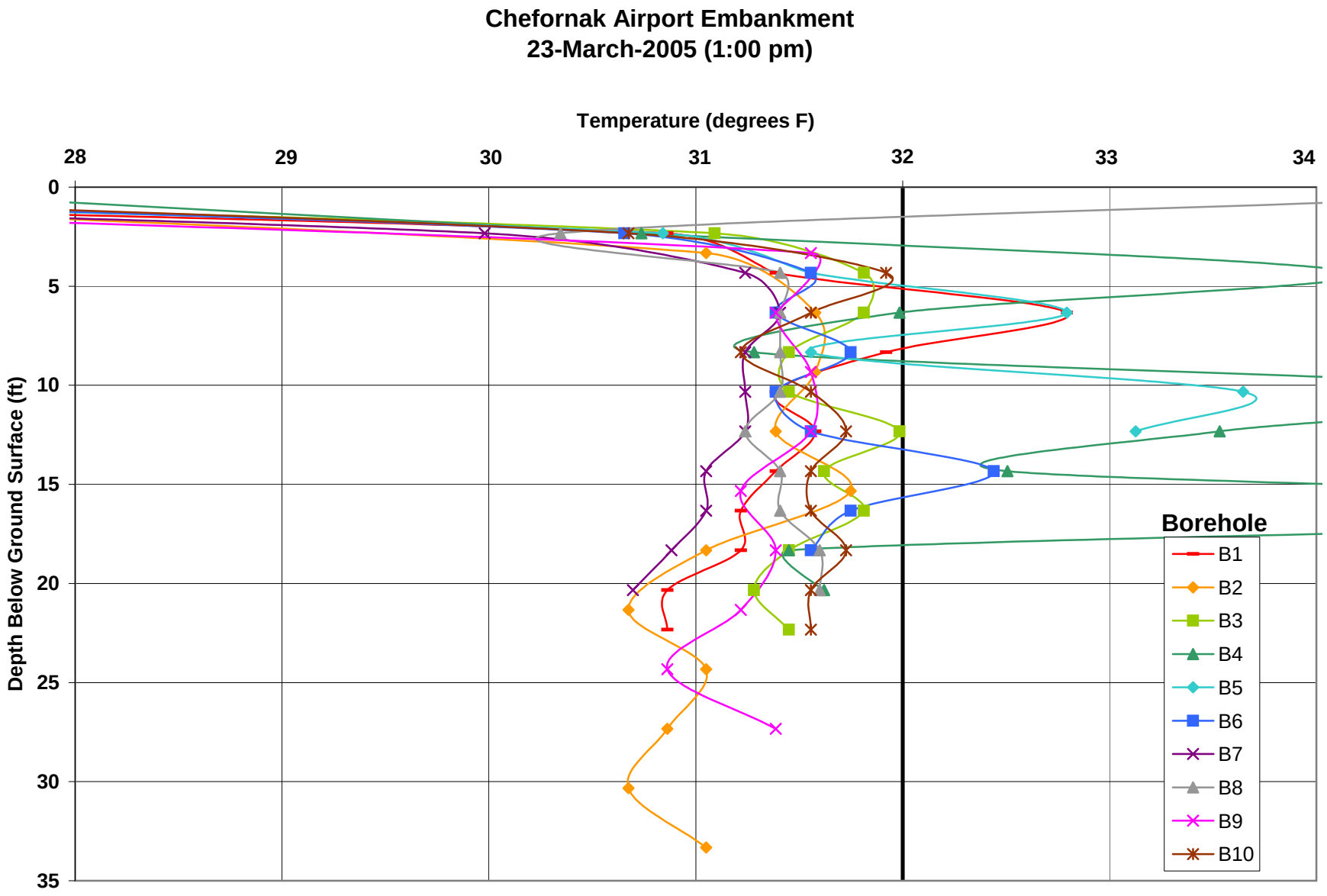
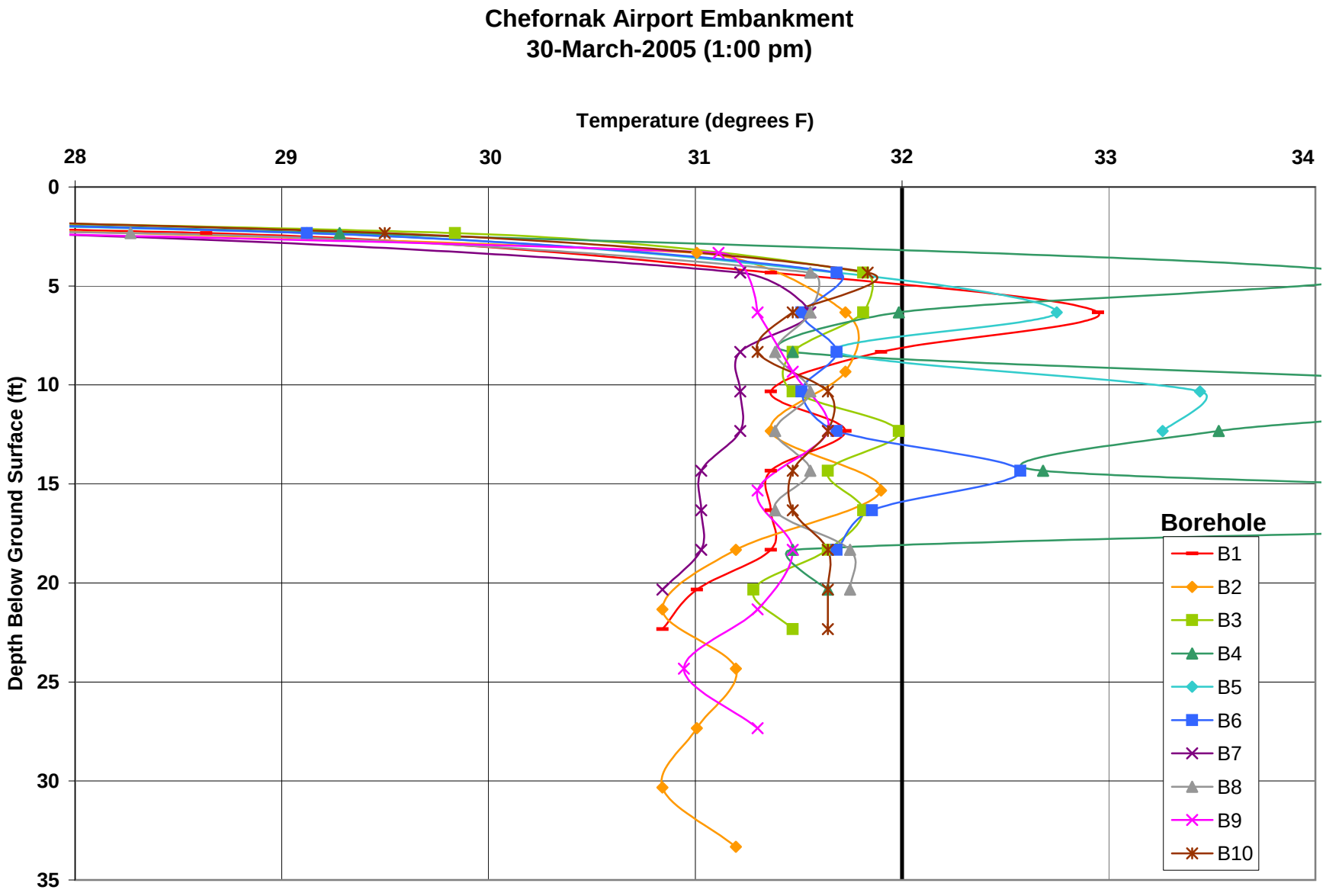
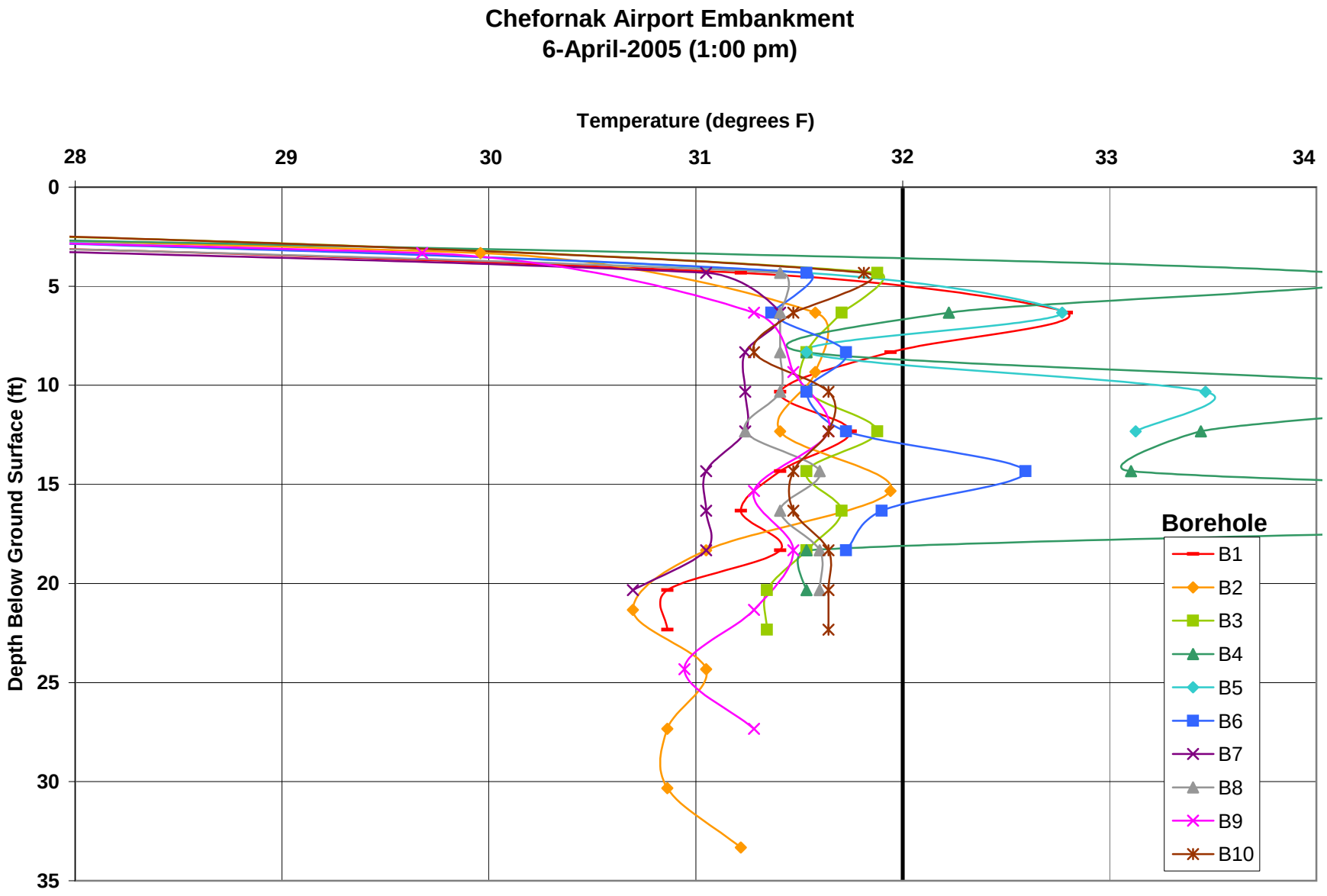
B6
B7
B8
B9
B10


Chefornak Airport Embankment
16-March-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
23-March-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
30-March-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
6-April-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
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B8
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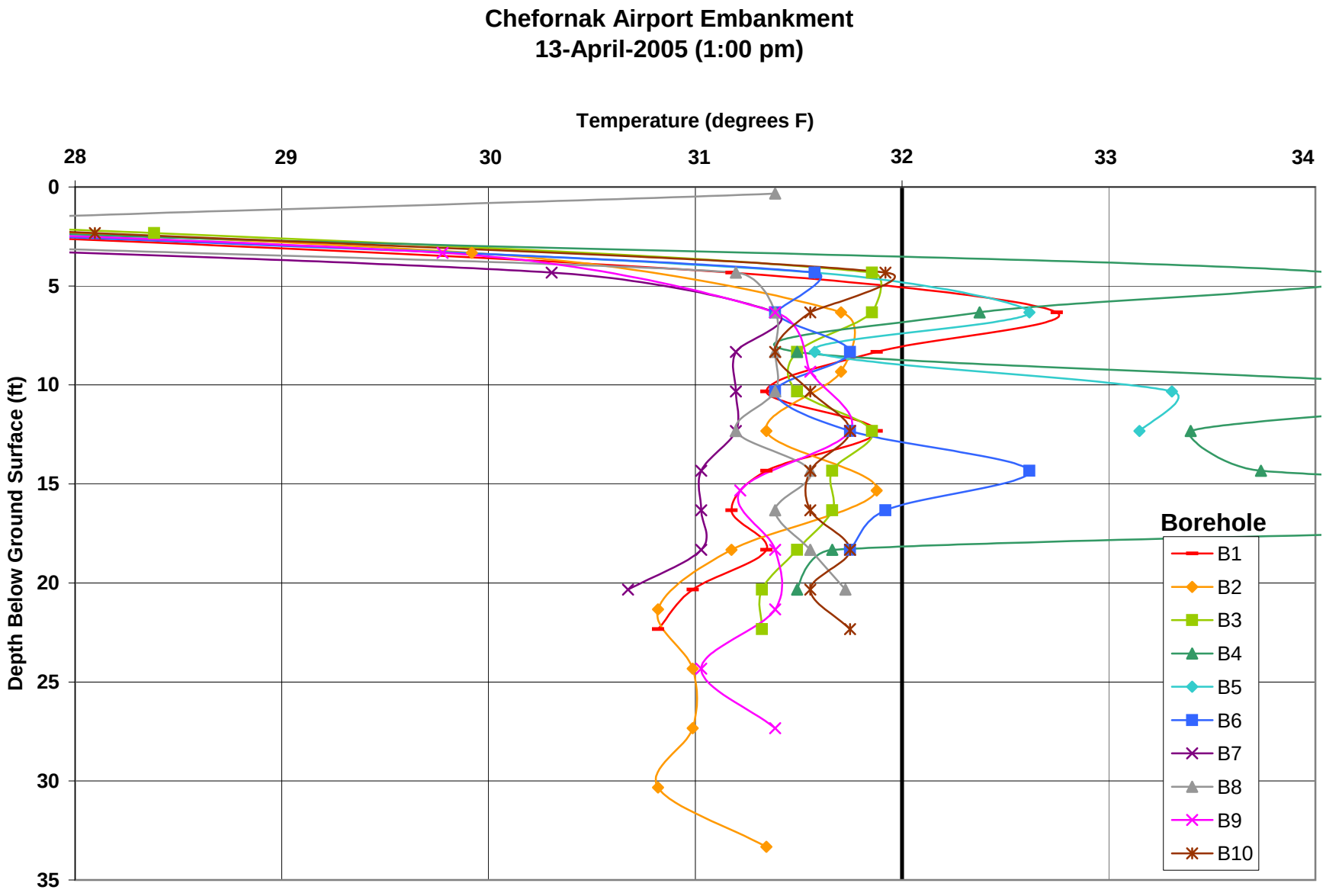
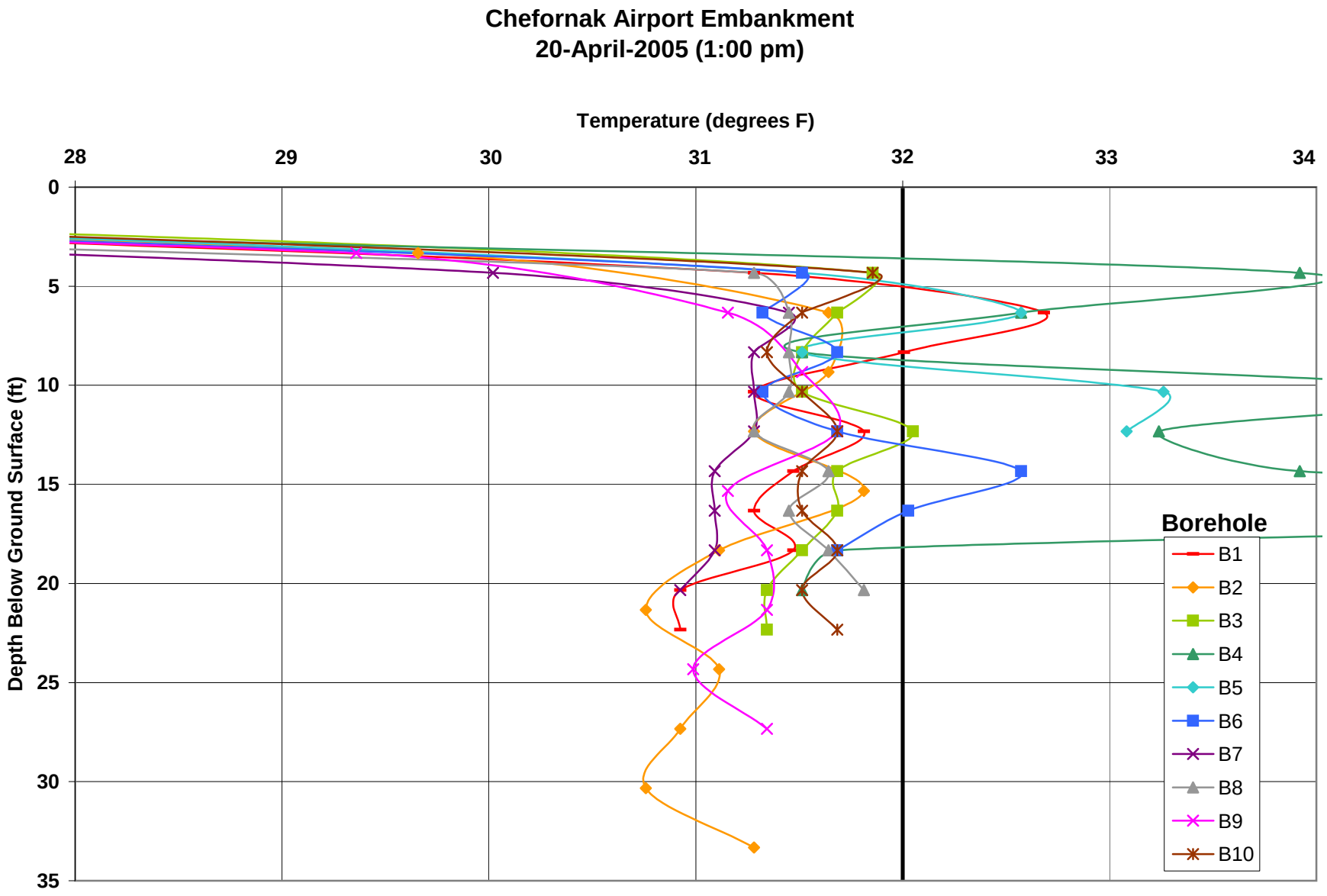
B10


Chefornak Airport Embankment
13-April-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
20-April-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
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B5
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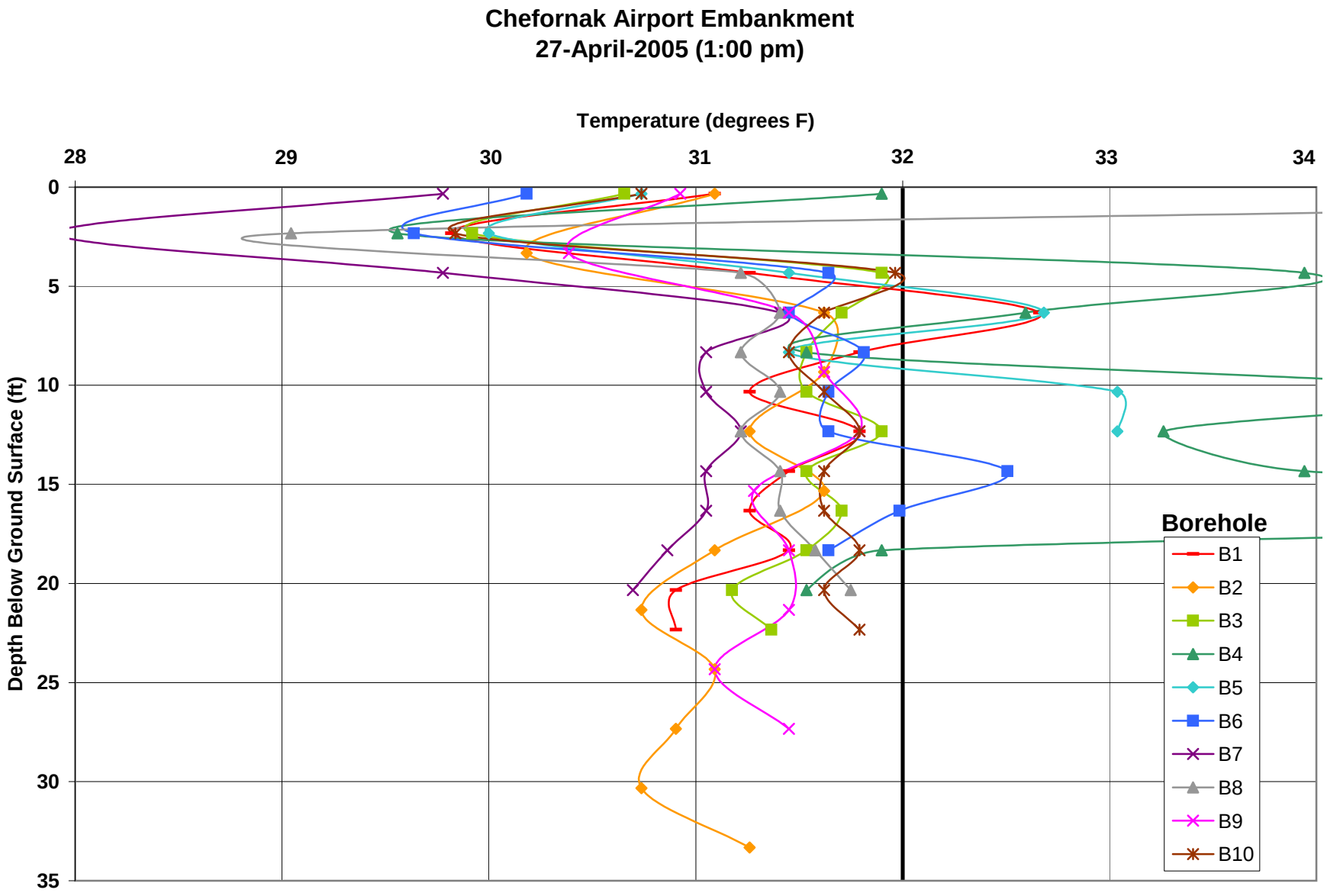
B8
B9
B10


Chefornak Airport Embankment
27-April-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
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B9
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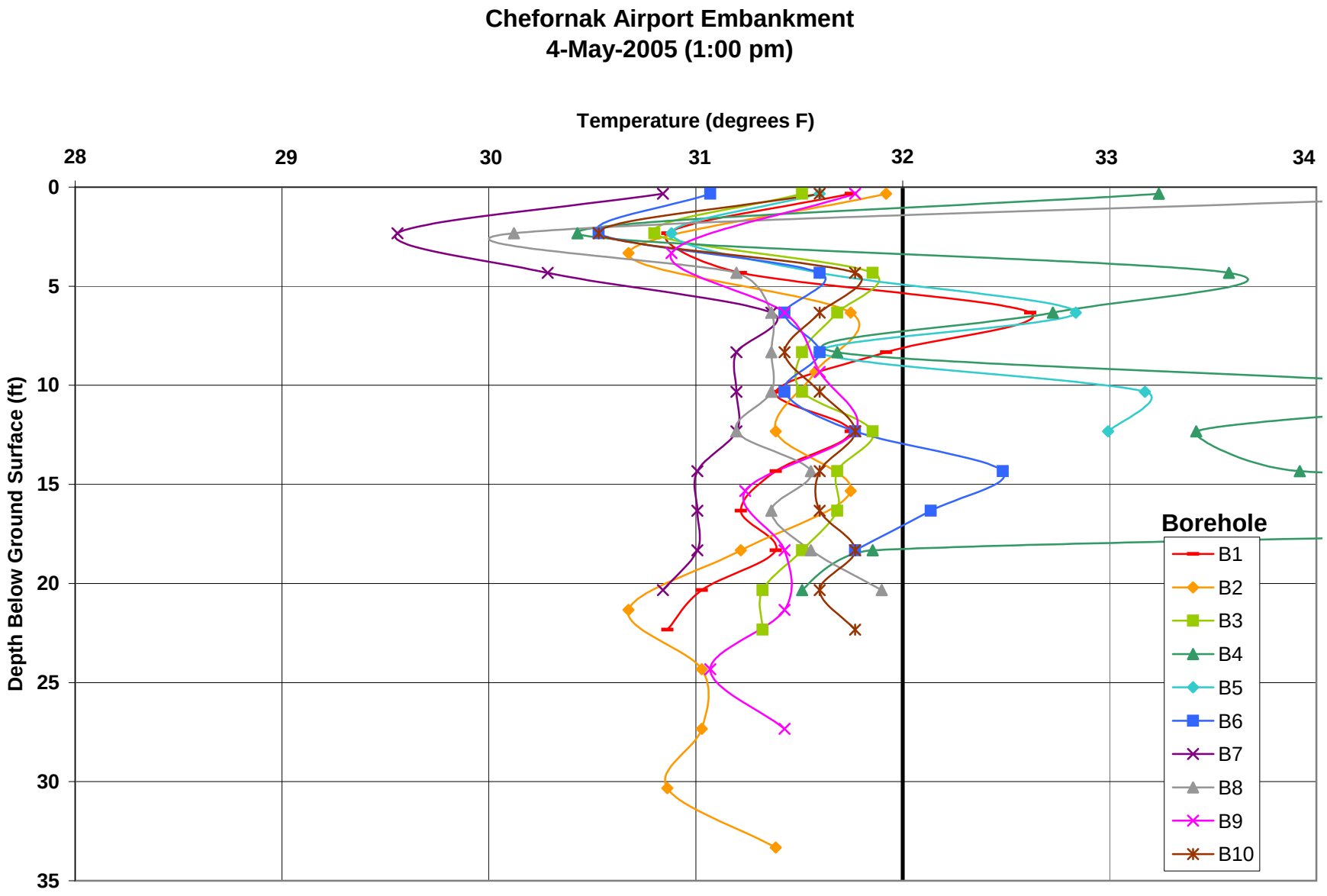
Chefornak Airport Embankment
4-May-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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B3
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B6
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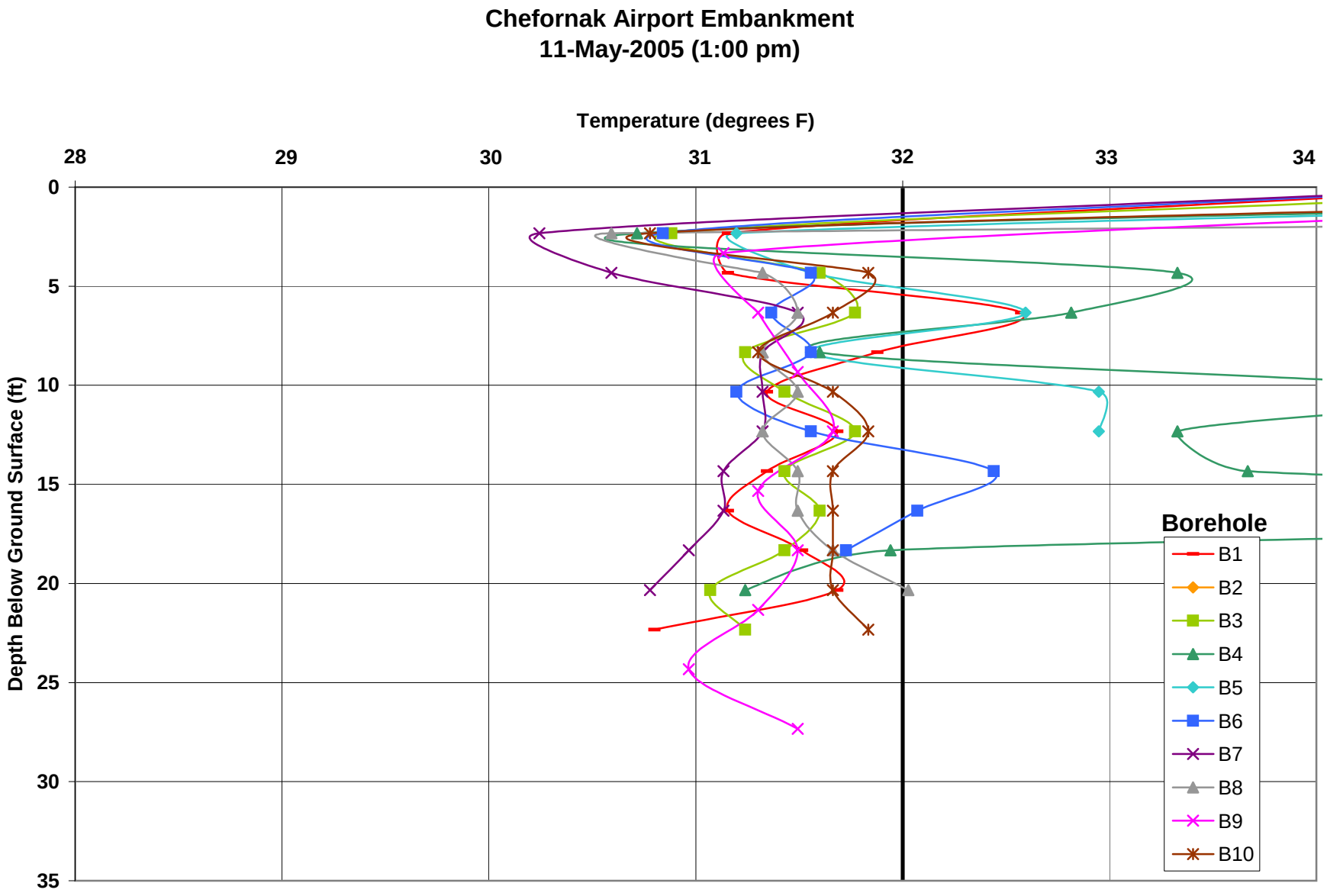
B8
B9
B10


Chefornak Airport Embankment
11-May-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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B3
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B5
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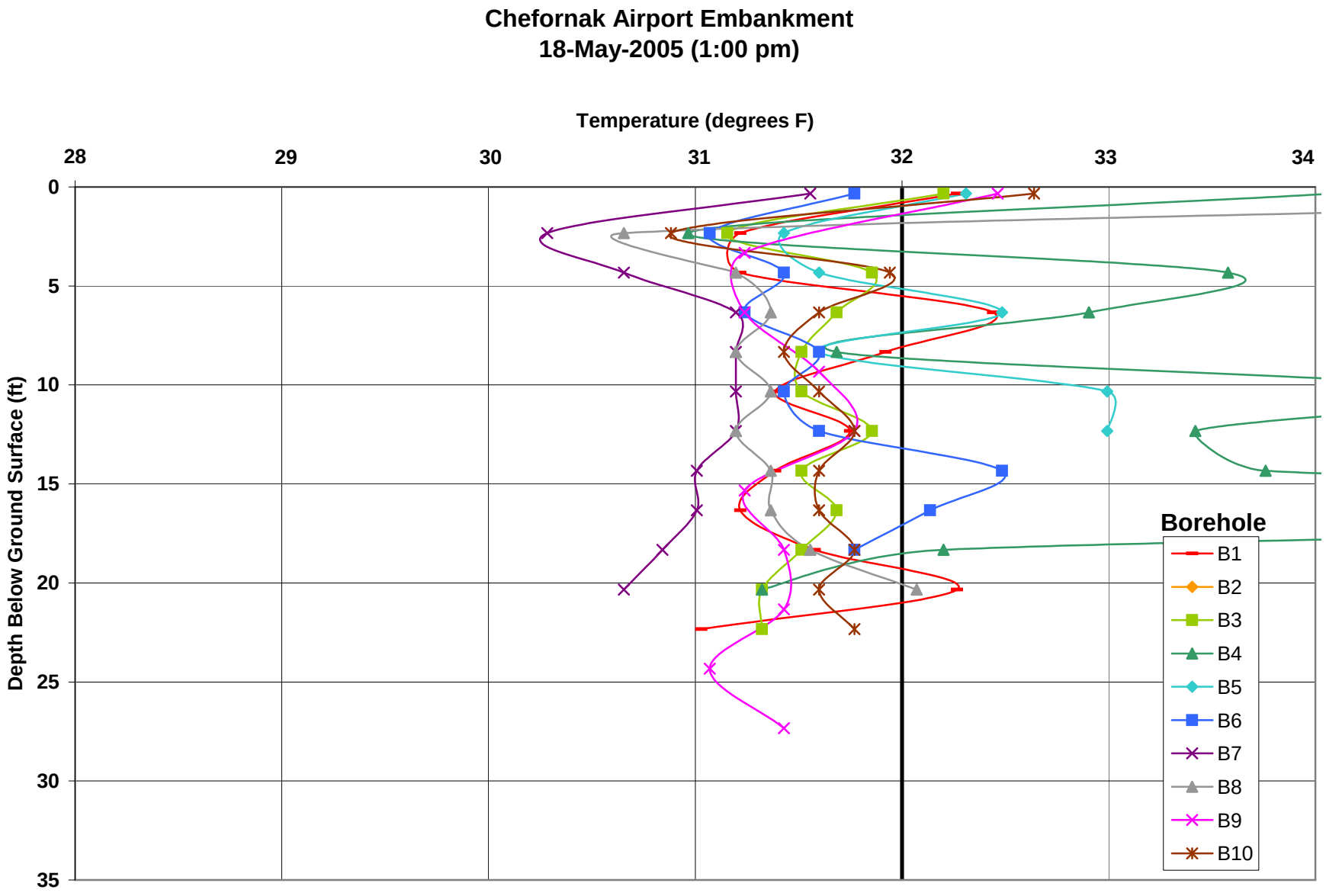
B9
B10


Chefornak Airport Embankment
18-May-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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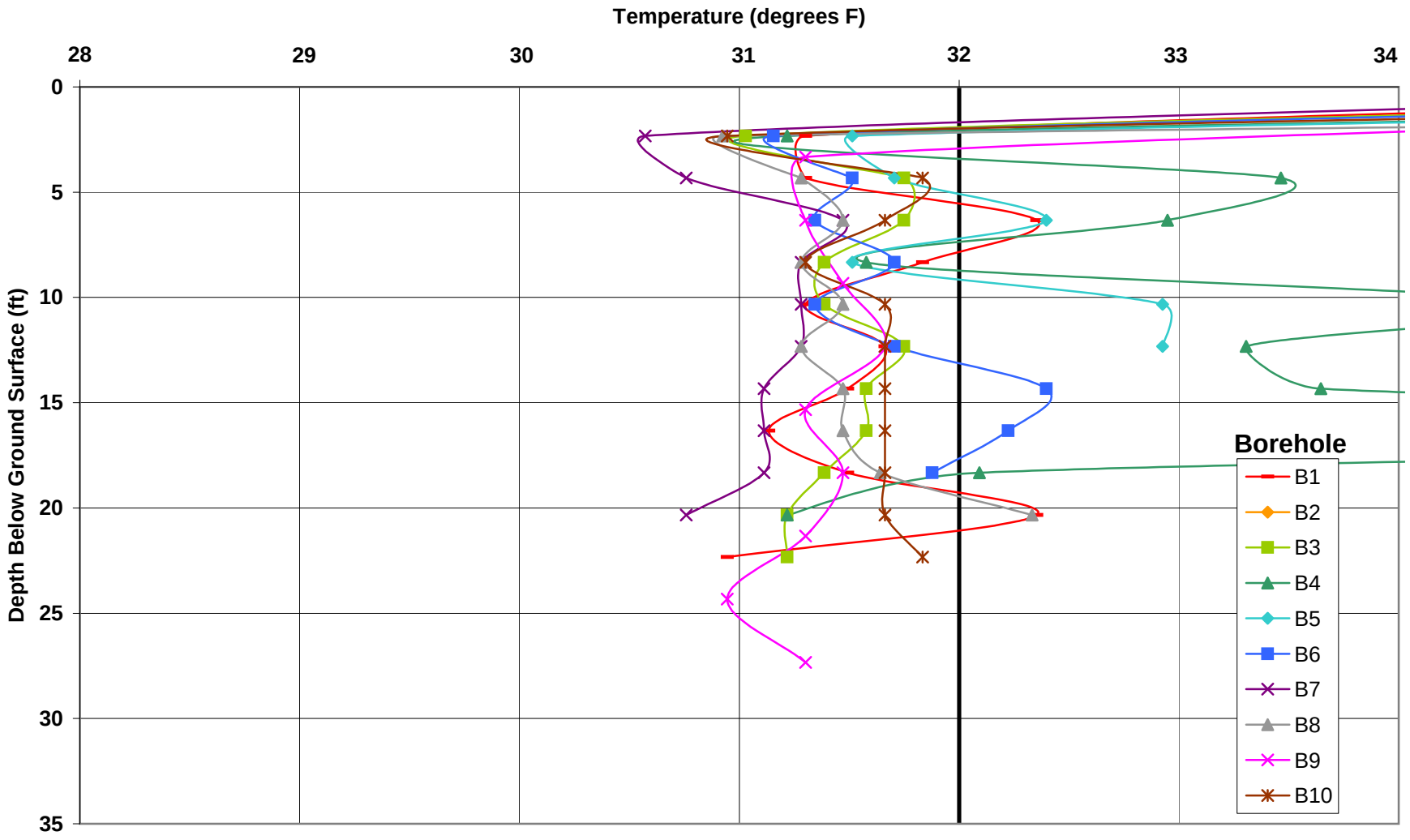
B10


Chefornak Airport Embankment
25-May-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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B3
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B8
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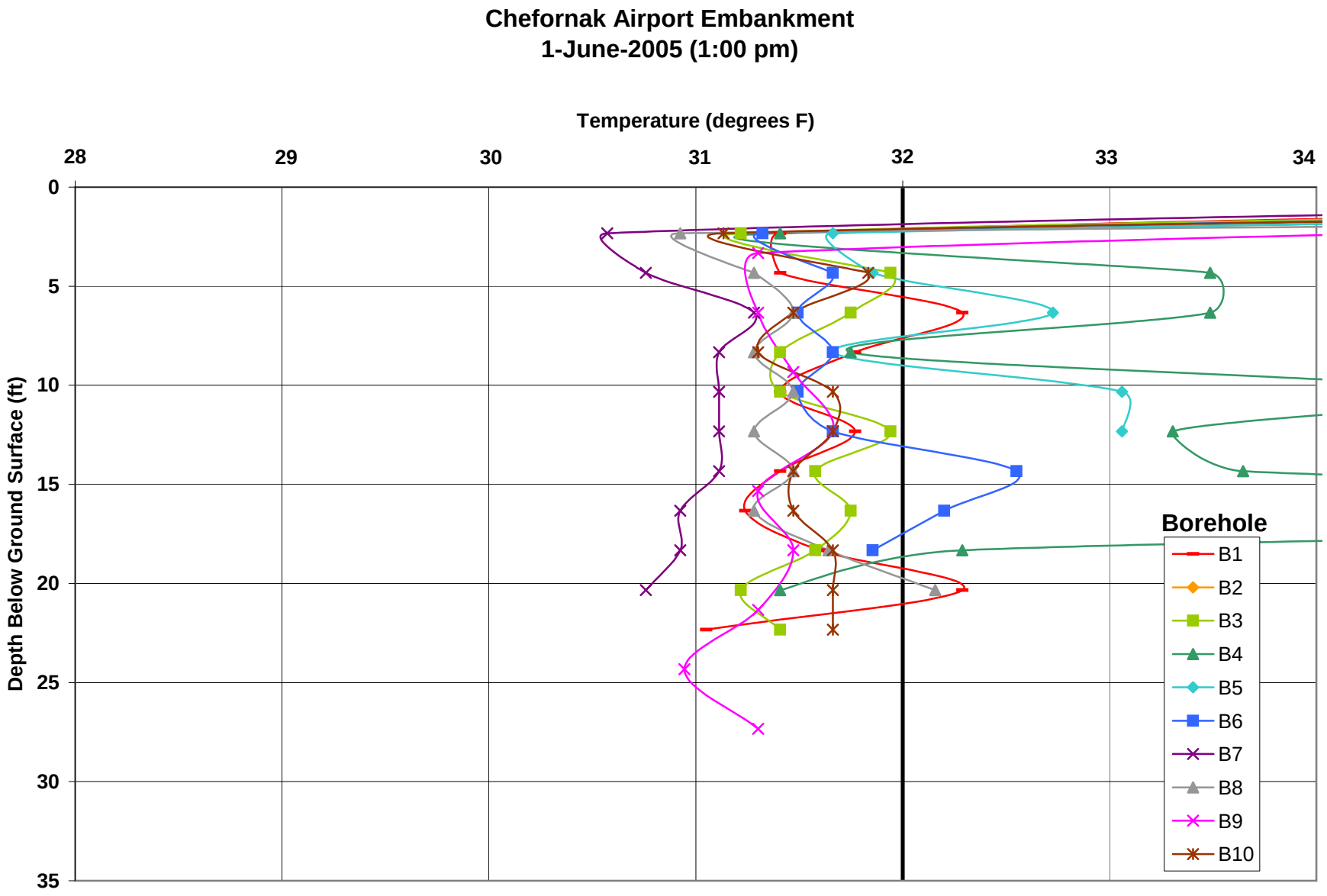
B10


Chefornak Airport Embankment
1-June-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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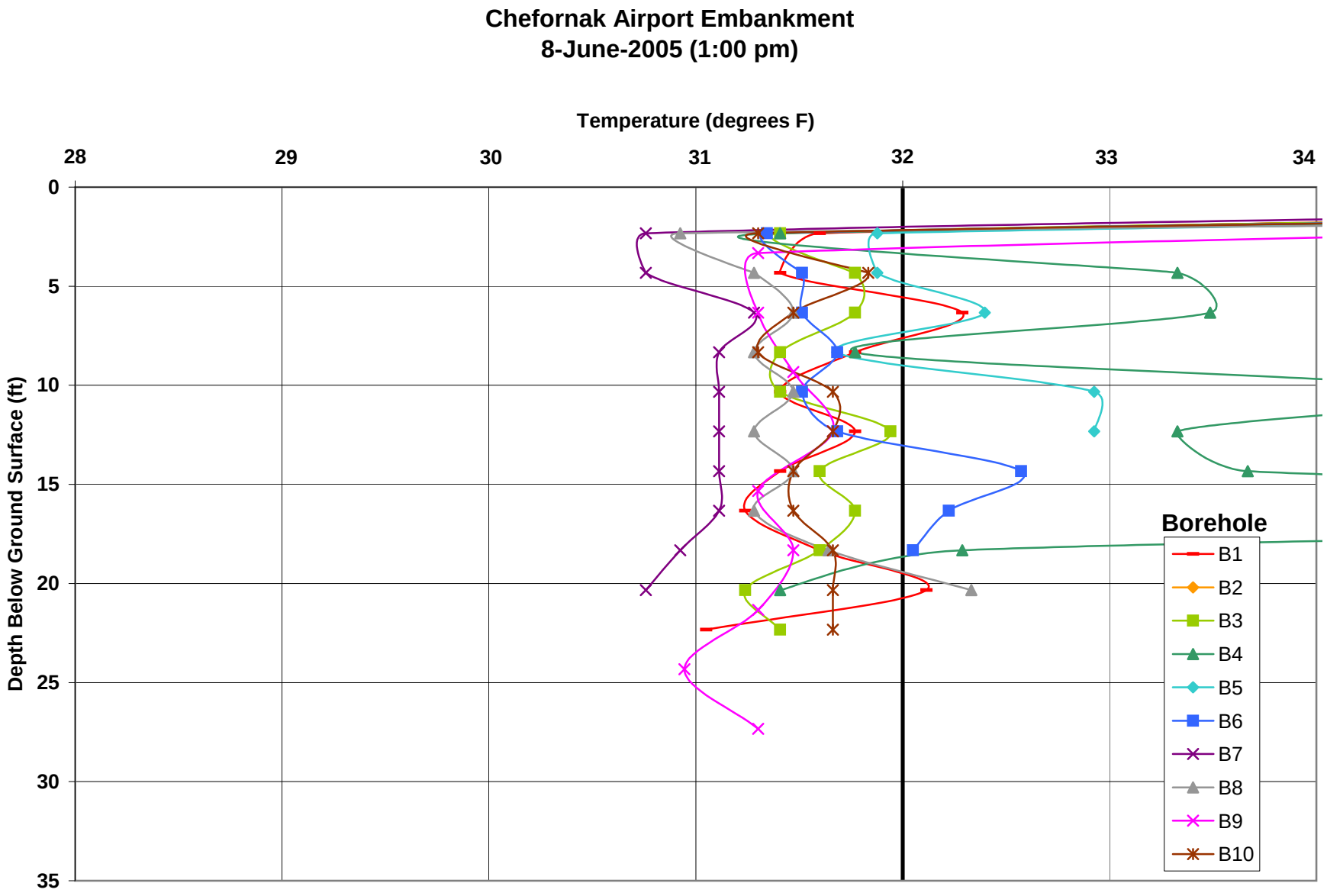
Chefornak Airport Embankment
8-June-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
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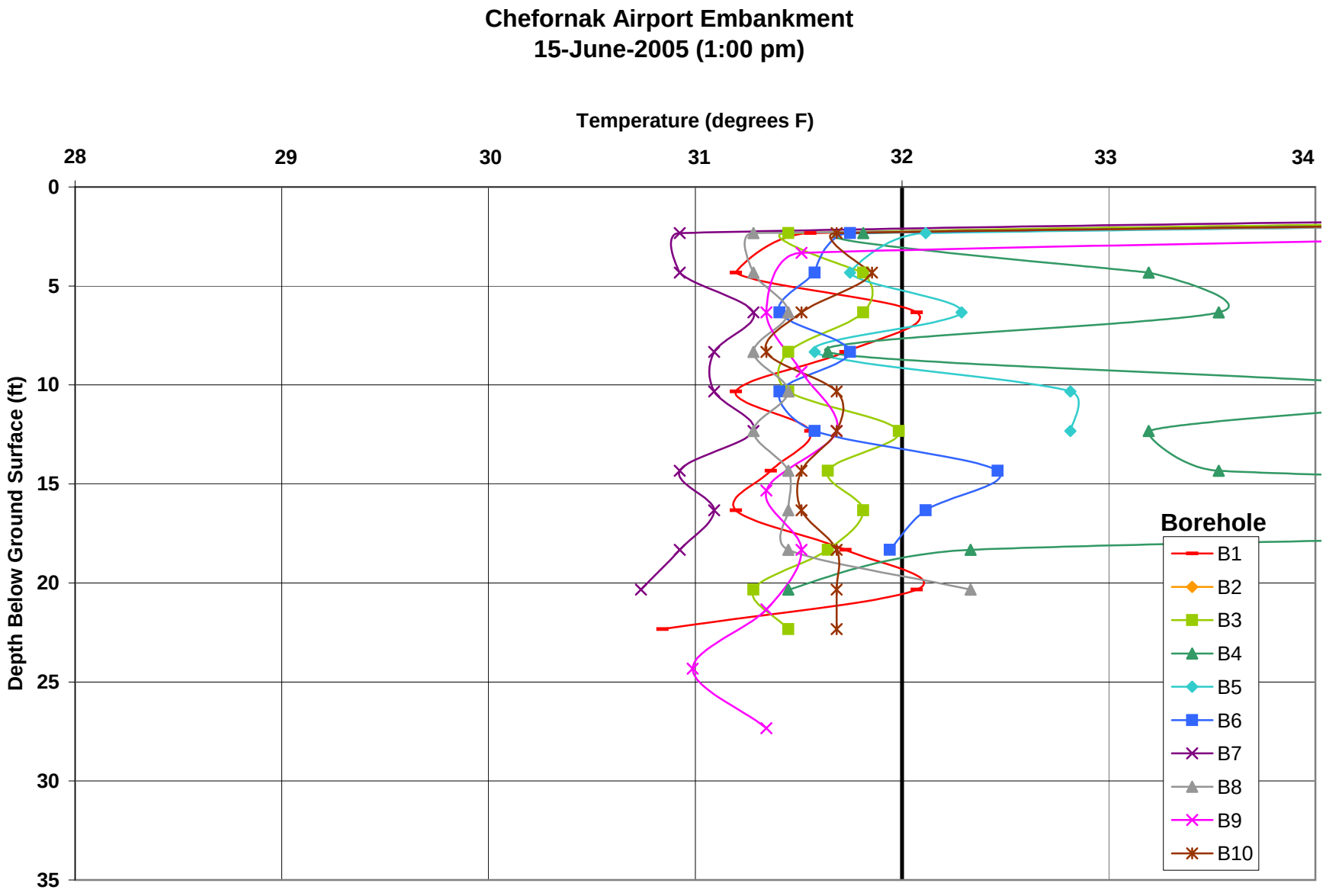
Chefornak Airport Embankment
15-June-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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B3
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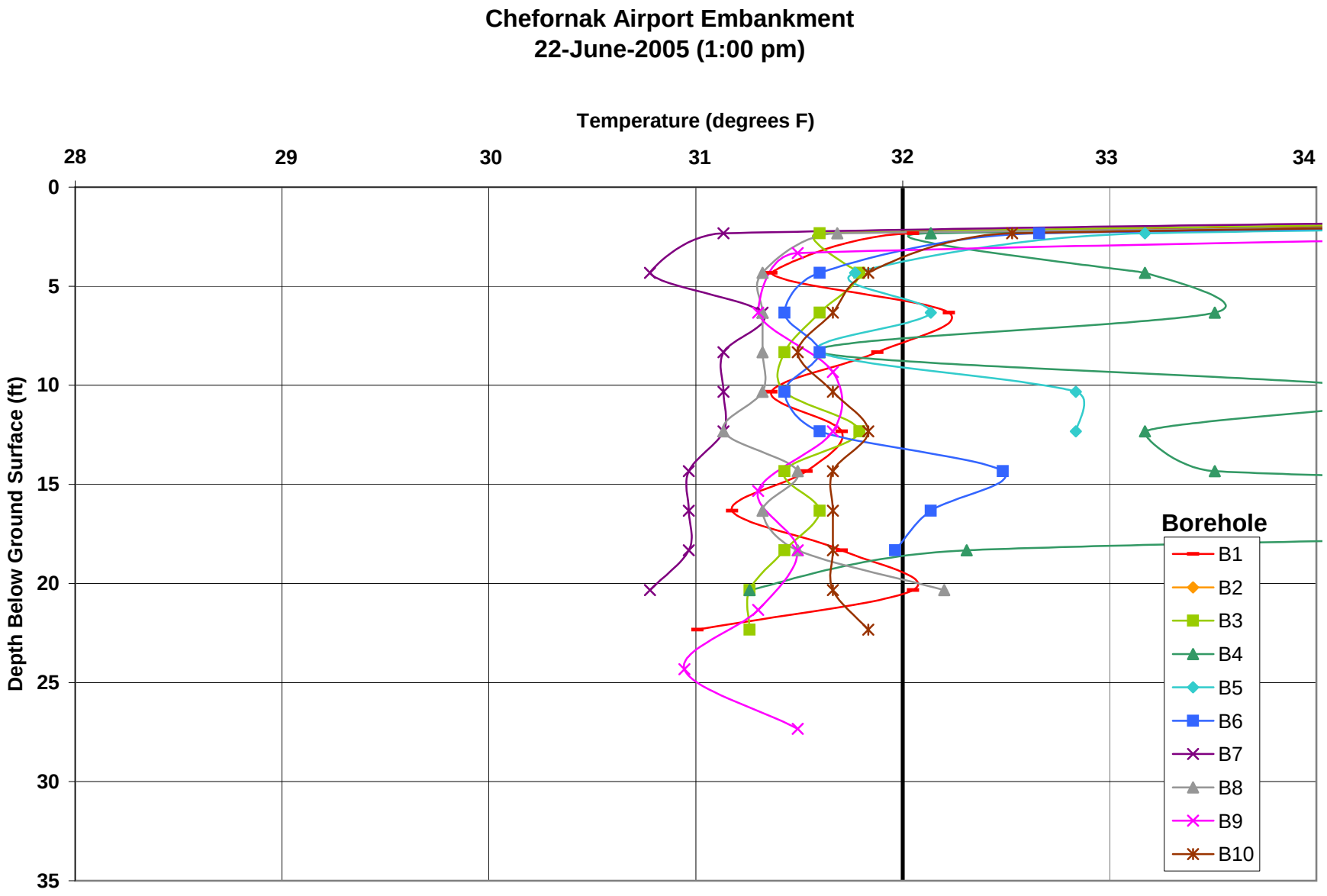
B8
B9
B10


Chefornak Airport Embankment
22-June-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
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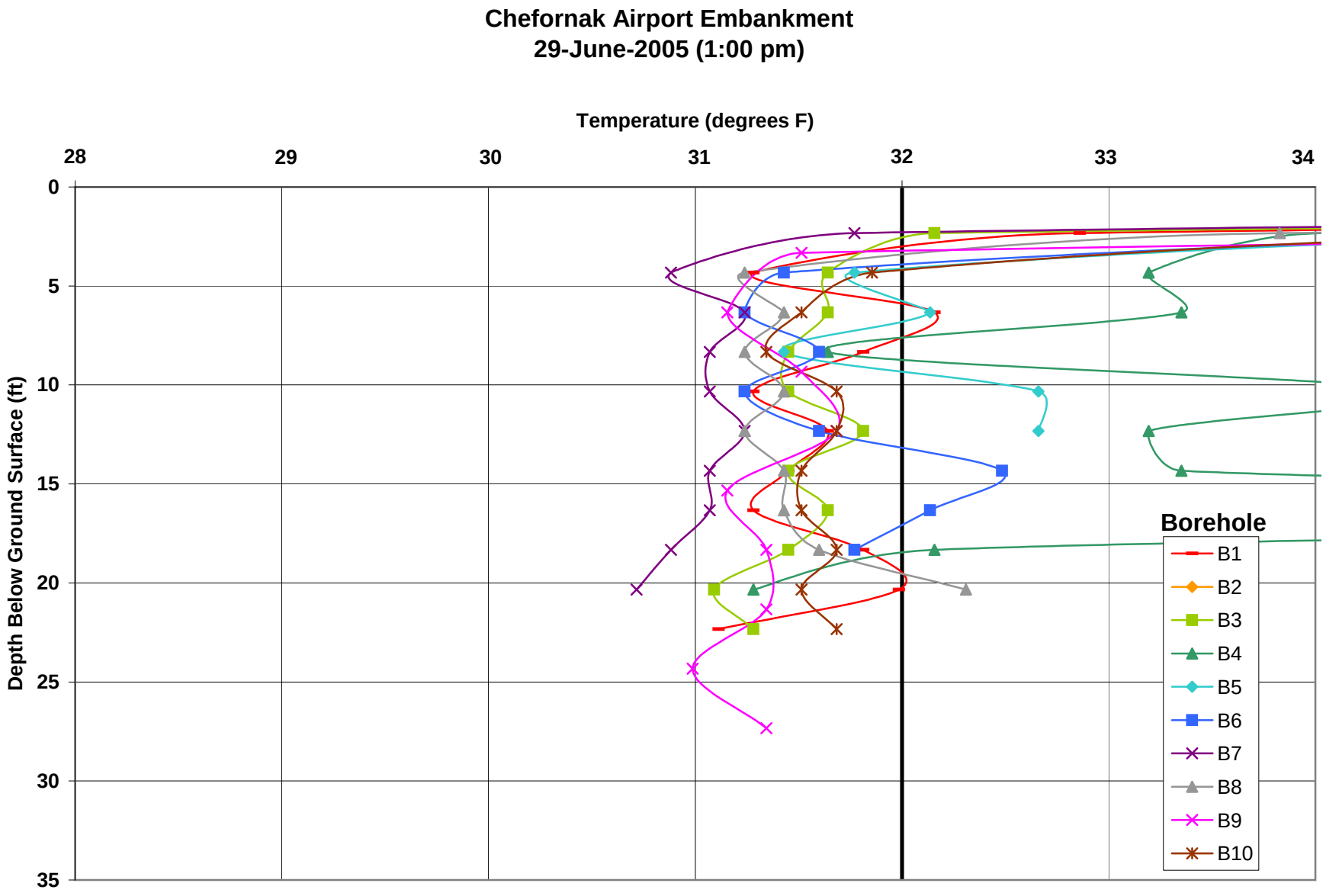
B9
B10


Chefornak Airport Embankment
29-June-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
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Borehole
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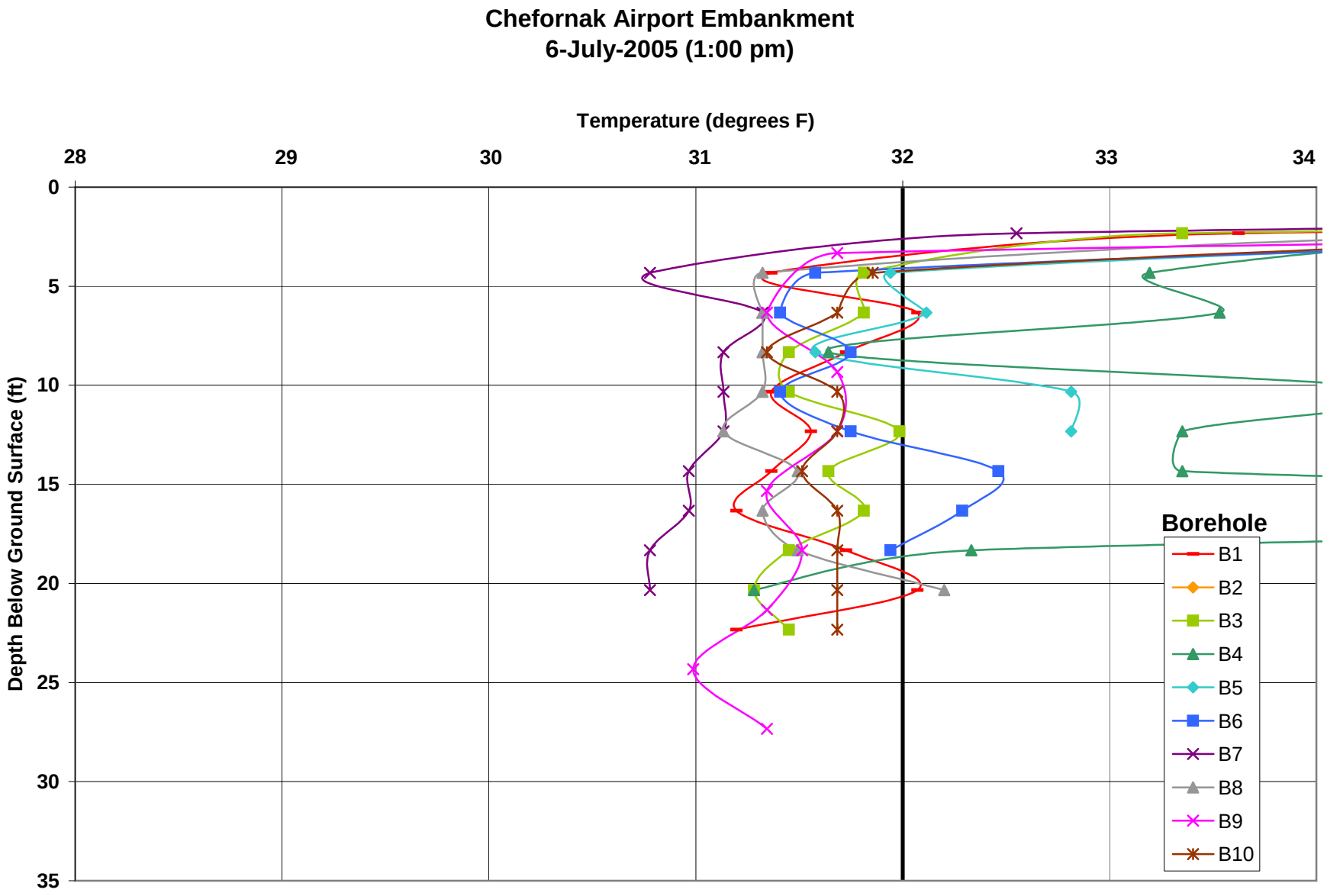
Chefornak Airport Embankment
6-July-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
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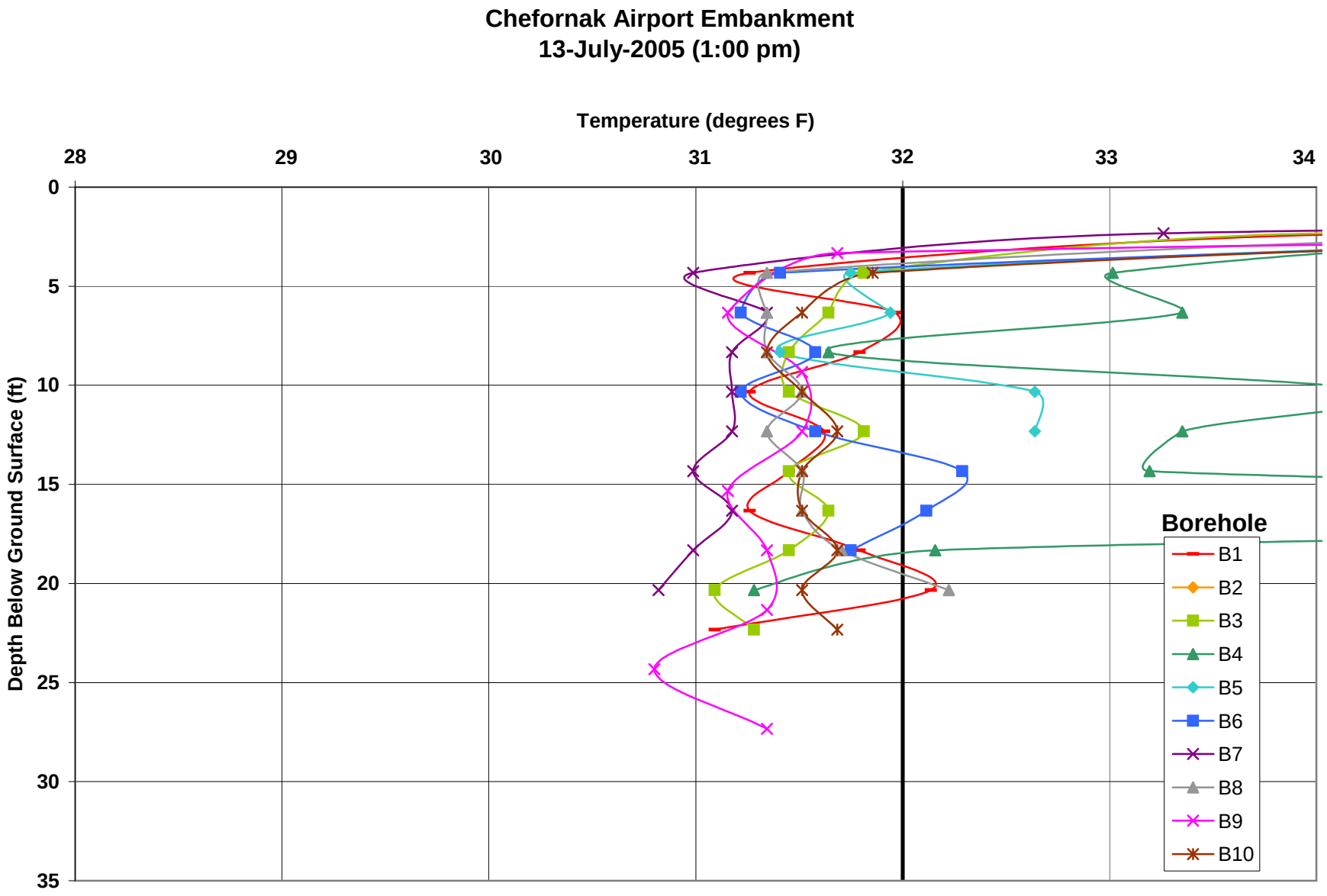
B8
B9
B10


Chefornak Airport Embankment
13-July-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
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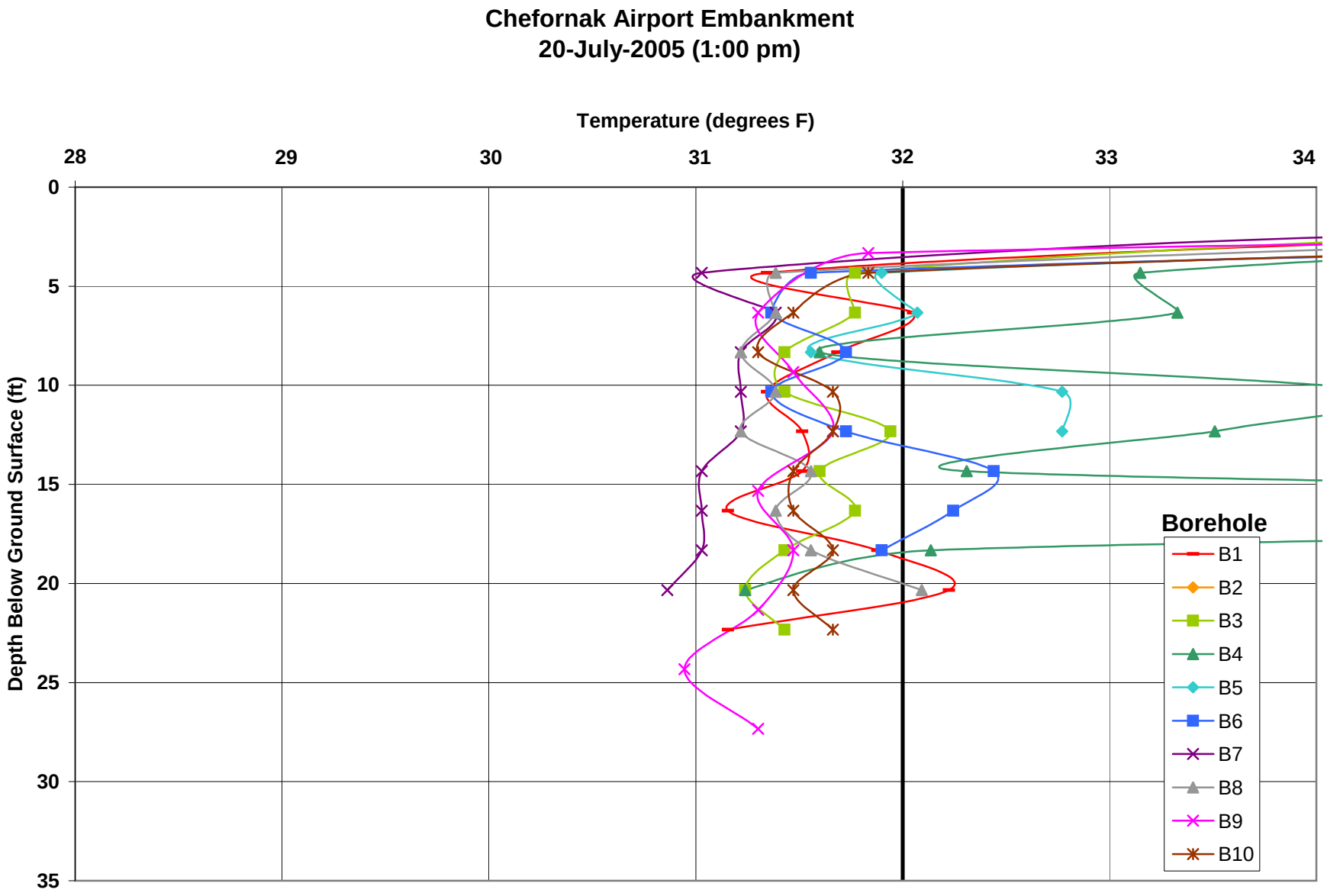
Chefornak Airport Embankment
20-July-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
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20
25
30
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Borehole
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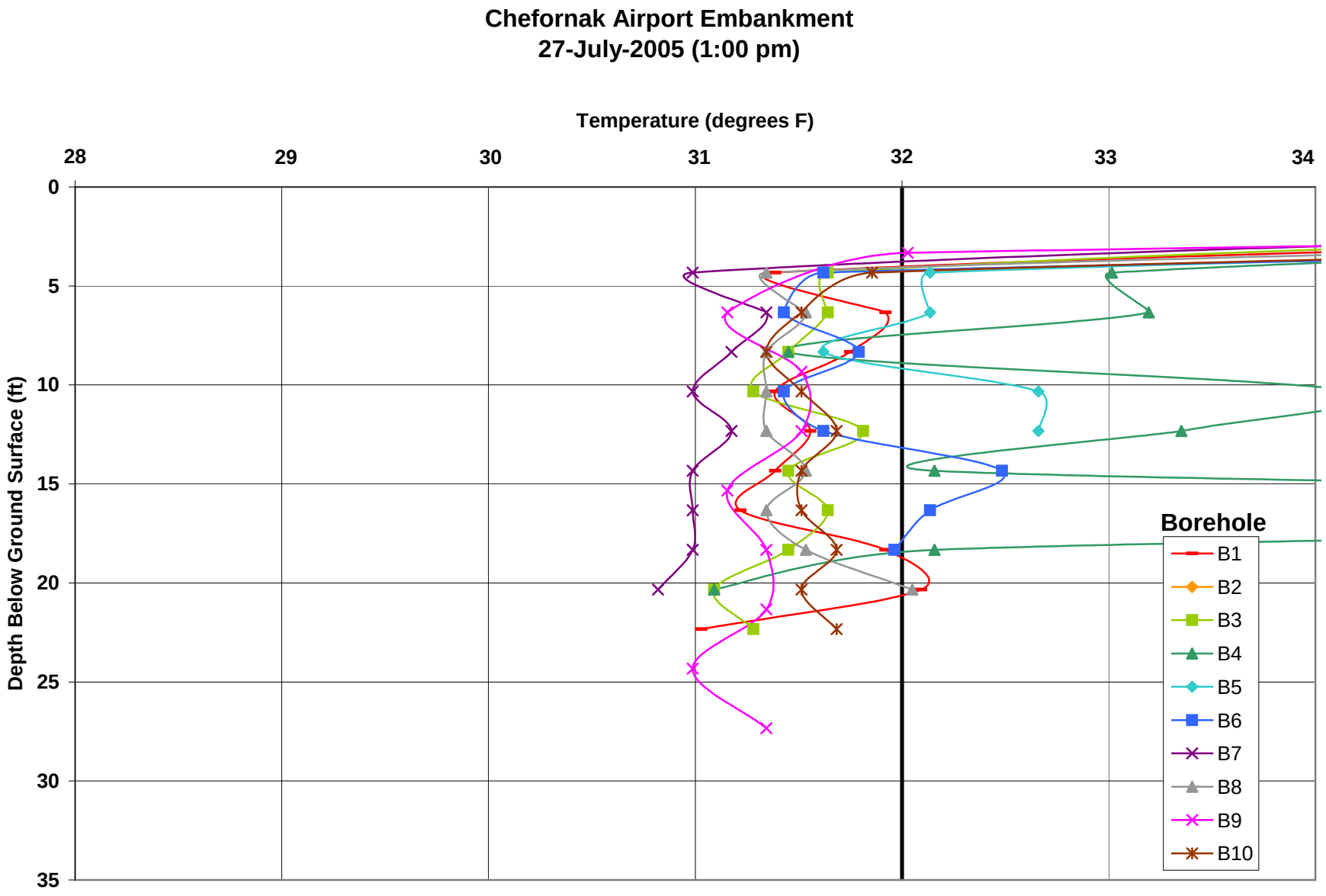
Chefornak Airport Embankment
27-July-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
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Borehole
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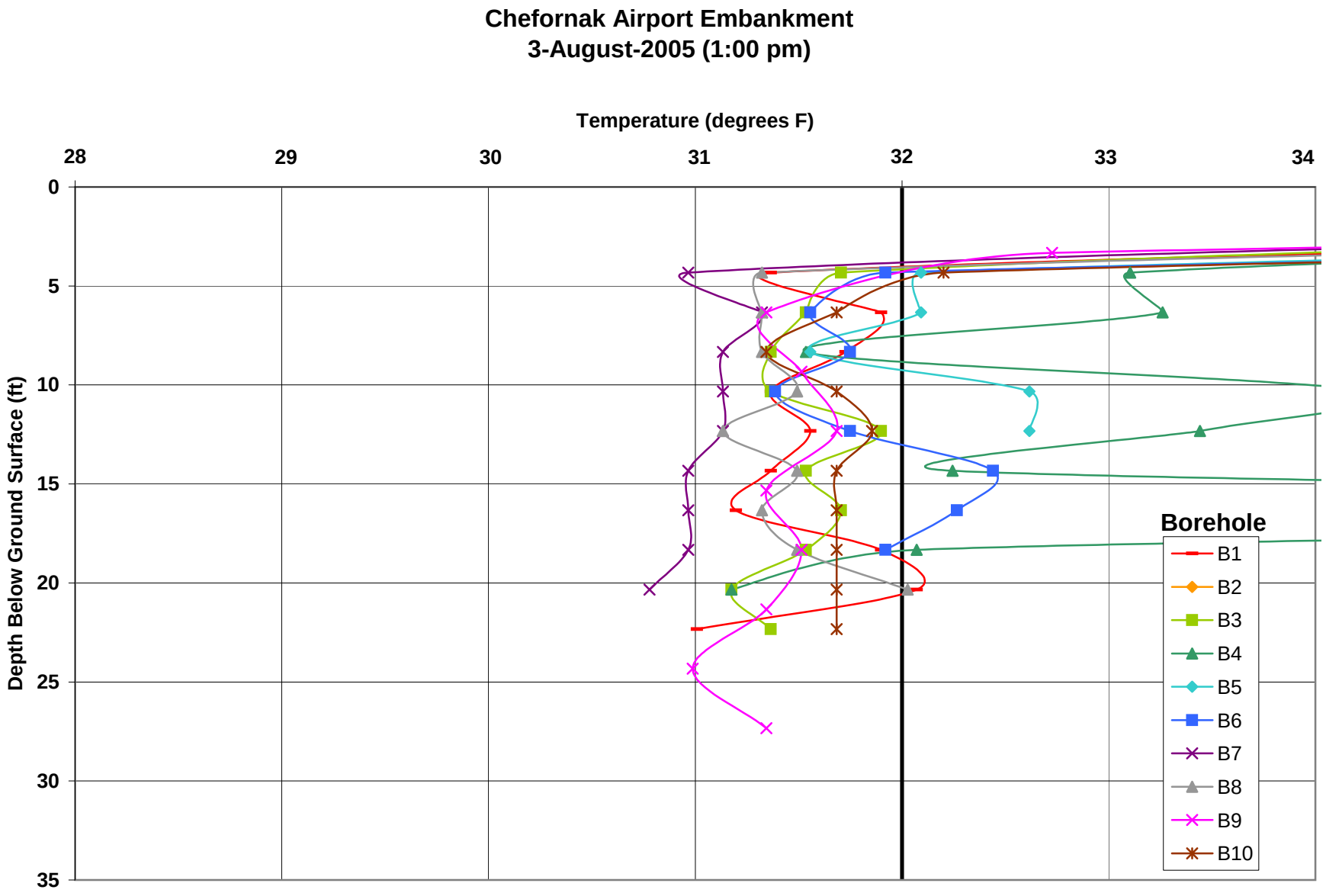
Chefornak Airport Embankment
3-August-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
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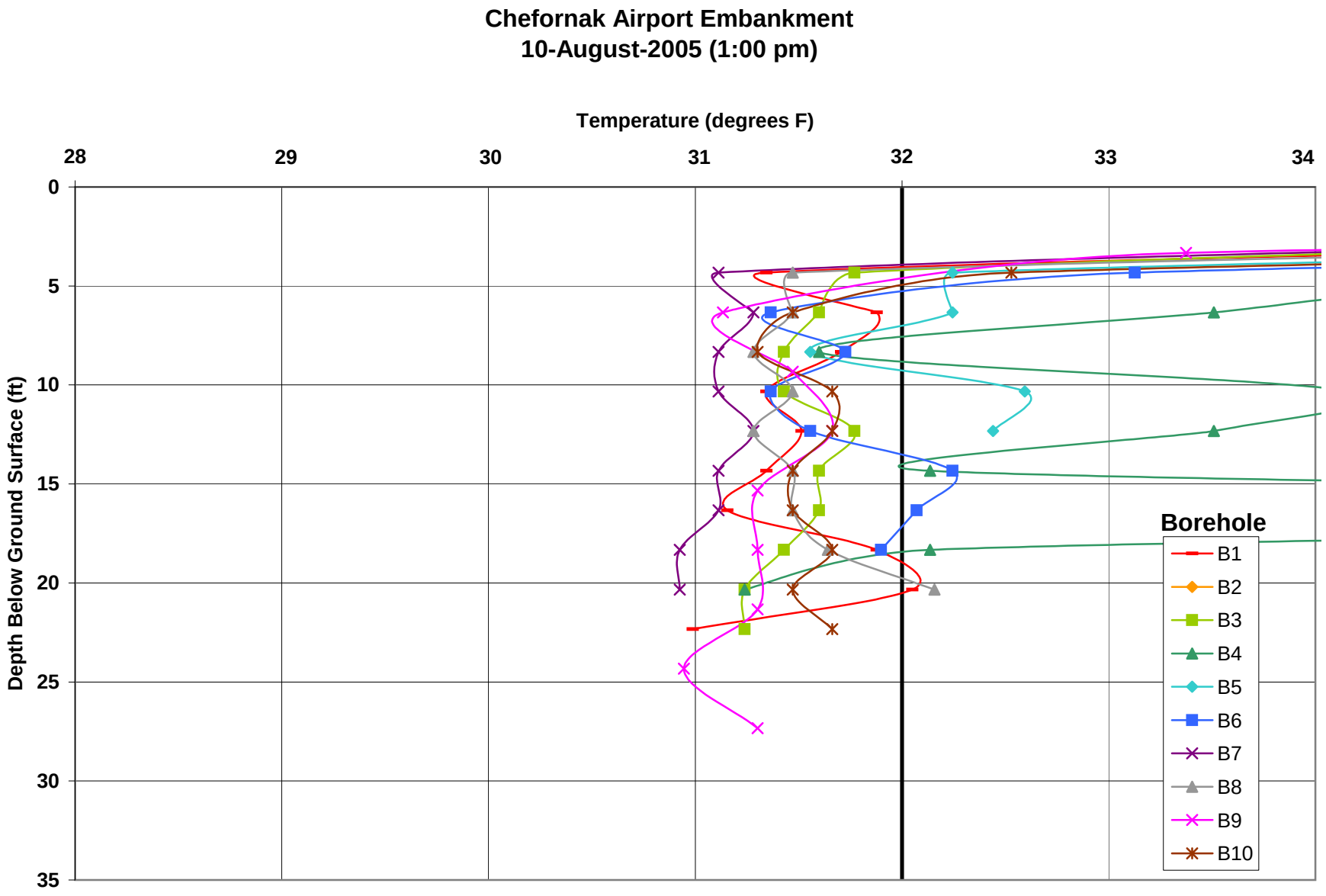
Chefornak Airport Embankment
10-August-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
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30
35
Borehole
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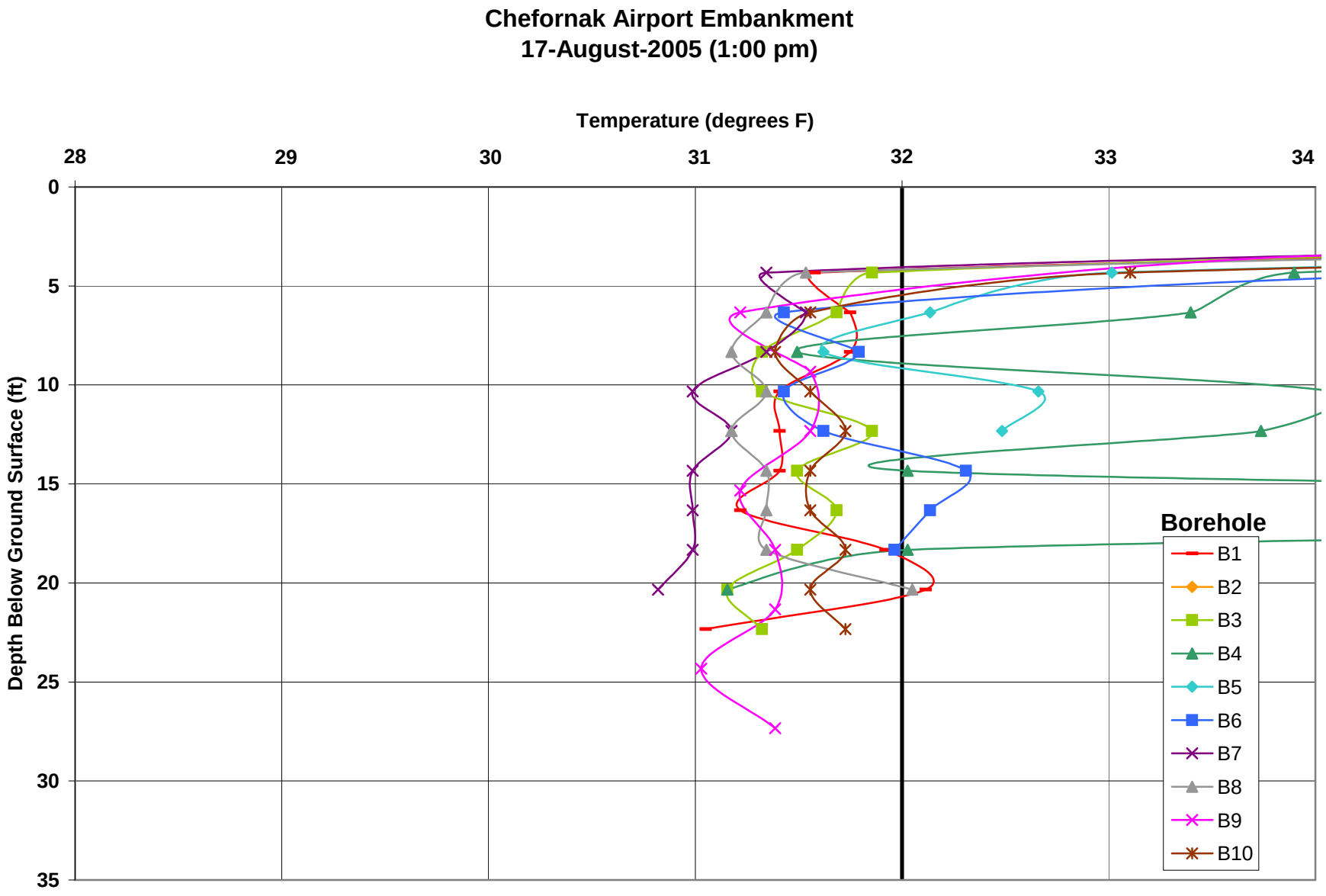
Chefornak Airport Embankment
17-August-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
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25
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35
Borehole
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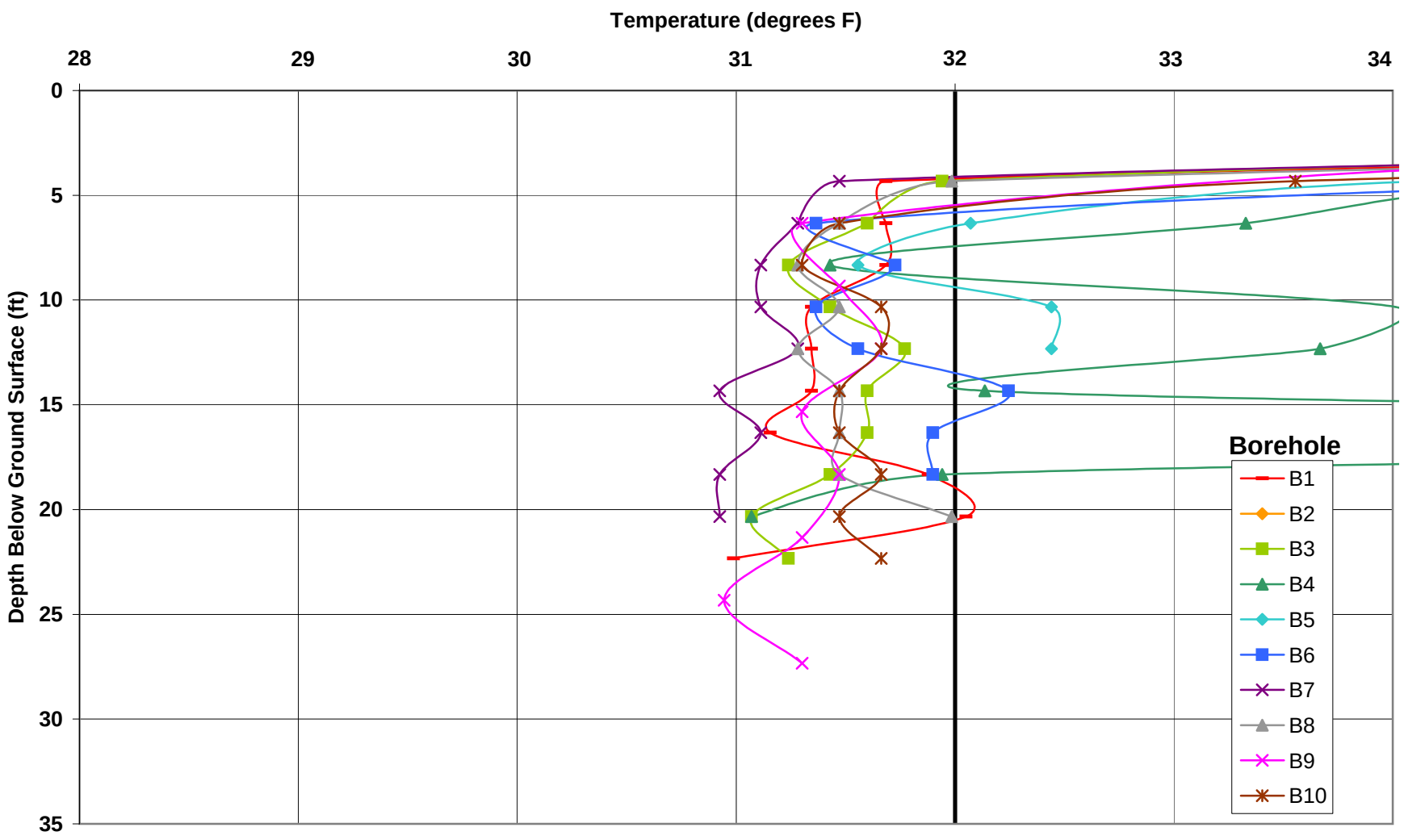
Chefornak Airport Embankment
24-August-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
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35
Borehole
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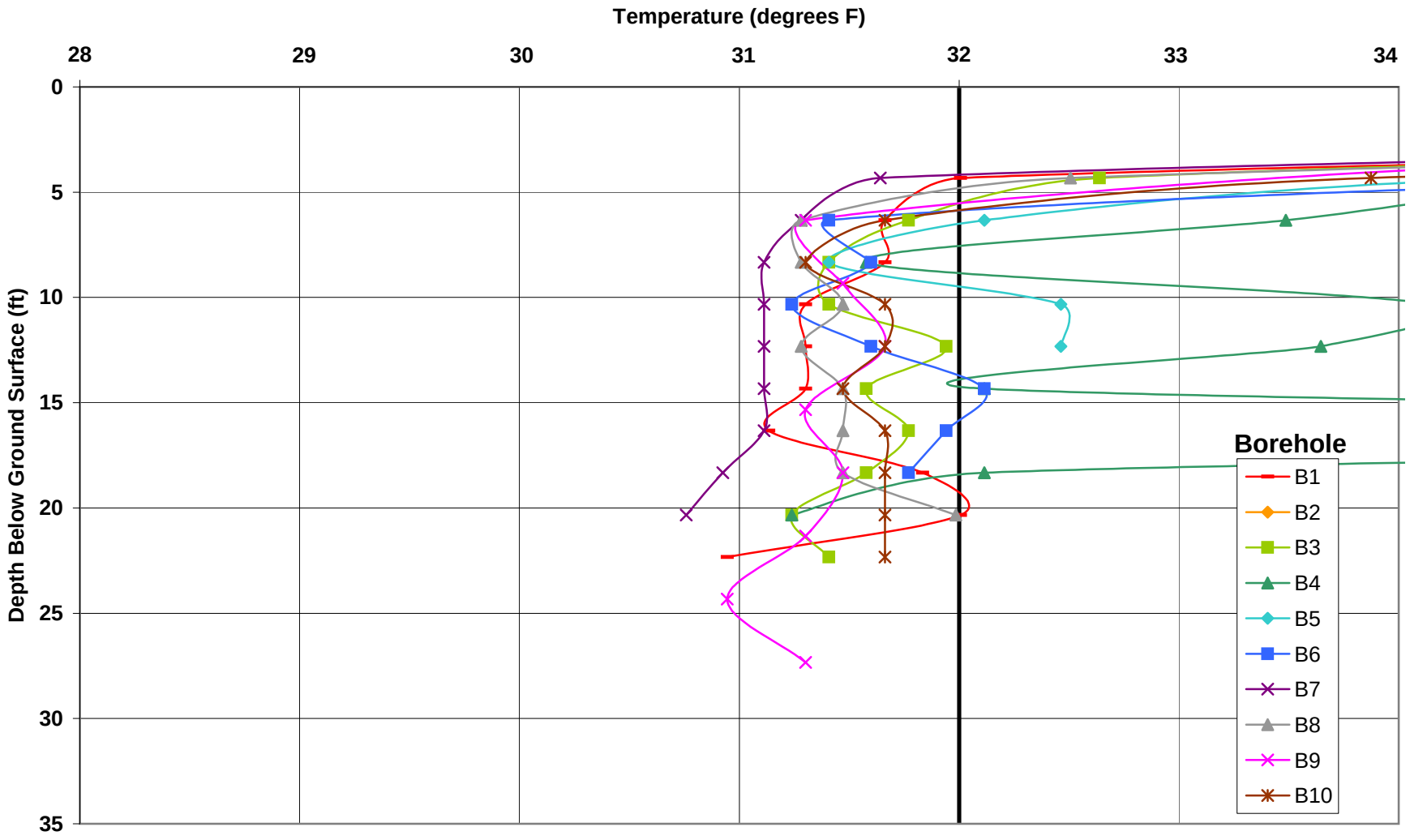
Chefornak Airport Embankment
31-August-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
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Borehole
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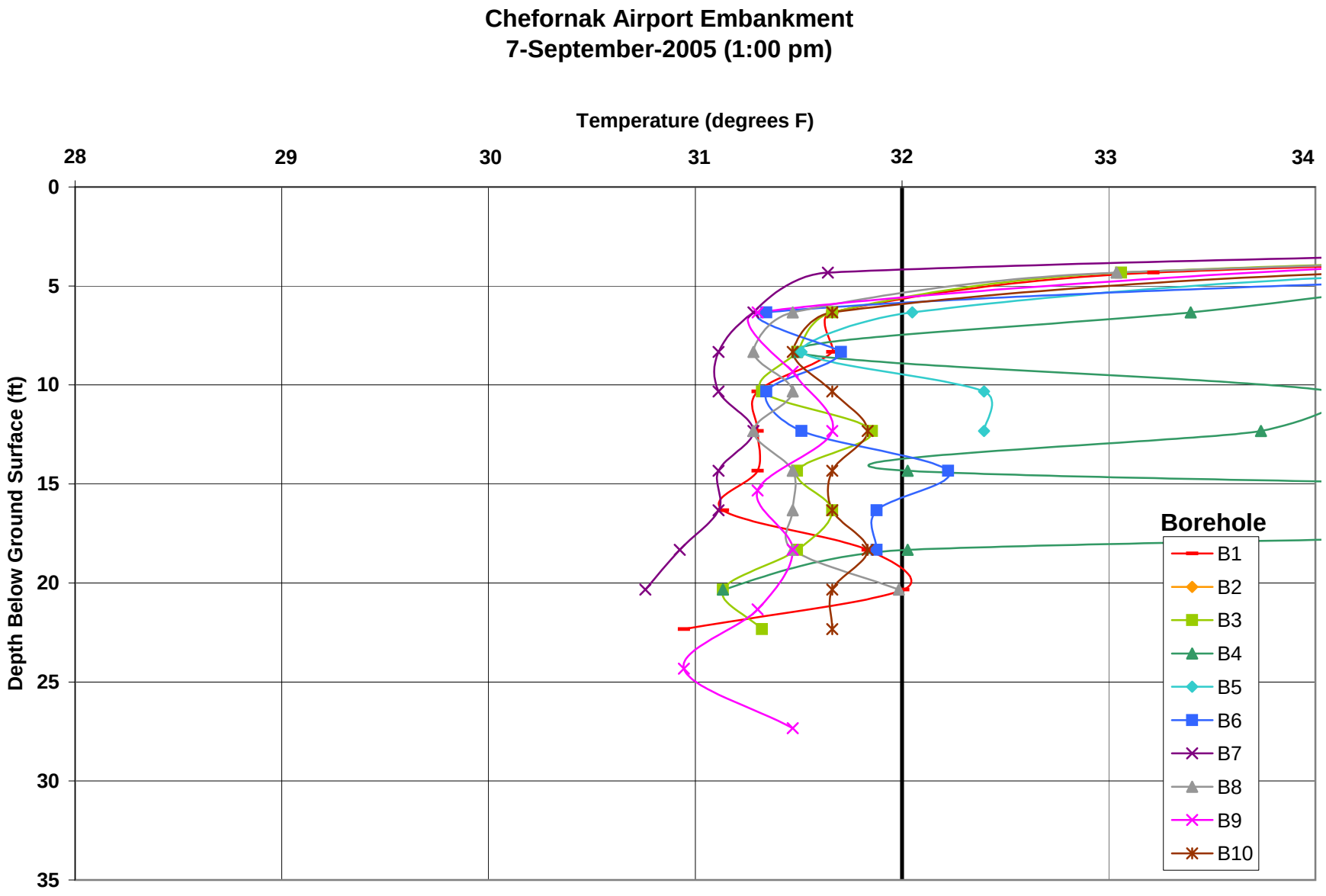
Chefornak Airport Embankment
7-September-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
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Borehole
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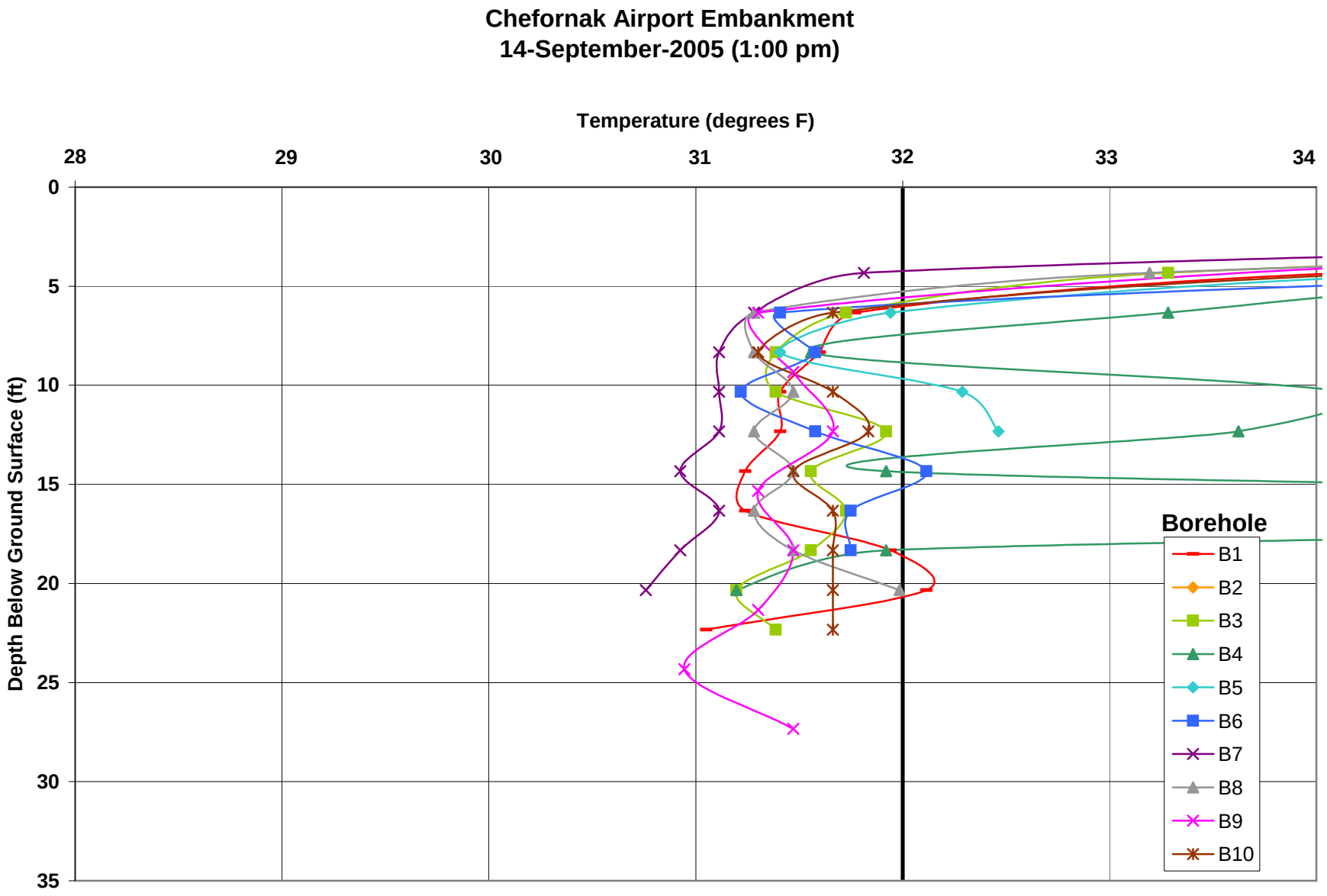
Chefornak Airport Embankment
14-September-2005 (1:00 pm)
Temperature (degrees F)
28
29
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31
32
33
34
Depth Below Ground Surface (ft)
0
5
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Borehole
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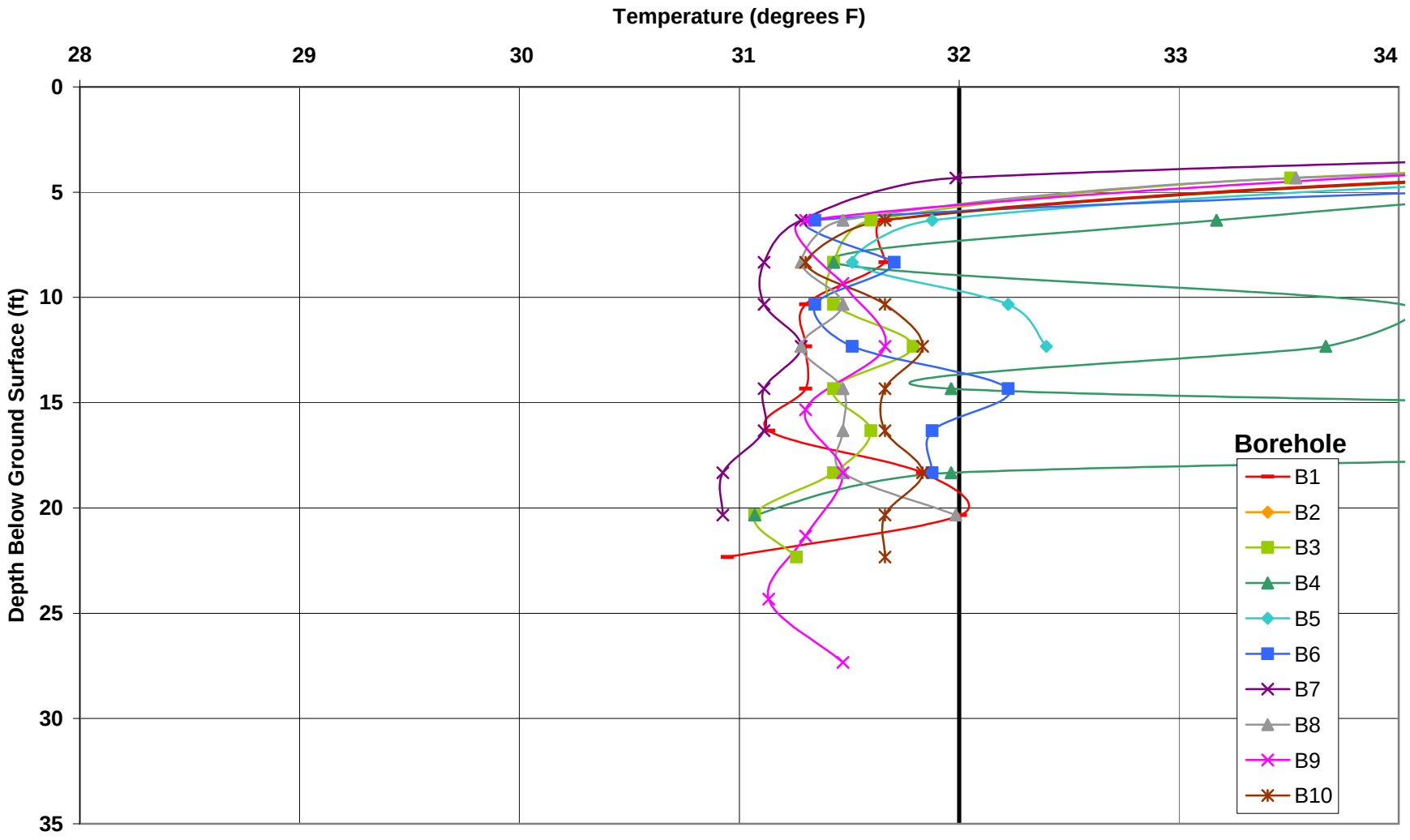
Chefornak Airport Embankment
21-September-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
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25
30
35
Borehole
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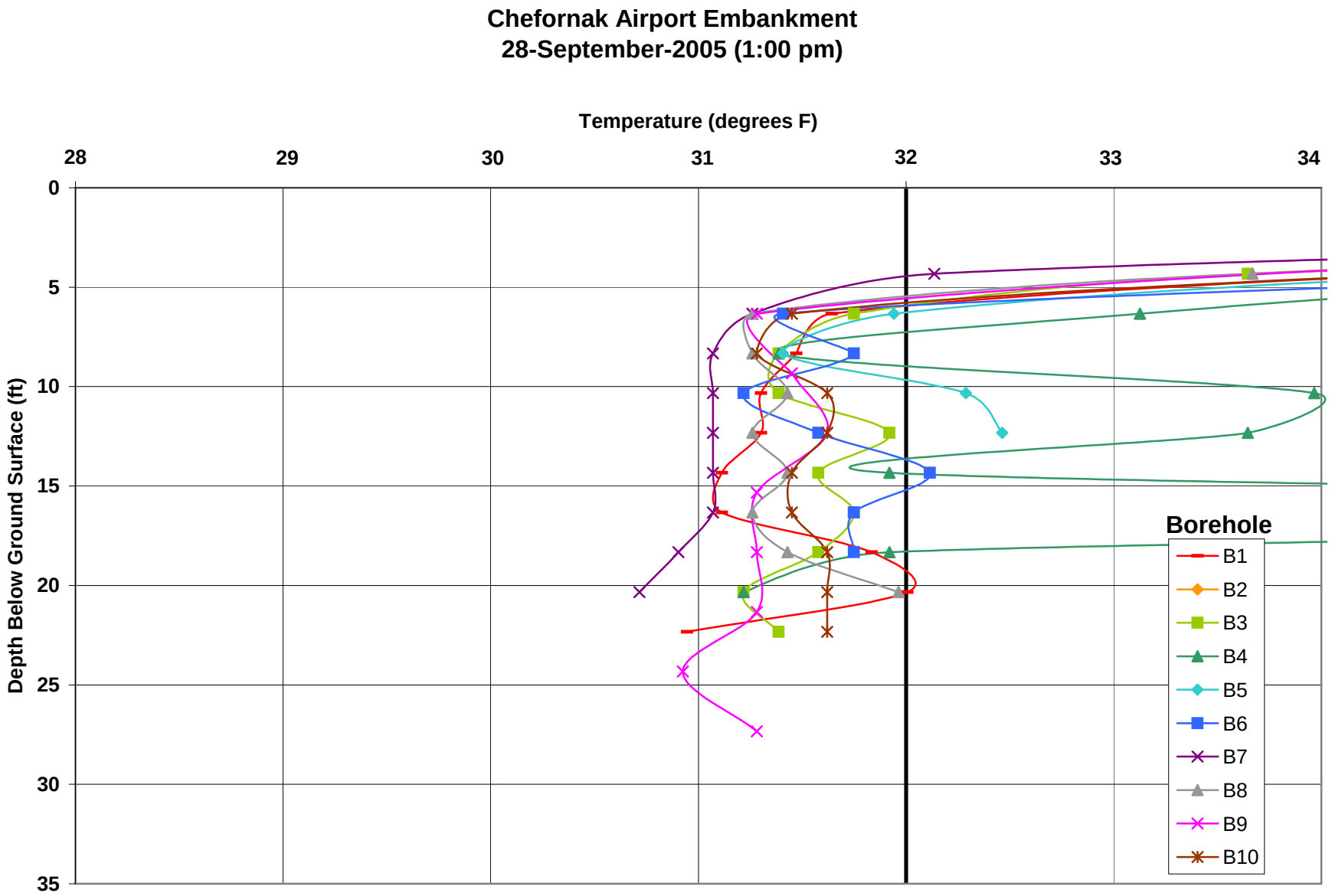
Chefornak Airport Embankment
28-September-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
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25
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35
Borehole
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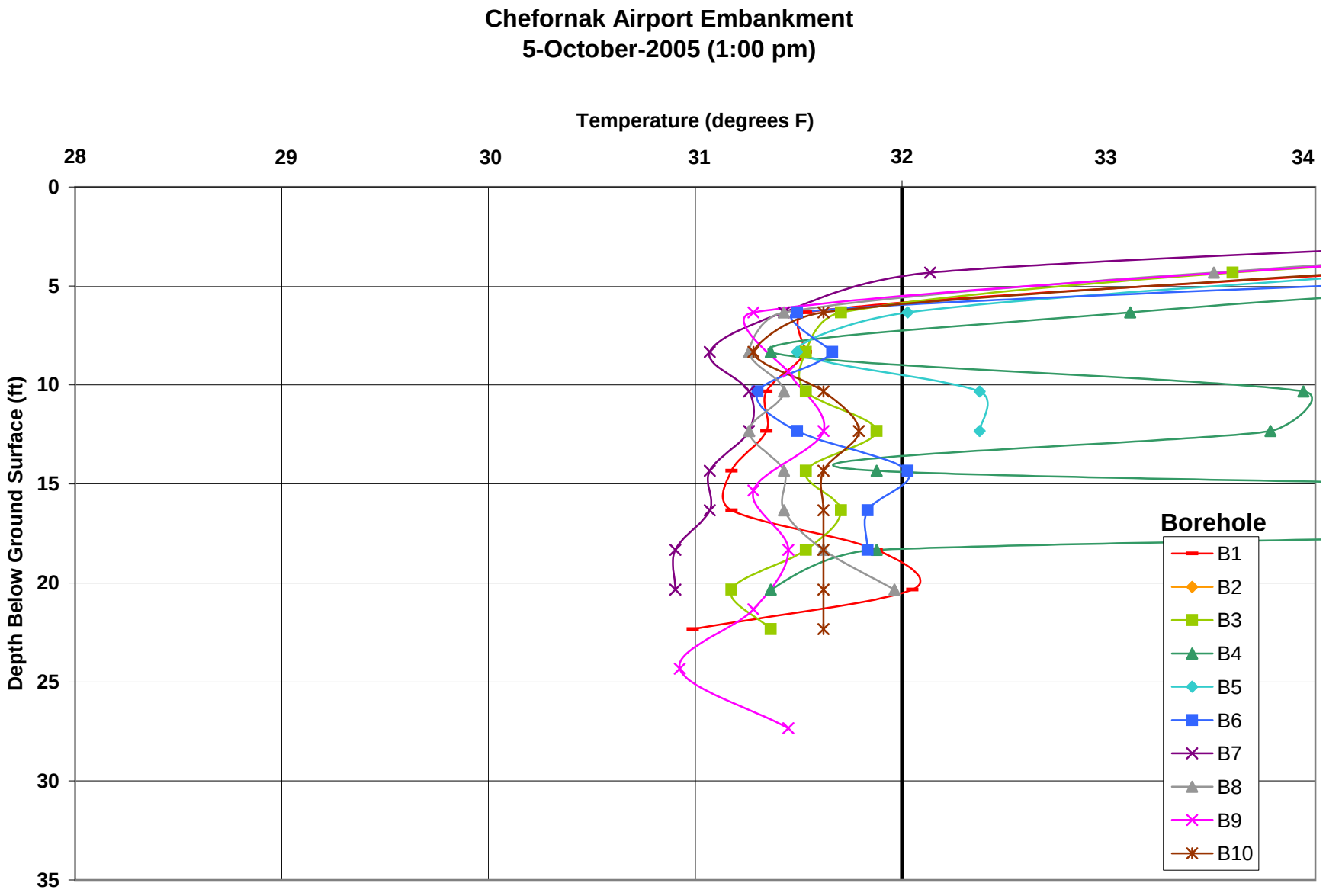
Chefornak Airport Embankment
5-October-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
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15
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25
30
35
Borehole
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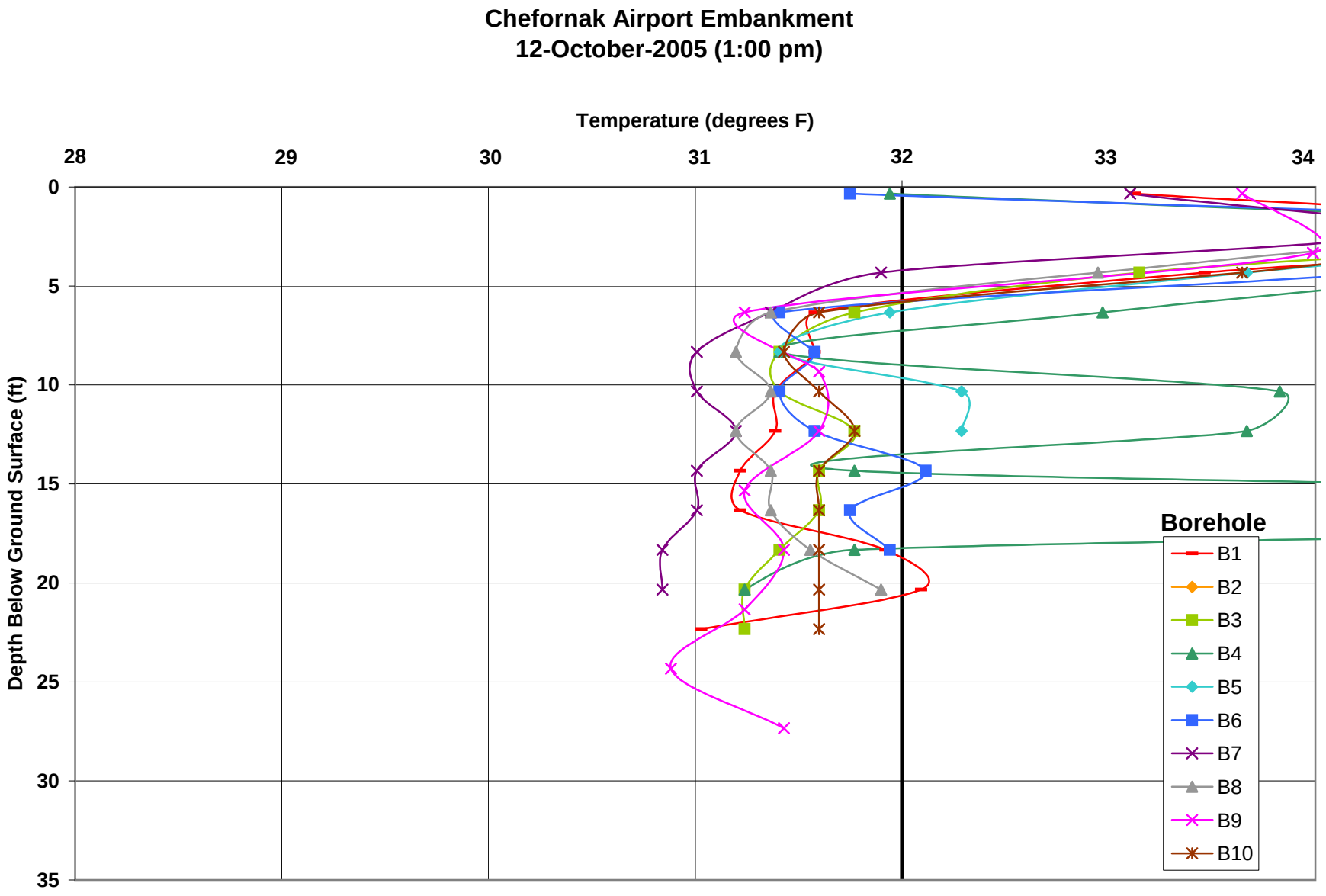
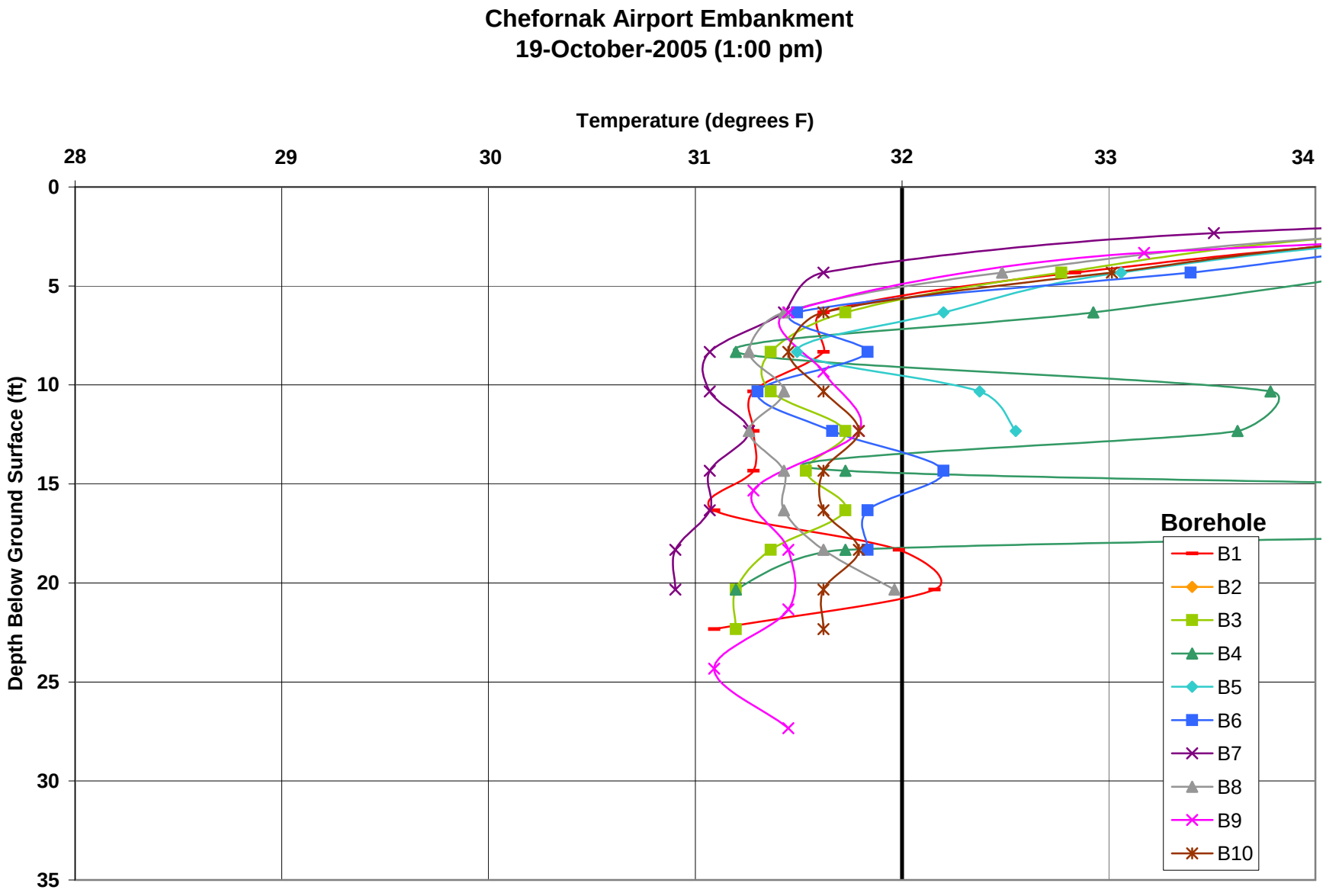

Chefornak Airport Embankment
12-October-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
19-October-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
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B6
B7
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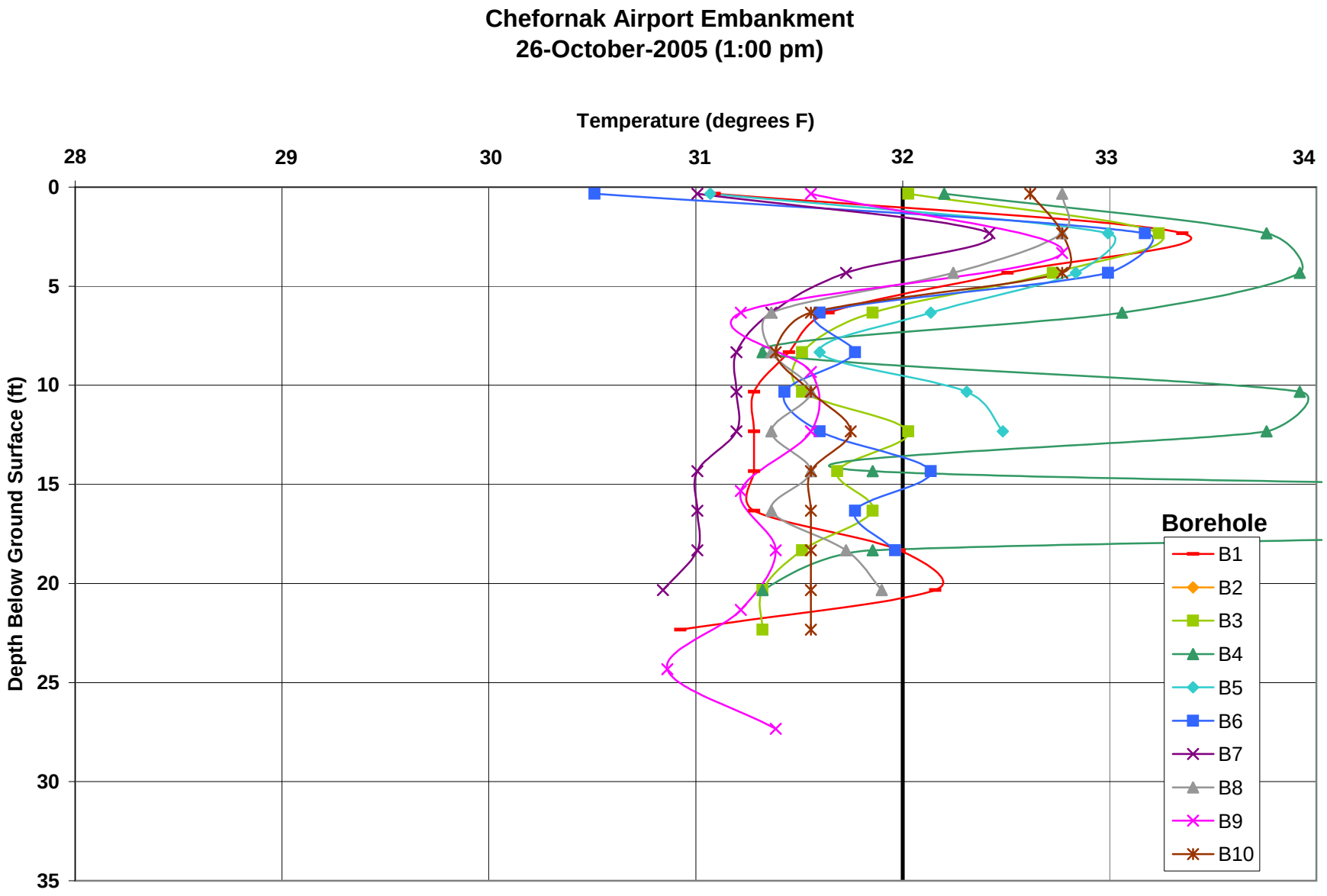
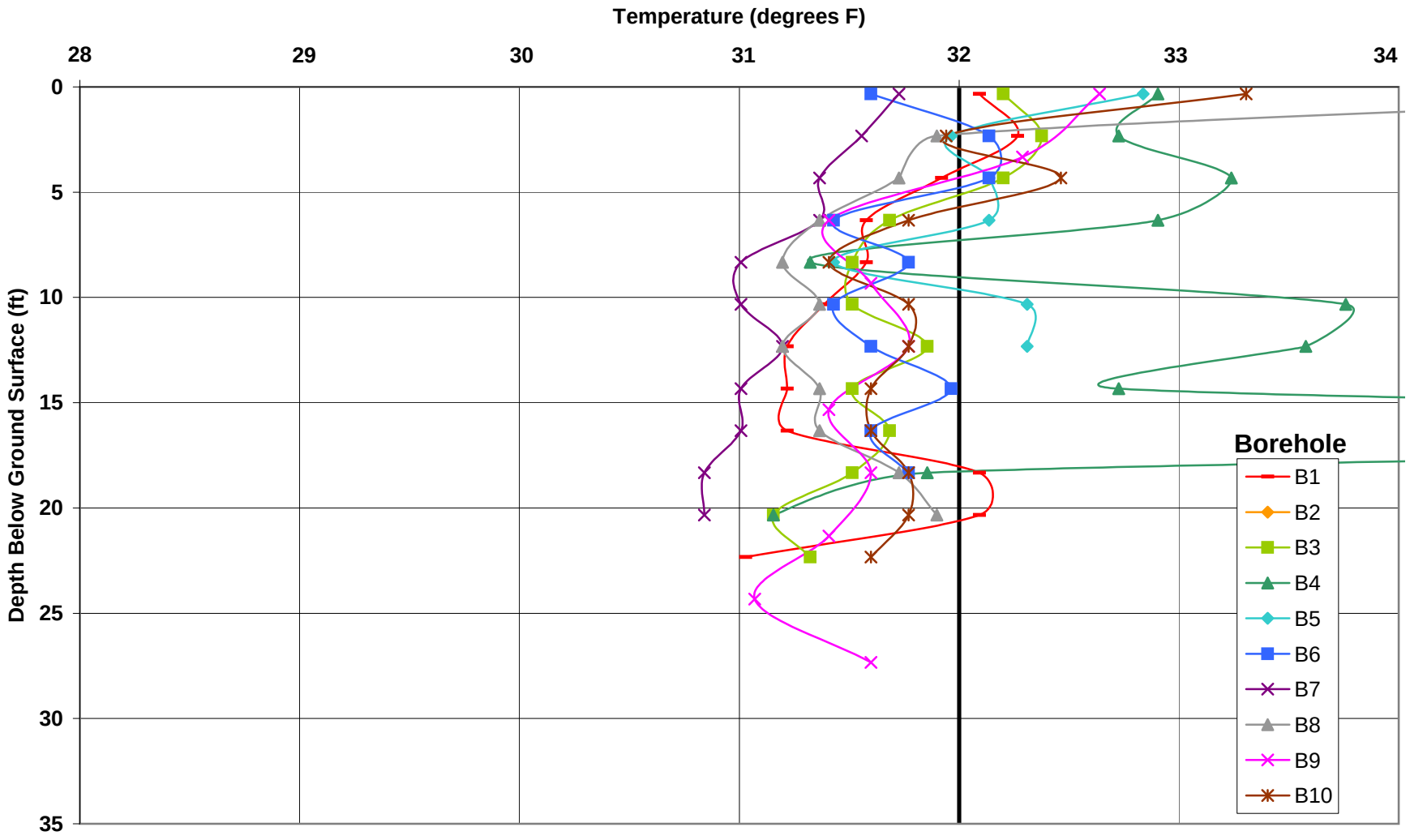
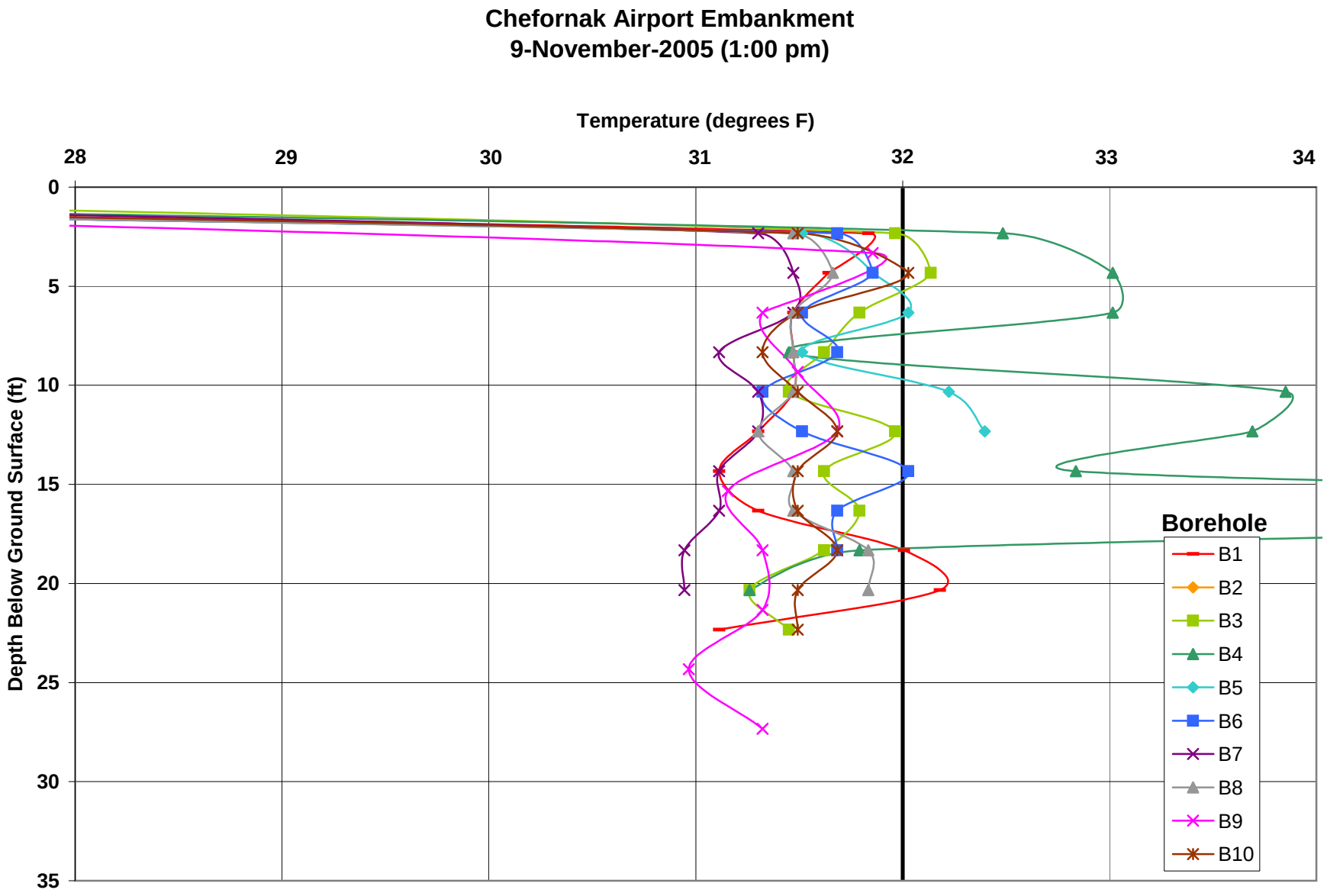
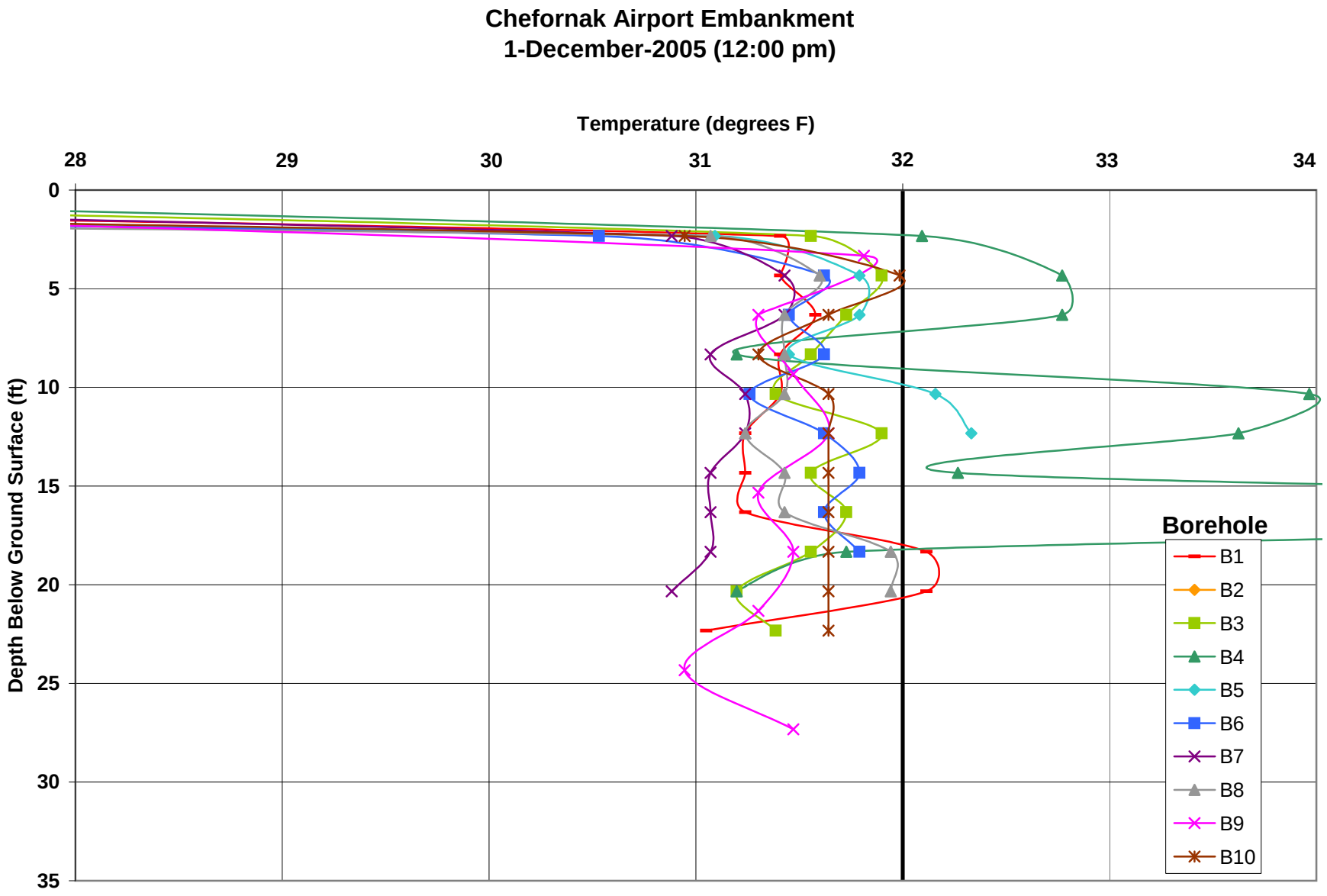
B10


Chefornak Airport Embankment
26-October-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
2-November-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
9-November-2005 (1:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-December-2005 (12:00 pm)
Temperature (degrees F)
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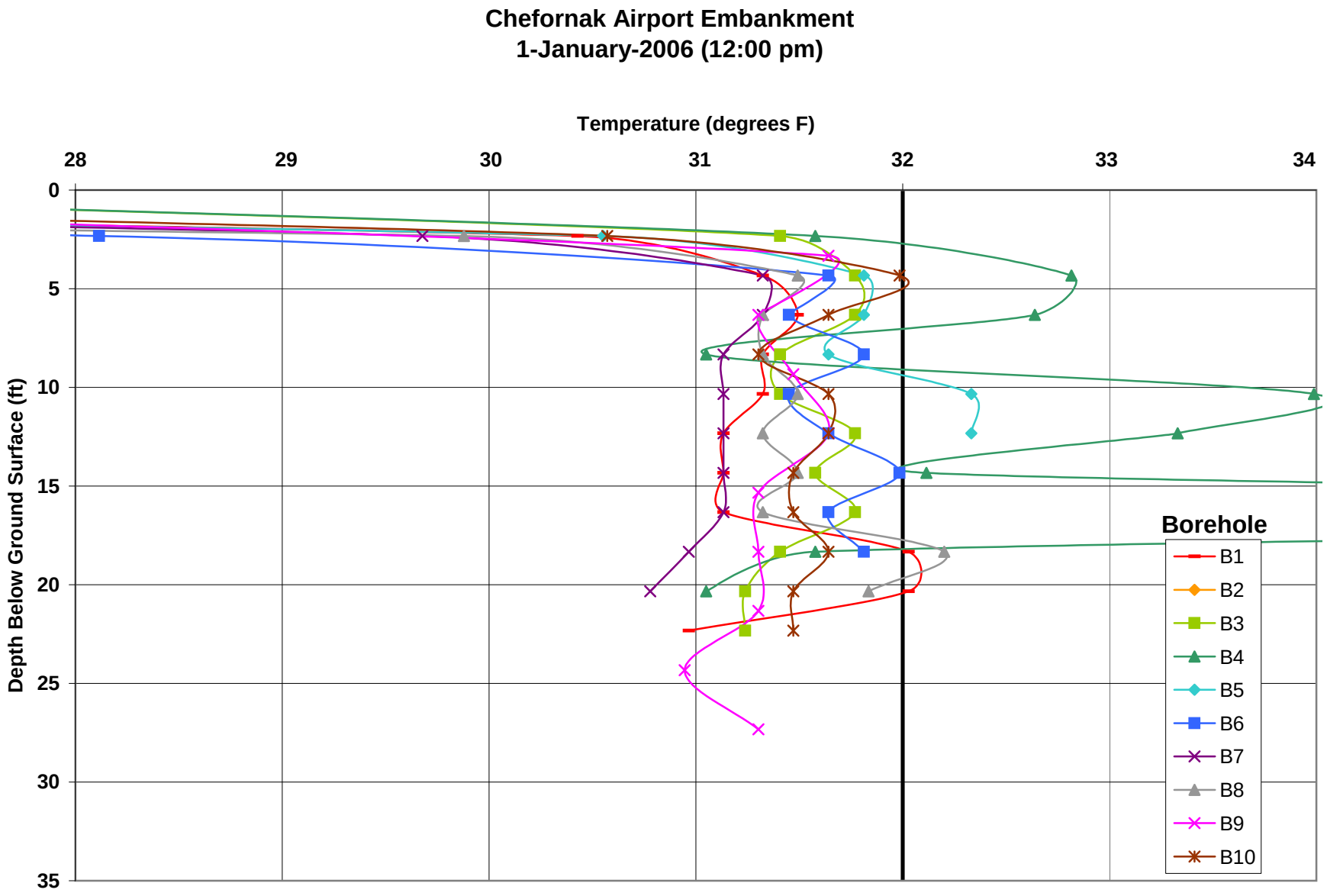
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-January-2006 (12:00 pm)
Temperature (degrees F)
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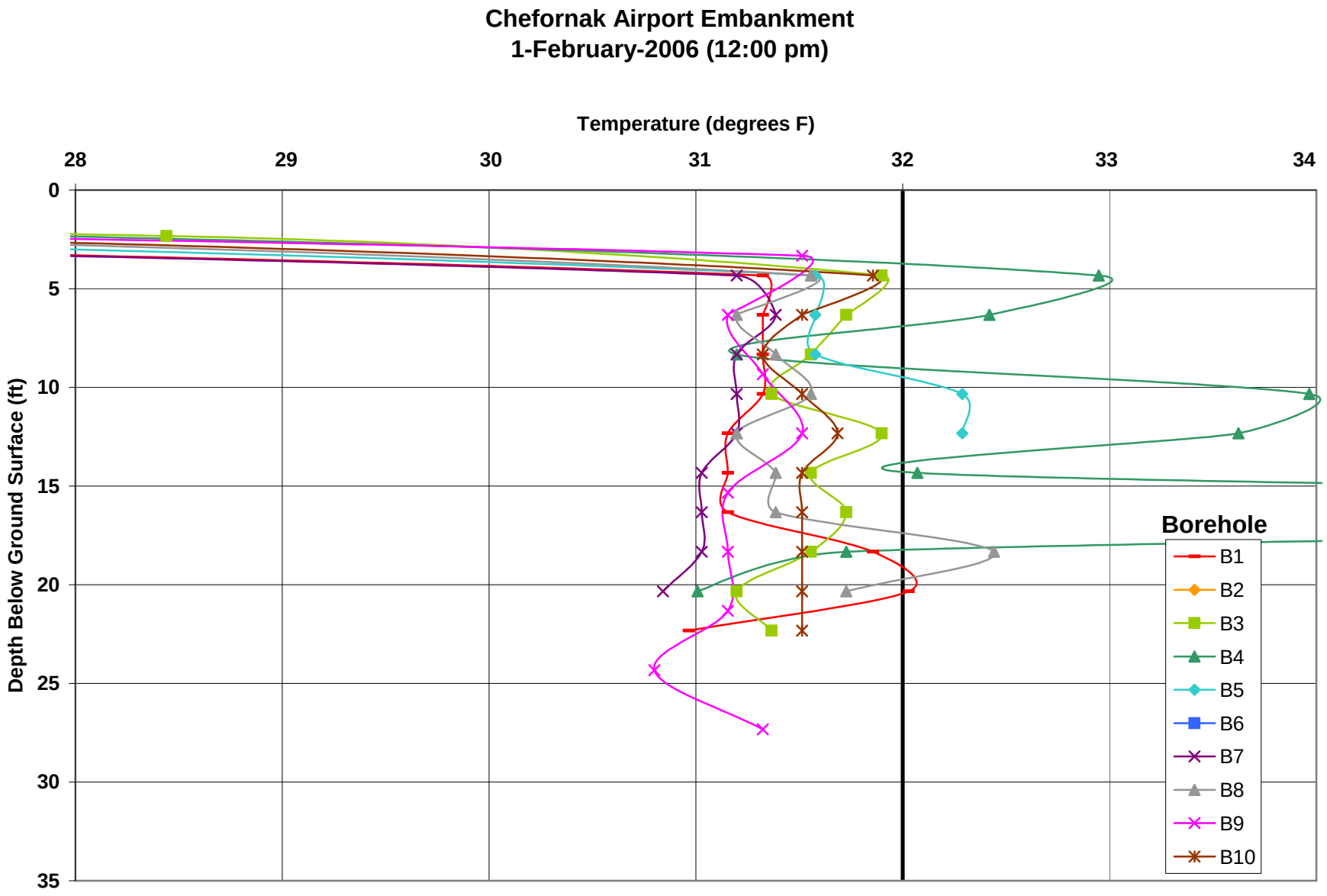
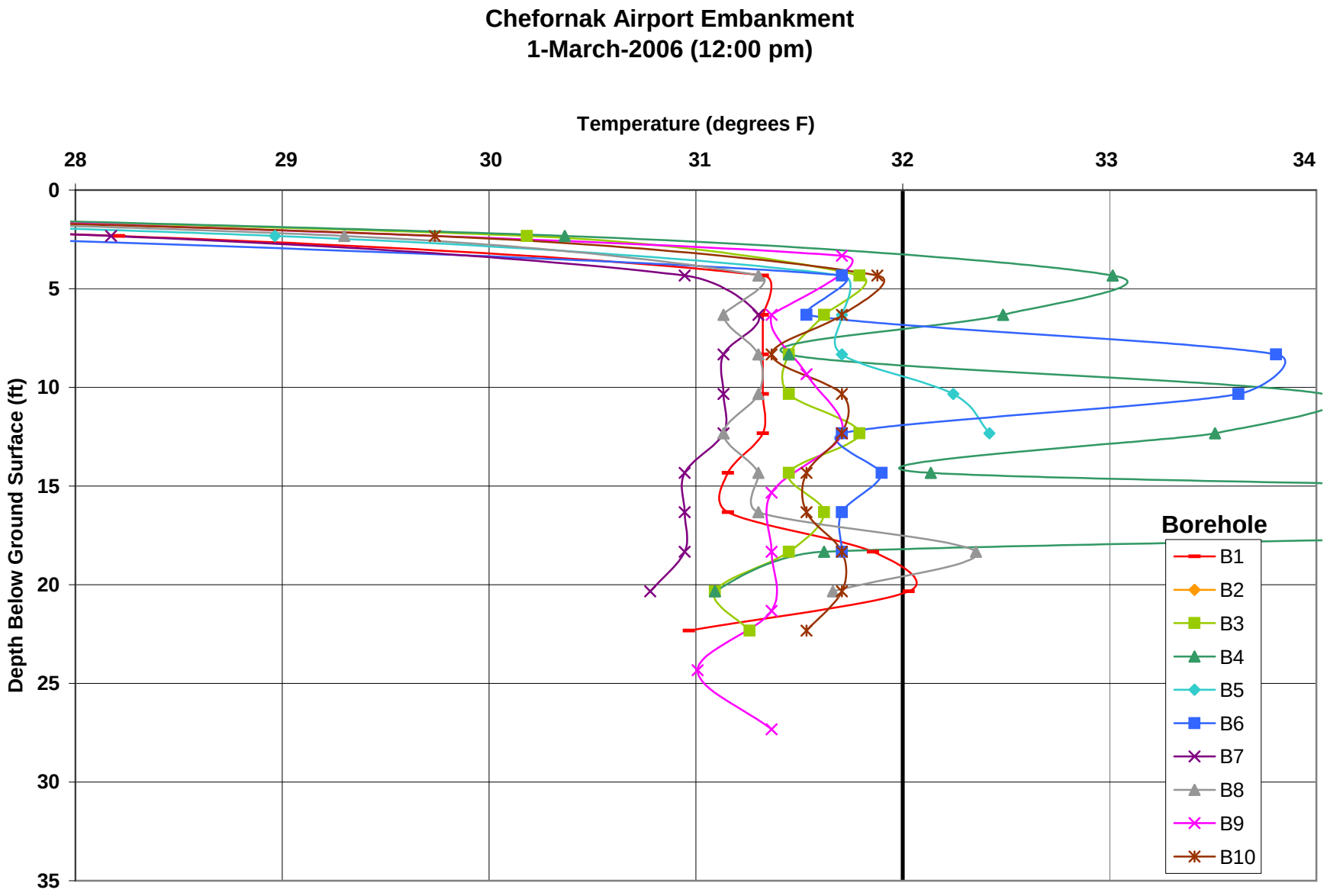
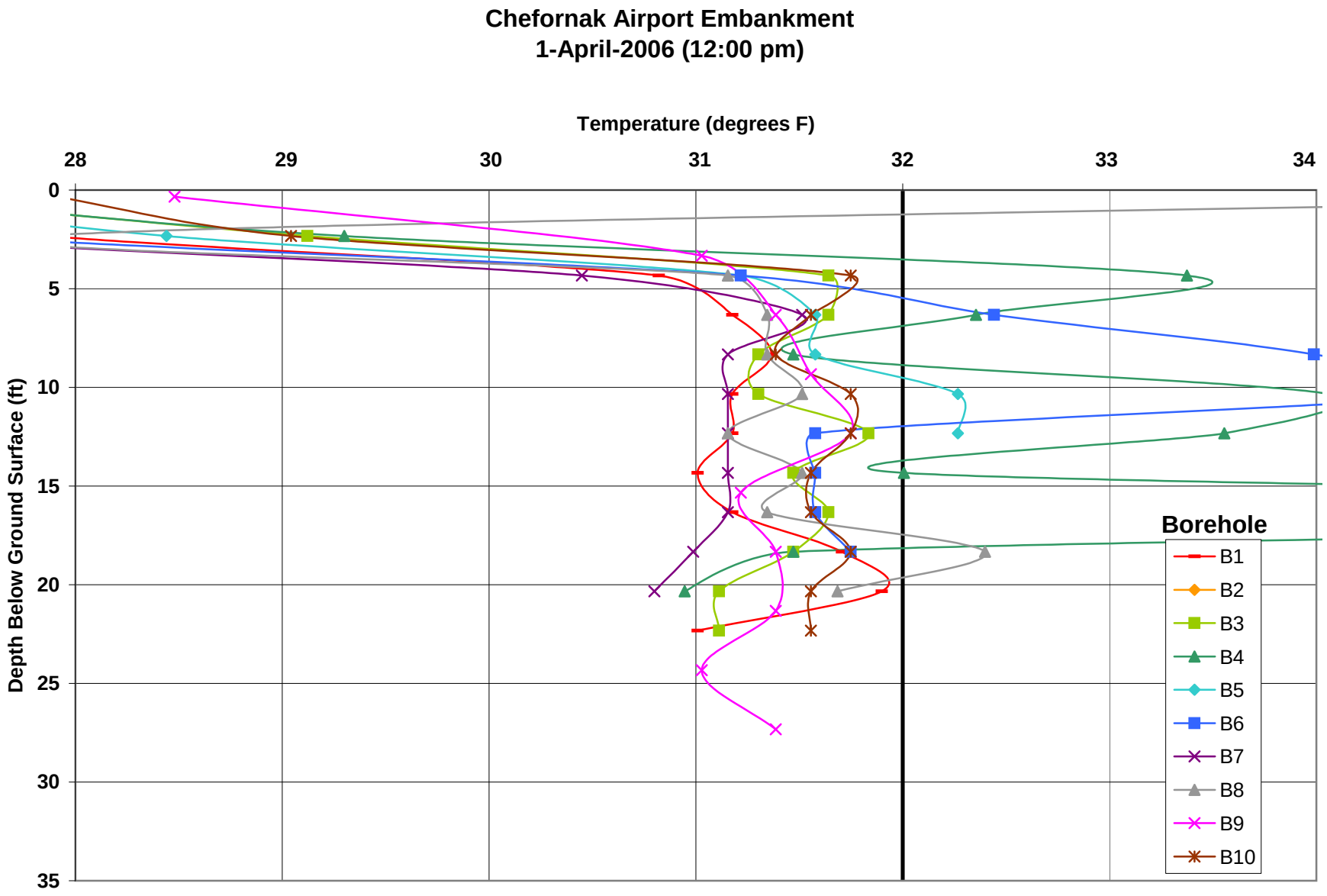
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-February-2006 (12:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-March-2006 (12:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-April-2006 (12:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
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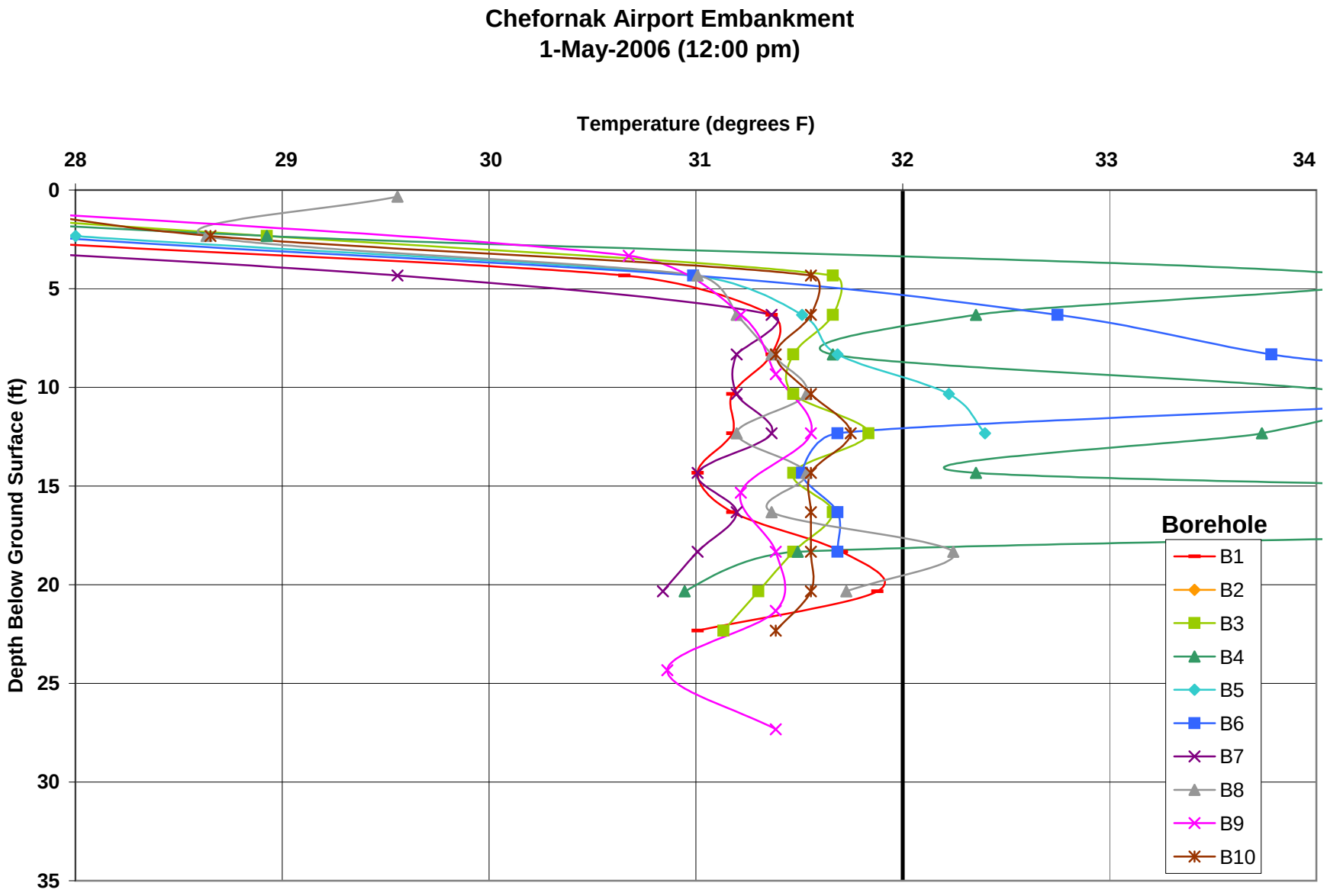
B8
B9
B10


Chefornak Airport Embankment
1-May-2006 (12:00 pm)
Temperature (degrees F)
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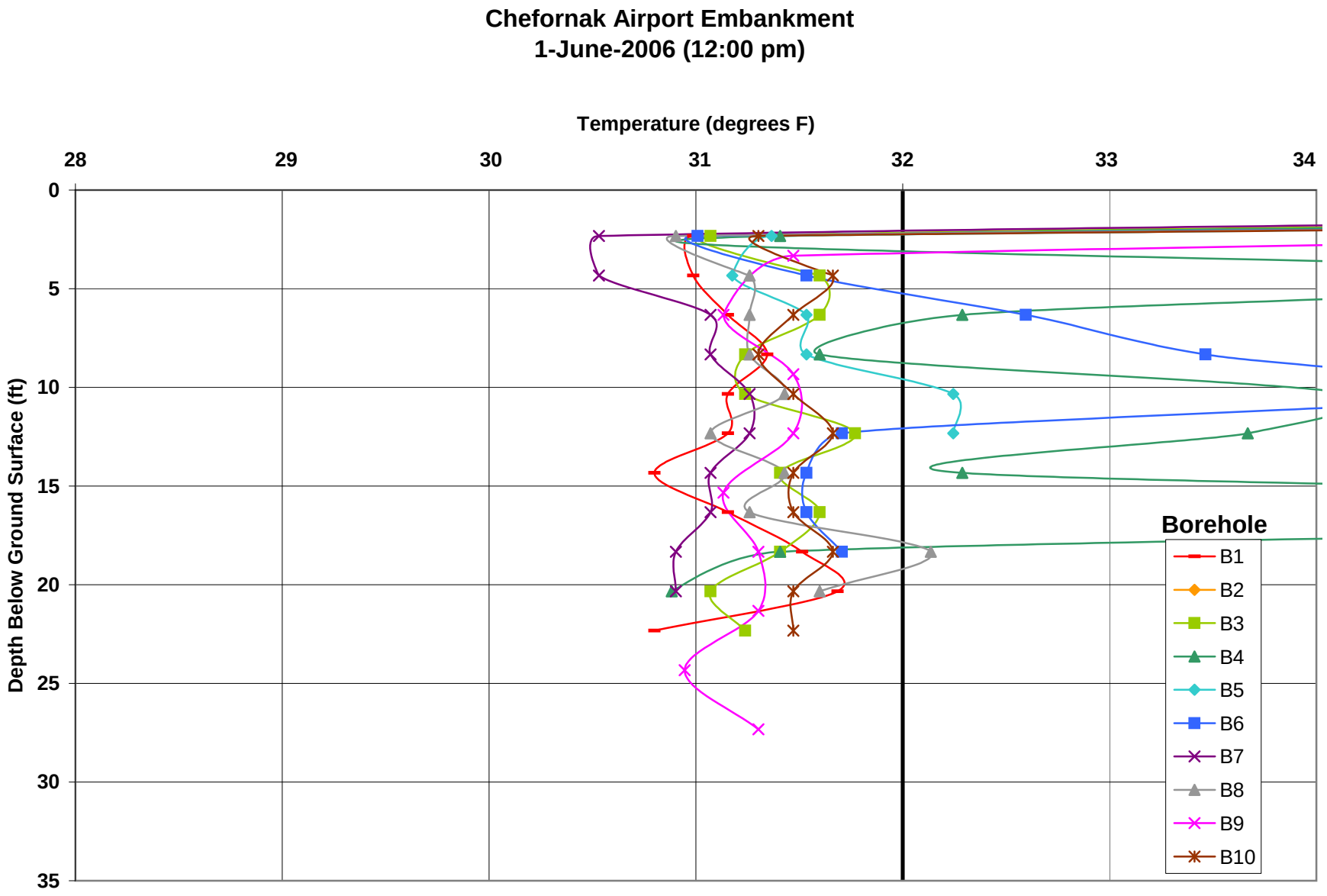
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-June-2006 (12:00 pm)
Temperature (degrees F)
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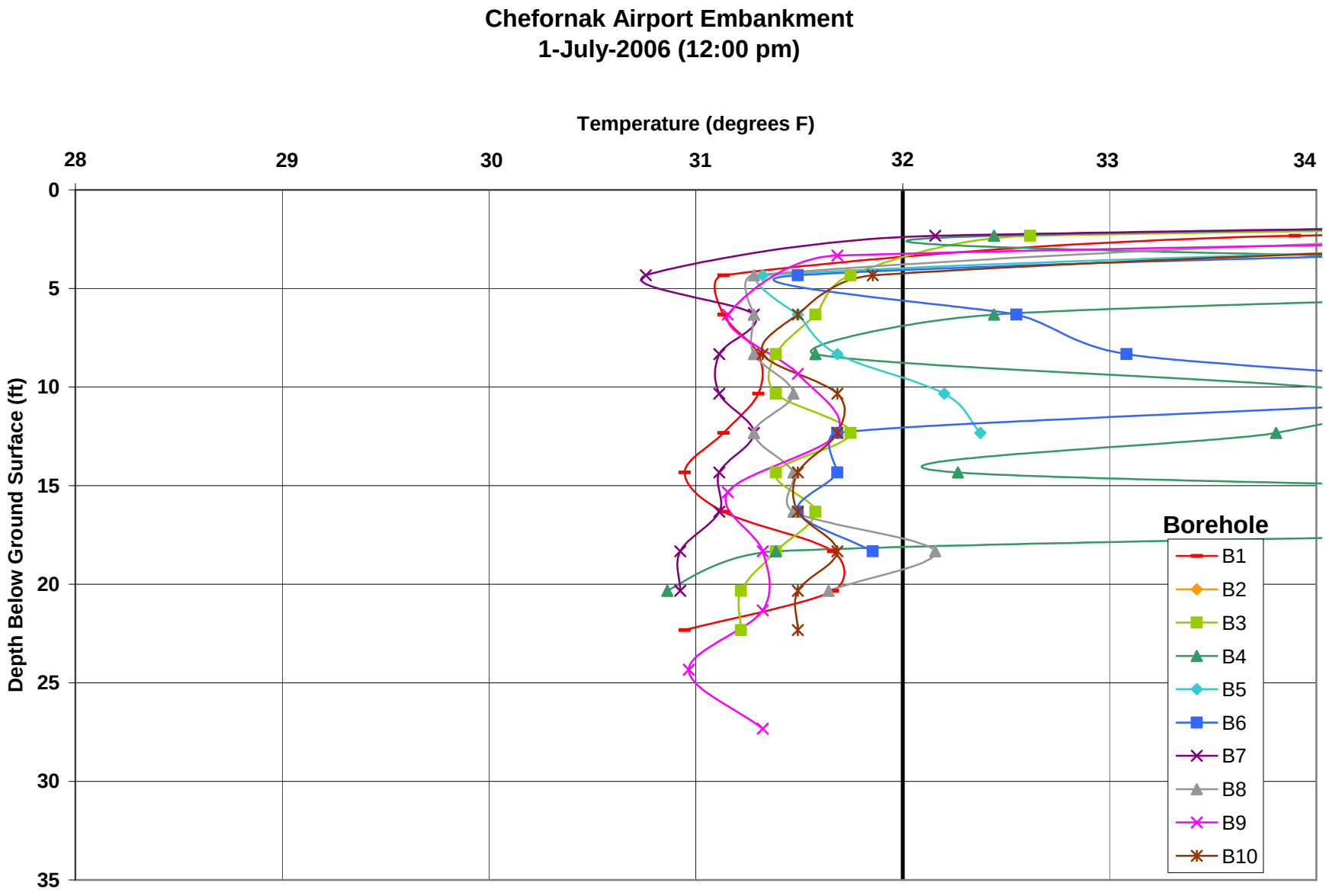
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-July-2006 (12:00 pm)
Temperature (degrees F)
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29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
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25
30
35
Borehole
B1
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B3
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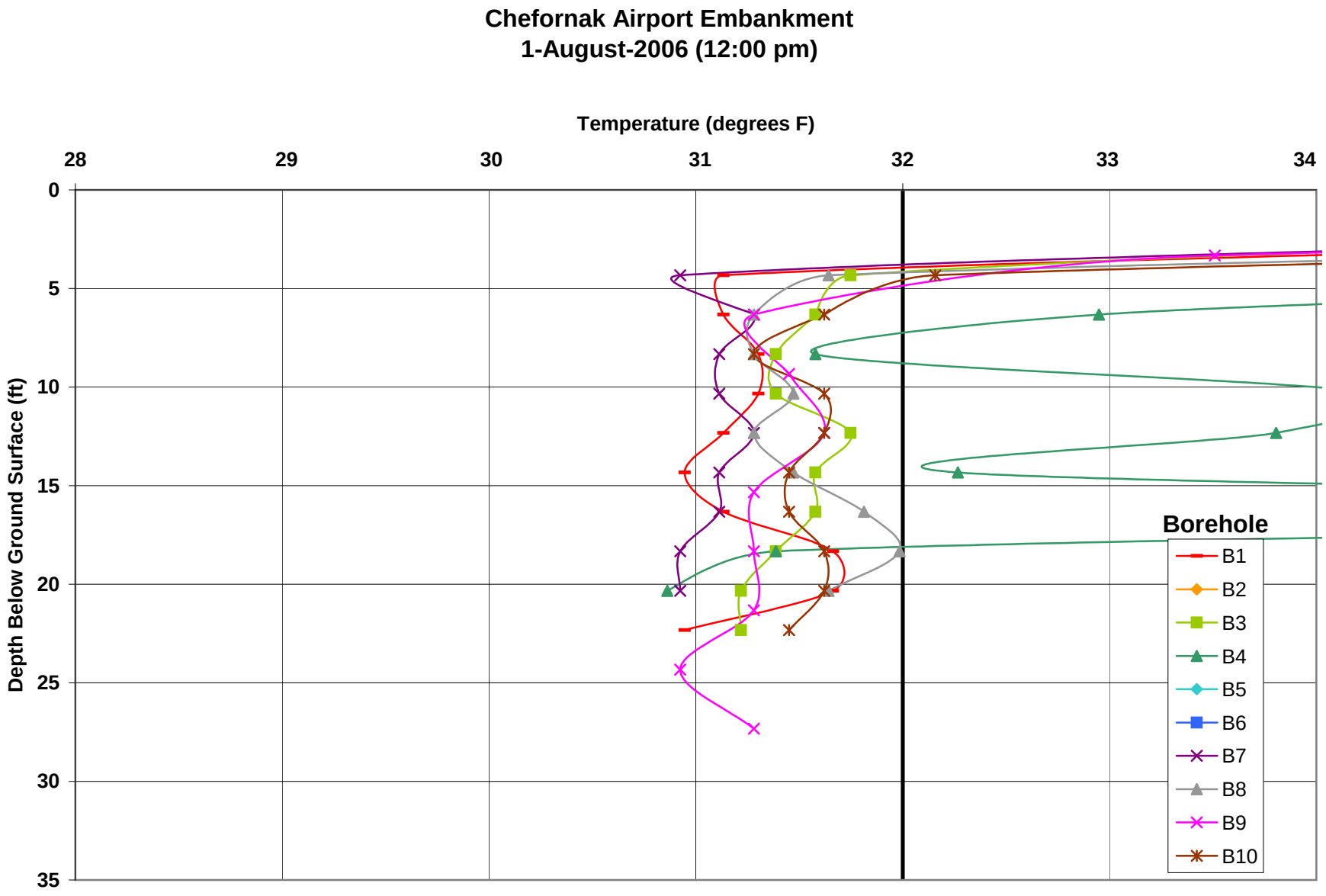
Chefornak Airport Embankment
1-August-2006 (12:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
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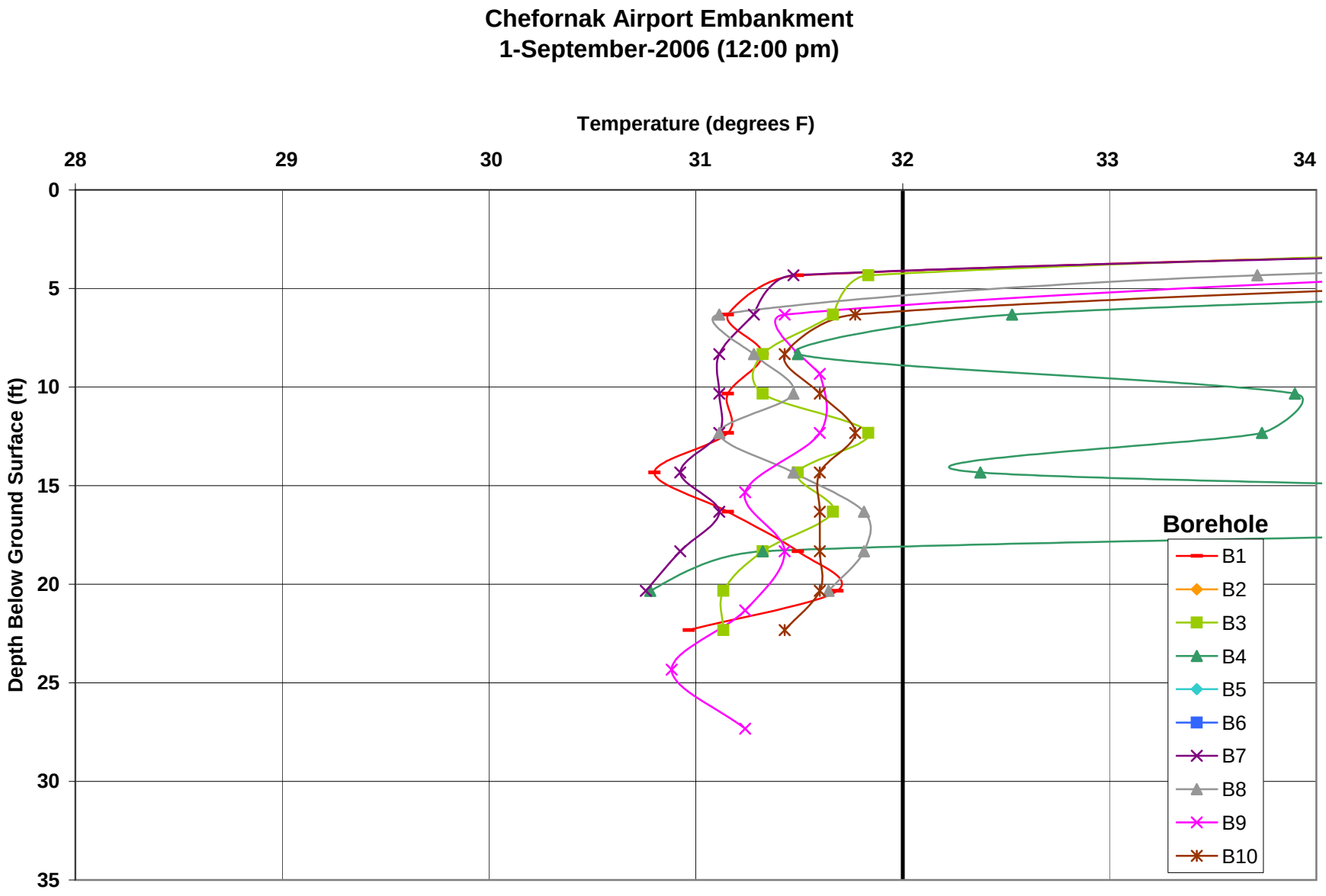
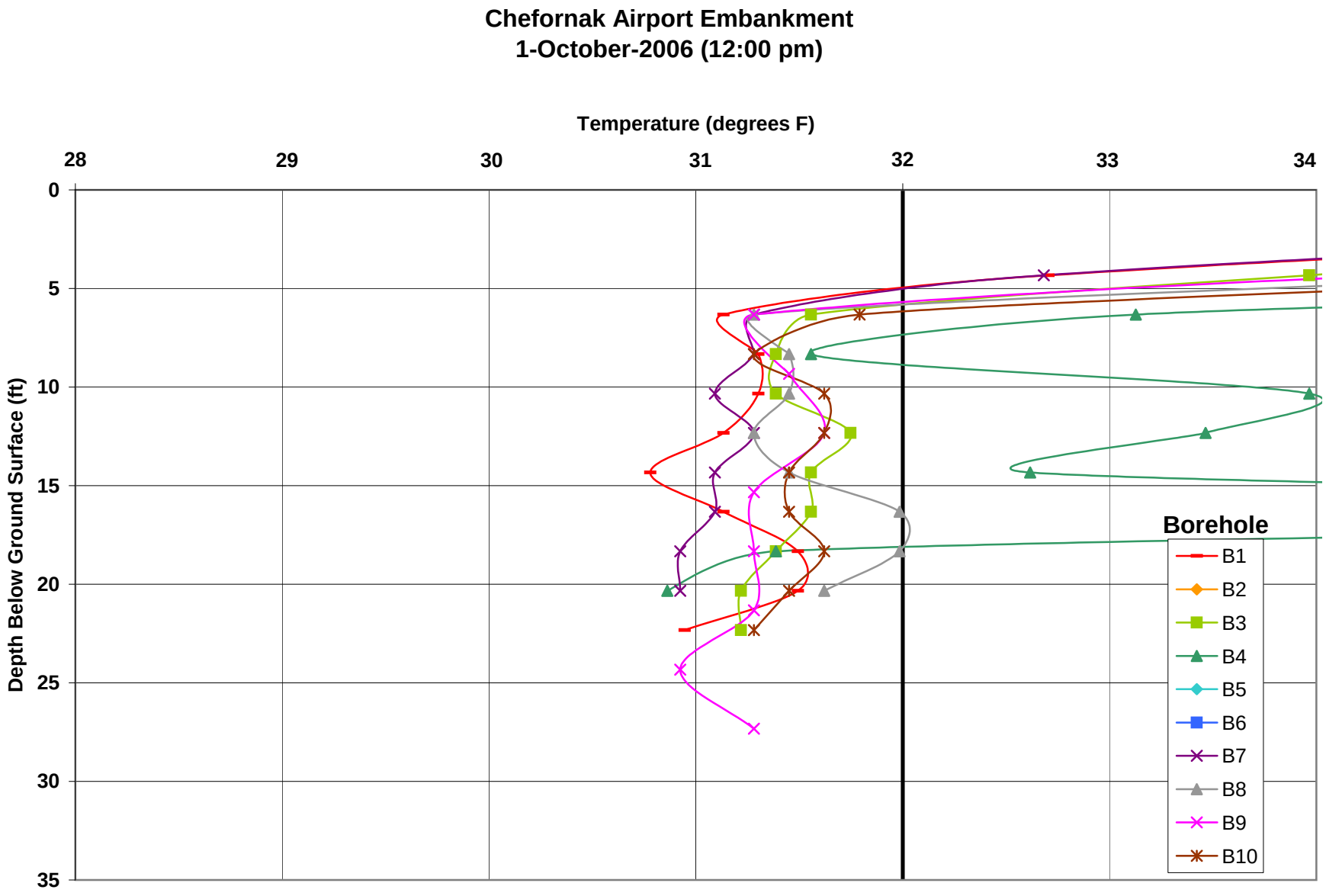

Chefornak Airport Embankment
1-September-2006 (12:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
B5
B6
B7
B8
B9
B10


Chefornak Airport Embankment
1-October-2006 (12:00 pm)
Temperature (degrees F)
28
29
30
31
32
33
34
Depth Below Ground Surface (ft)
0
5
10
15
20
25
30
35
Borehole
B1
B2
B3
B4
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APPENDIX C

Summary of Laboratory Results
Grain Size Curves
Atterberg Limits' Results
Salinity Test Results
Consolidation Test Graphs

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Fines	Class-ification	Water Content (%)	Organic Content (%)	Pore Water Salinity (ppt)
B-01	9.0				0.3	1.7	97.9	ML	43.5		
B-01	13.0								62.3		
B-01	14.0								500.6		
B-01	19.0				0.0	3.1	96.9	ML	225.7		
B-01	24.0								60.2		
B-02	1.0								44.3		
B-02	9.0						90.1	ML	61.0		
B-02	12.0								290.3		
B-02	19.0								259.1		
B-02	24.0	73	NP	NP					55.1		
B-02	29.0								48.3		
B-02	34.0								45.1		
B-03	2.0								41.4		
B-03	12.0								536.9		
B-03	14.0								169.3		
B-03	19.0				0.0	1.1	98.9	ML	55.5		
B-03	24.0								38.7		
B-04	1.5								22.3		
B-04	3.0								51.4		
B-04	7.0				14.5	6.5	79.0	ML	50.7		
B-04	9.0								333.6		
B-04	10.5	89	NP	NP					213.5		
B-04	14.0								32.9		
B-04	22.0								26.6		
B-05	6.0						29.1		12.5		
B-05	9.0				0.0	27.4	72.6	ML	113.7		
B-06	2.0								25.0		
B-06	4.0								21.1		
B-06	10.5								82.3		
B-06	14.0				0.0	3.1	96.9	ML	28.1		
B-06	19.0								18.6		
B-07	1.5								71.7		
B-07	6.0				5.4	3.3	91.3	ML	41.2		
B-07	9.0								686.6		
B-07	14.0				0.0	7.0	93.0	ML	34.5		
B-07	19.0								64.5		
B-07	22.0								24.4		
B-08	9.0								64.7		
B-08	11.0						29.9		18.2		
B-08	13.0								71.5		
B-08	14.5								7.3		
B-08	17.0								25.4		

Summary of Laboratory Results

Chefornak Airport Embankment

Figure C1

Alaska DOT&PF

Chefornak, Alaska

04-108

H:\Jobs\04-108 Chefornak Airport Embankment\CAD\Drawings\04108_GEO_FC1, 1=1, 01/04/06 at 13:30 by mdb
LAYOUT: Model

Borehole	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	% Gravel	% Sand	% Fines	Class-ification	Water Content (%)	Organic Content (%)	Pore Water Salinity (ppt)
B-08	21.5								48.2		
B-09	1.0								34.9		
B-09	12.0				0.0	2.4	97.6	ML	68.9		
B-09	14.0								220.4		
B-09	24.0								65.7		
B-09	29.0								19.0		
B-10	1.0								47.0		
B-10	2.0								50.7		
B-10	7.0				0.0	8.4	91.6	ML	103.4		
B-10	9.0								39.6		
B-10	14.0								54.5		
B-10	19.0				0.0	2.0	98.0	ML	54.7		
B-10	24.0								69.9		
B-11	1.0								39.1		
B-11	2.5	38	NP	NP					39.4		
B-11	9.0				0.0	4.3	95.7	ML	54.1		
B-11	14.0								33.5		

Summary of Laboratory Results

Chefornak Airport Embankment

Figure C2

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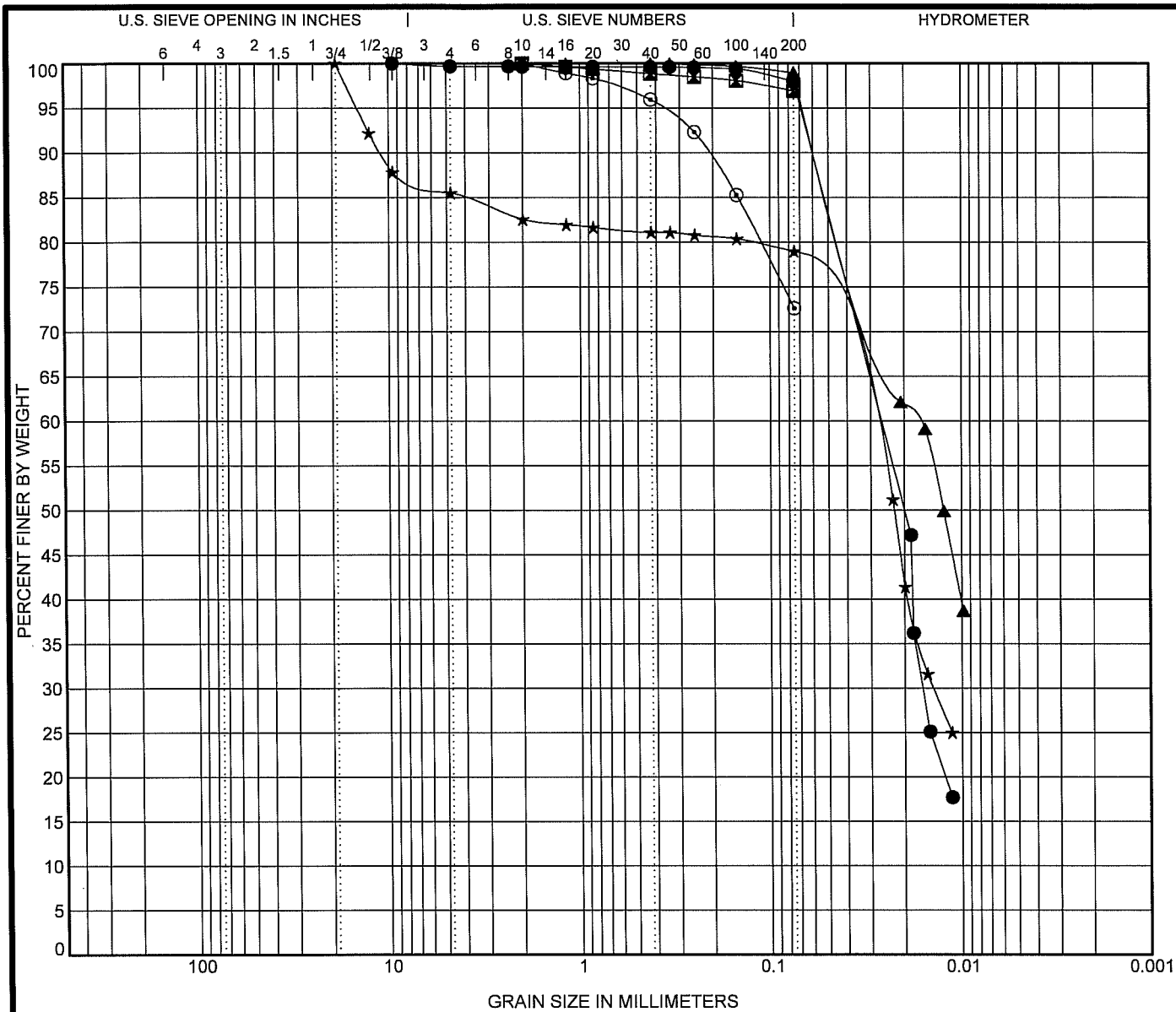
04-108

H:\jobs\04-108 Chefornak Airport Embankment\CAD\Drawings\04108_GEO_FC2, 1=1, 01/04/06 at 13:51 by mdb
LAYOUT: Model



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-01	Depth 9.0	SILT (ML)					
⊠	B-01	Depth 19.0	SILT (ML) w/ trace sand					
▲	B-03	Depth 19.0	SILT (ML)					
★	B-04	Depth 7.0	slightly sandy, gravelly SILT (ML)					
⊙	B-05	Depth 9.0	sandy SILT (ML)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-01	Depth 9.0	9.53	0.026	0.016		0.3	1.7	97.9	
⊠	B-01	Depth 19.0	2				0.0	3.1	96.9	
▲	B-03	Depth 19.0	2	0.017			0.0	1.1	98.9	
★	B-04	Depth 7.0	19.1	0.033	0.014		14.5	6.5	79.0	
⊙	B-05	Depth 9.0	2				0.0	27.4	72.6	

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GRAIN SIZE DISTRIBUTION

Chefornak Airport Embankment

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Chefornak, Alaska

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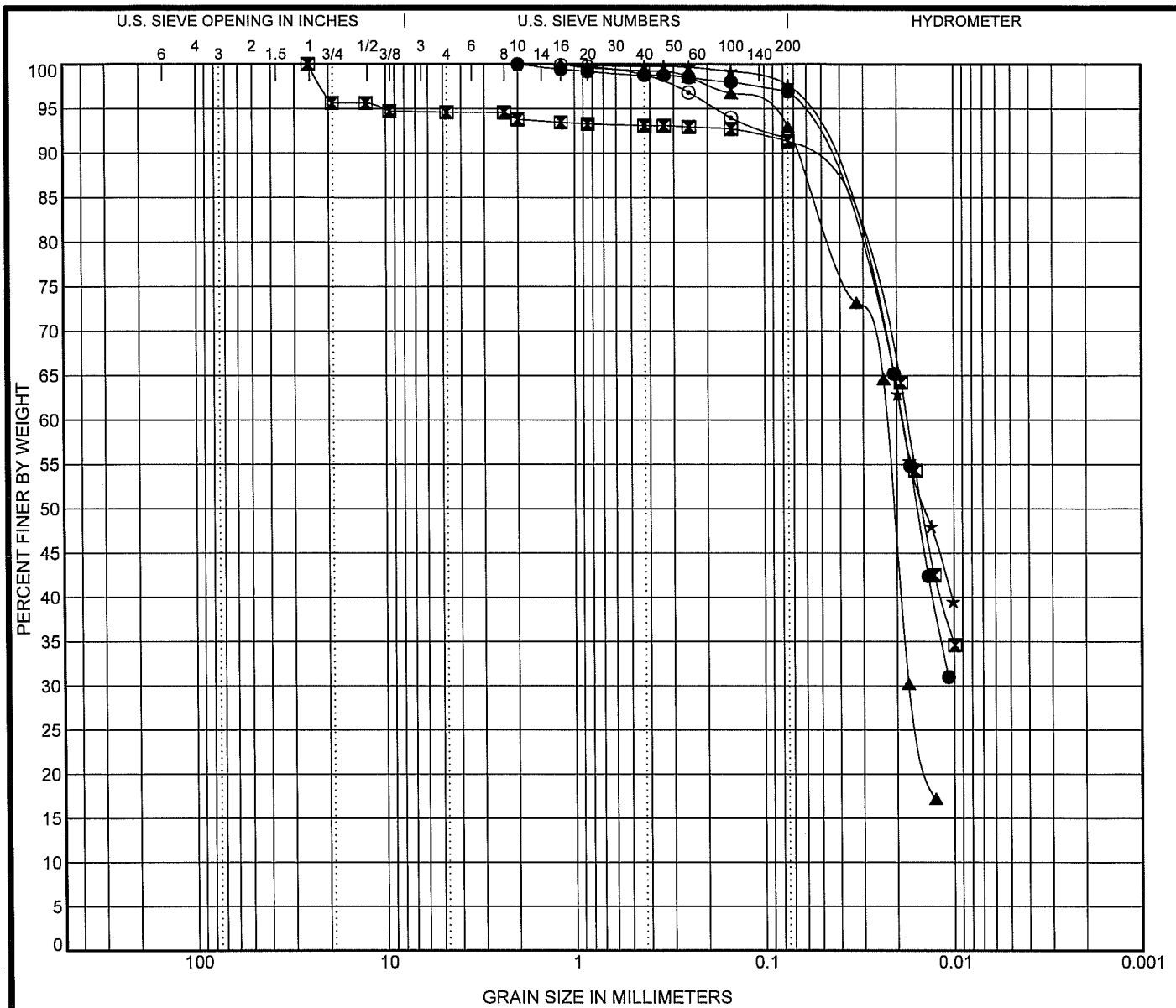
GRAIN SIZE 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 15:39



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	B-06	Depth 14.0	SILT (ML) w/ trace sand					
⊠	B-07	Depth 6.0	slightly gravelly SILT (ML) w/ trace sand					
▲	B-07	Depth 14.0	slightly sandy SILT (ML)					
★	B-09	Depth 12.0	SILT (ML)					
⊙	B-10	Depth 7.0	slightly sandy SILT (ML)					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-06	Depth 14.0	2	0.019			0.0	3.1	96.9	
⊠	B-07	Depth 6.0	25.4	0.018			5.4	3.3	91.3	
▲	B-07	Depth 14.0	1.18	0.023	0.017		0.0	7.0	93.0	
★	B-09	Depth 12.0	2	0.019			0.0	2.4	97.6	
⊙	B-10	Depth 7.0	2				0.0	8.4	91.6	

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GRAIN SIZE DISTRIBUTION

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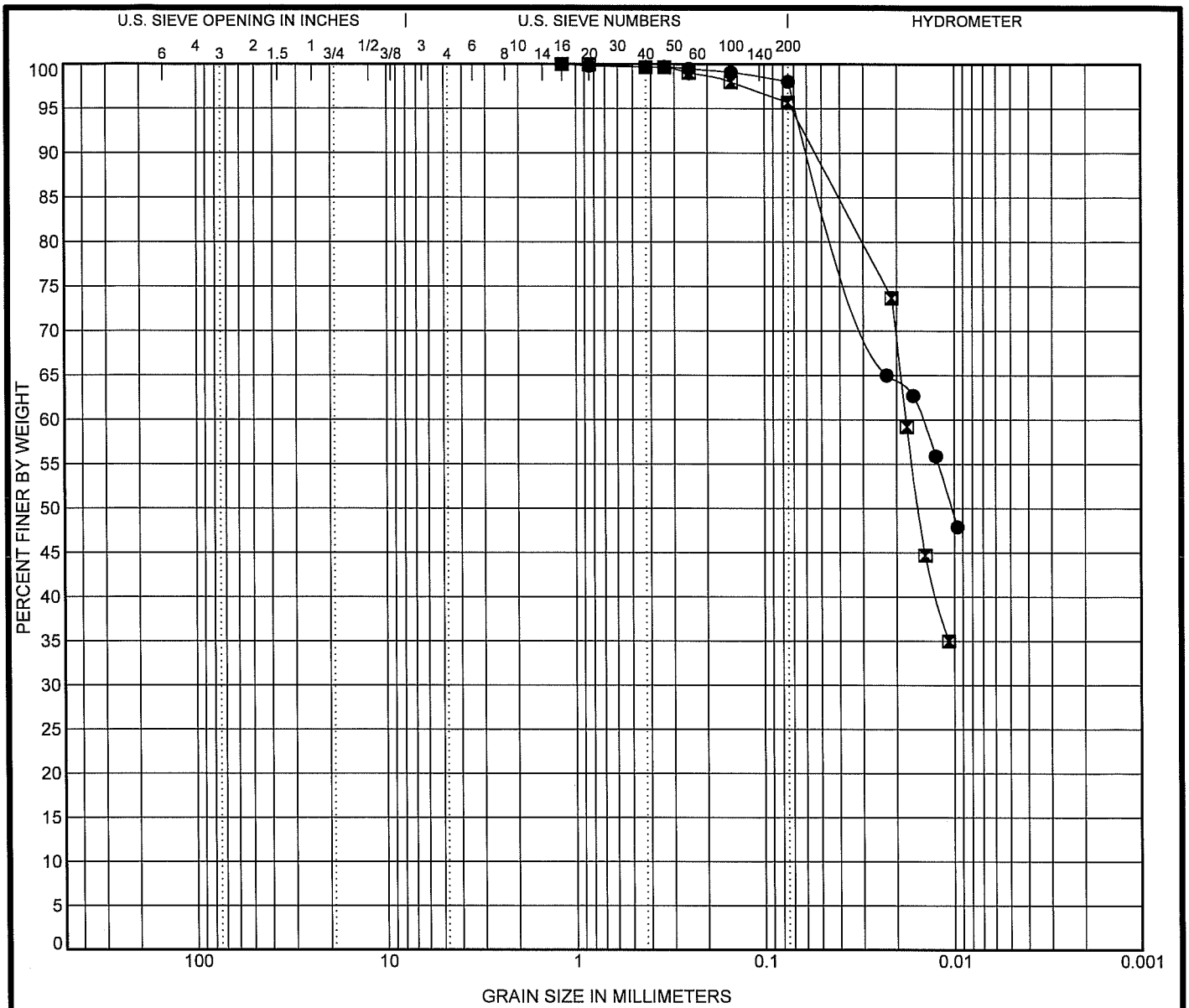
04-108

GRAIN SIZE 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 15:39



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-10**	**Depth 19.0**	**SILT (ML)**					
⊠	**B-11**	**Depth 9.0**	**SILT (ML) w/ trace sand**					

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-10**	**Depth 19.0**	**1.18**	**0.015**			**0.0**	**2.0**	**98.0**	
⊠	**B-11**	**Depth 9.0**	**1.18**	**0.018**			**0.0**	**4.3**	**95.7**	

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GRAIN SIZE DISTRIBUTION

Chefornak Airport Embankment

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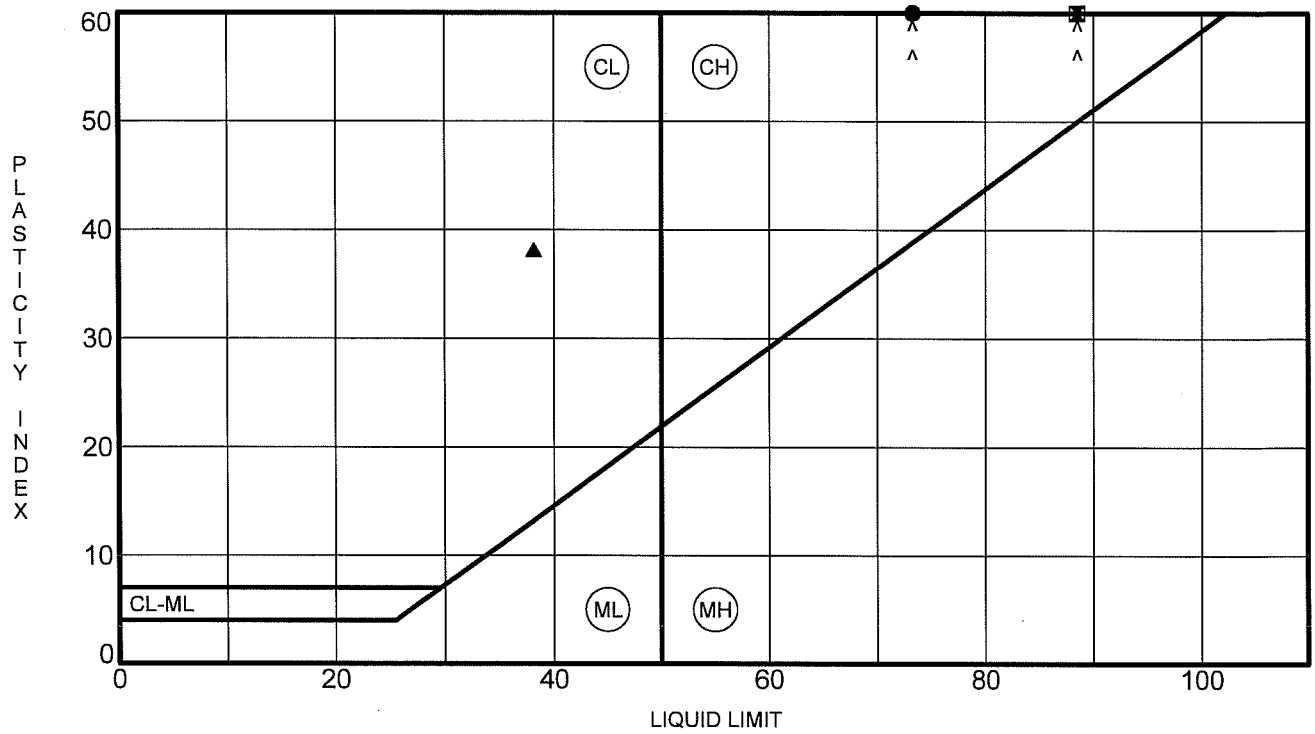
04-108

GRAIN SIZE 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/22/05 15:39



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-02**	**24.0**	**73**	**NP**	**NP**		
⊠	**B-04**	**10.5**	**89**	**NP**	**NP**		
▲	**B-11**	**2.5**	**38**	**NP**	**NP**		

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ATTERBERG LIMITS' RESULTS

Chefornak Airport Embankment

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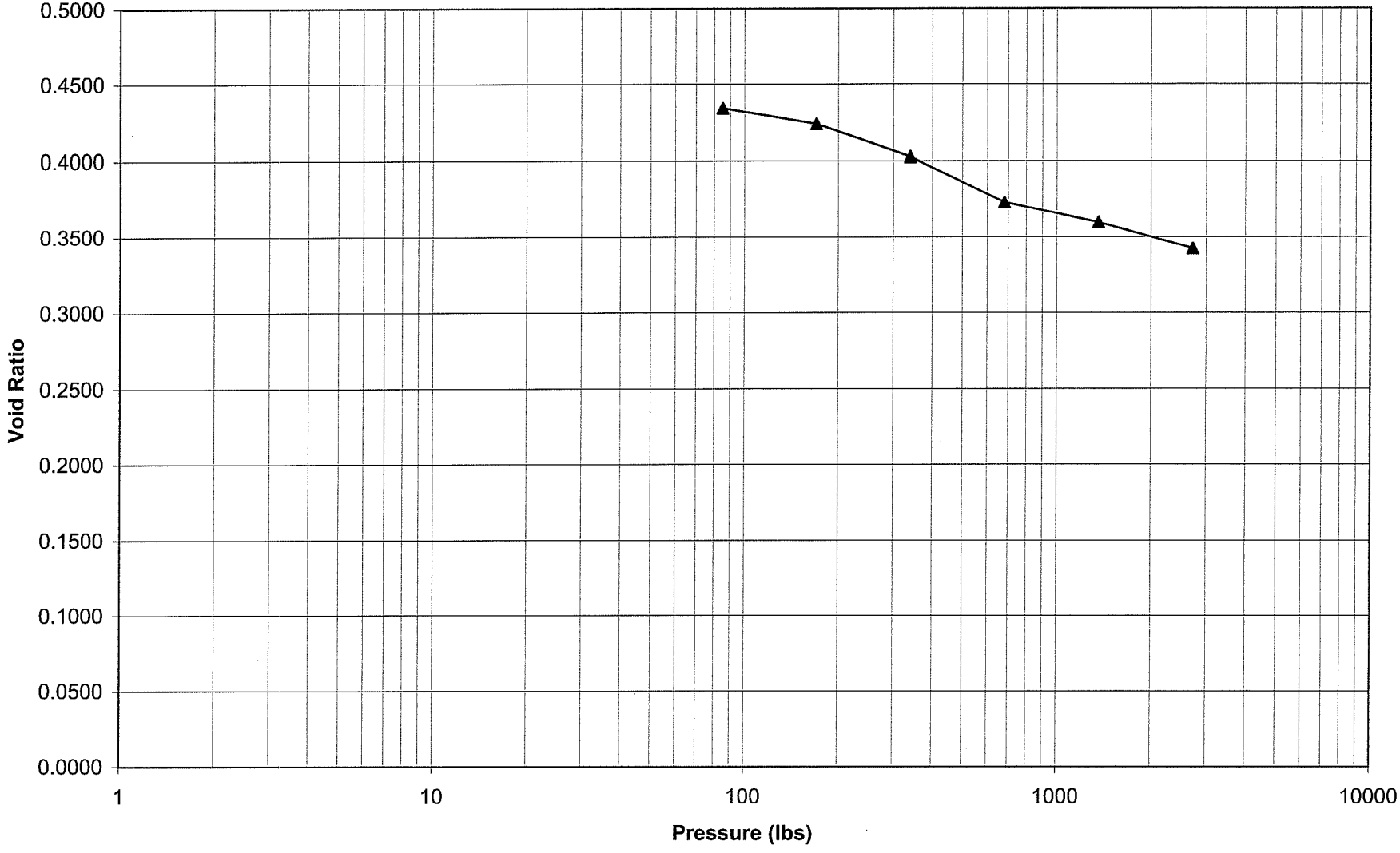
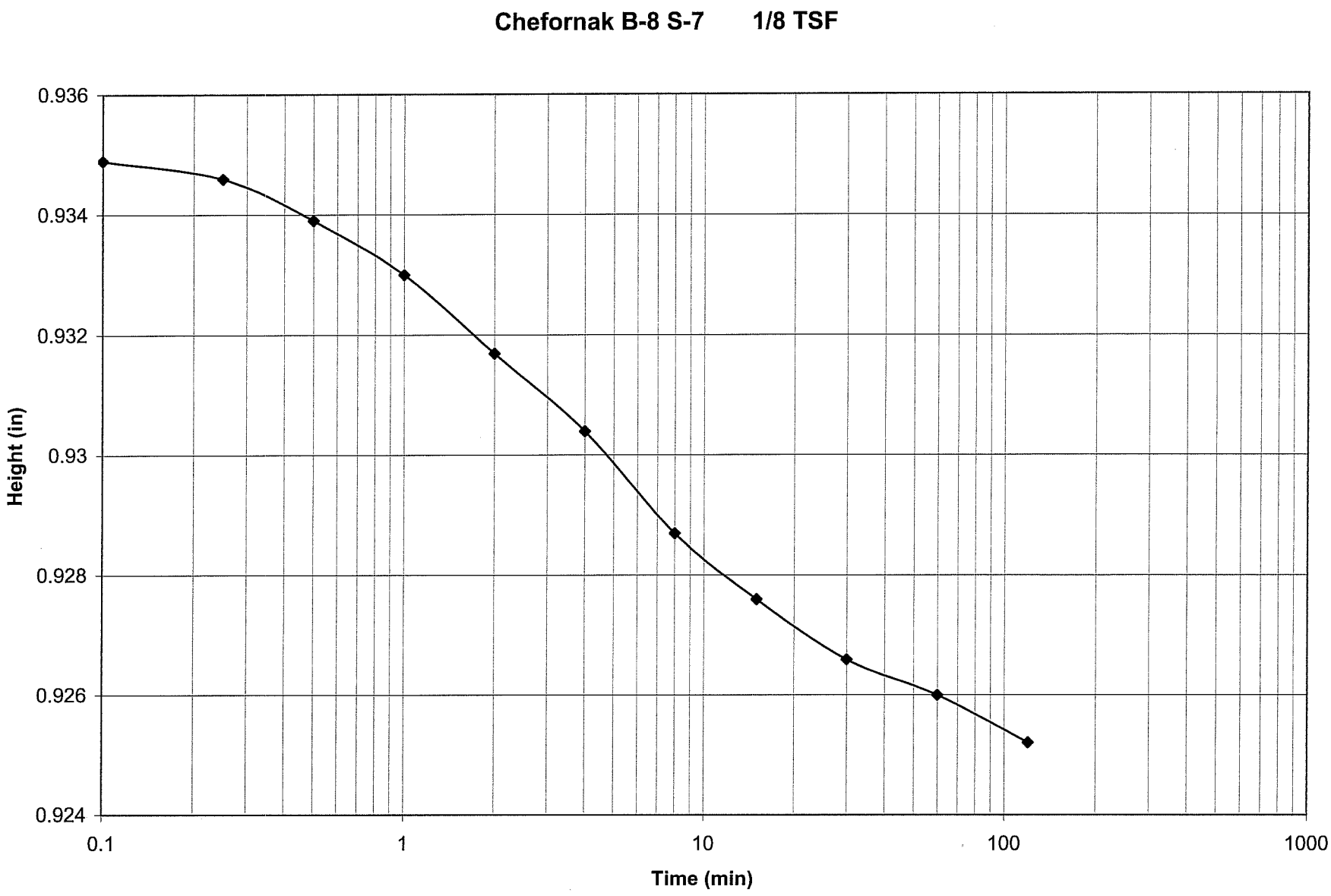
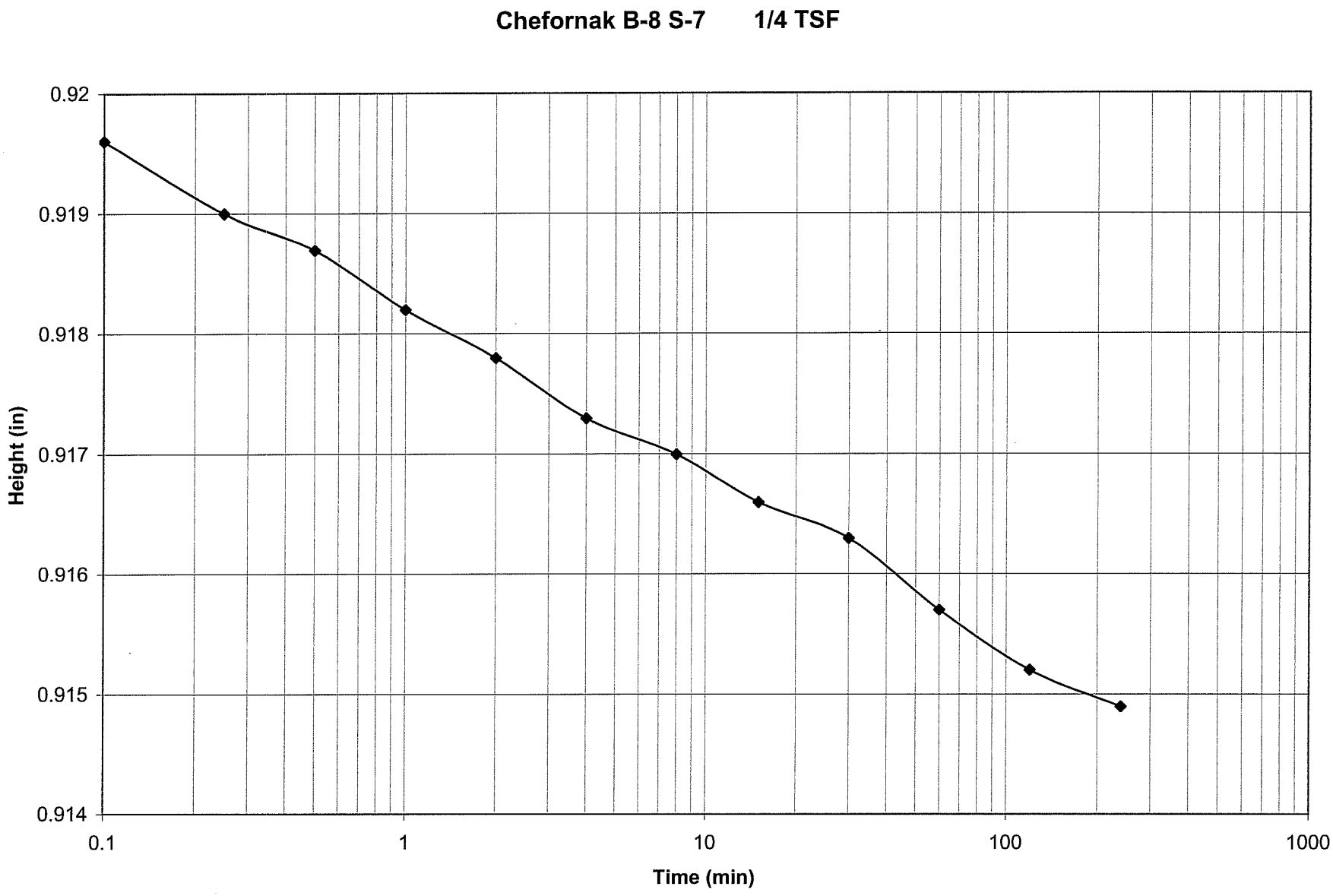
04-108

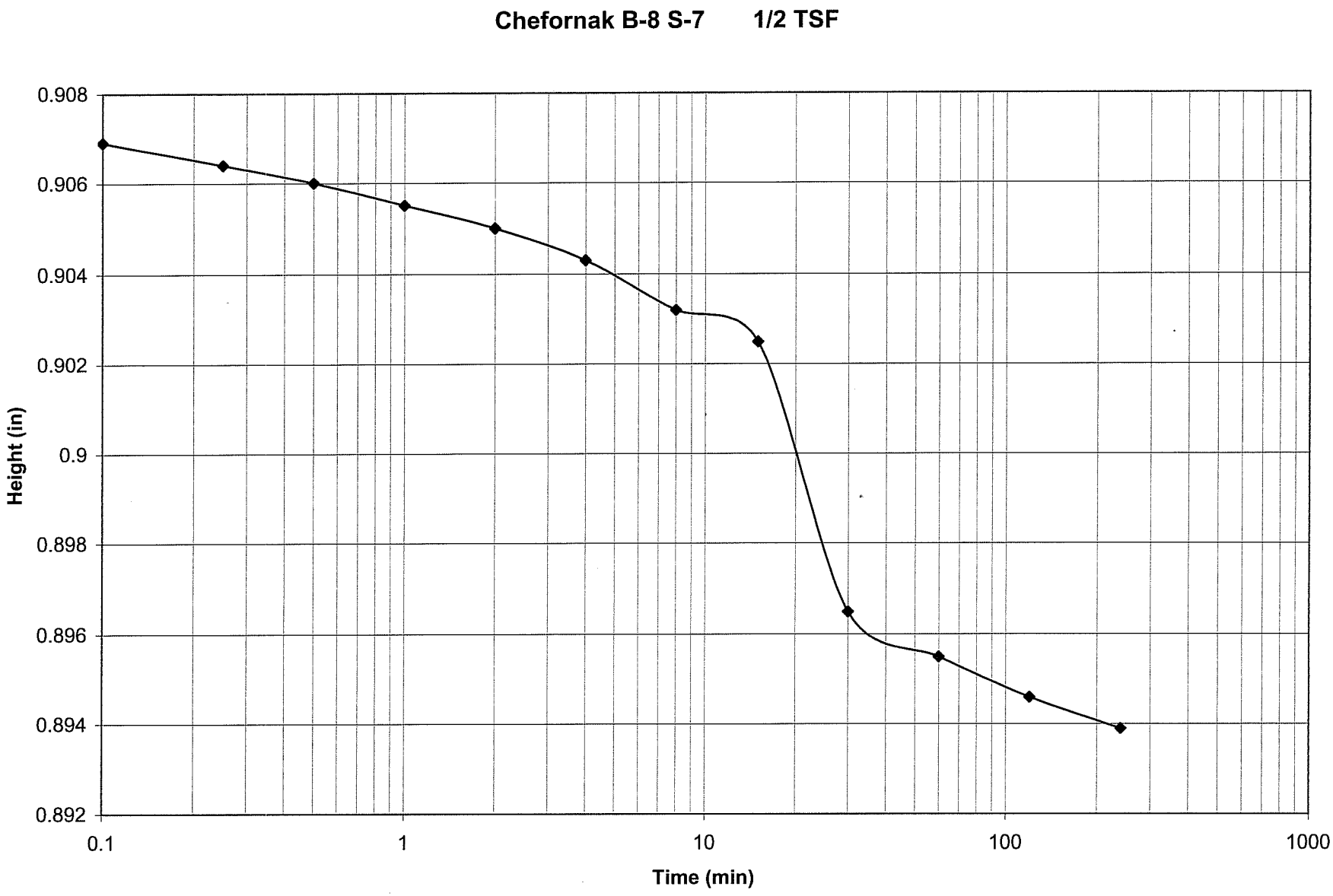
ATTERBERG LIMITS 04-108 CHEFORNAK-BLOGS.GPJ HDEC.GDT 12/23/05 10:09

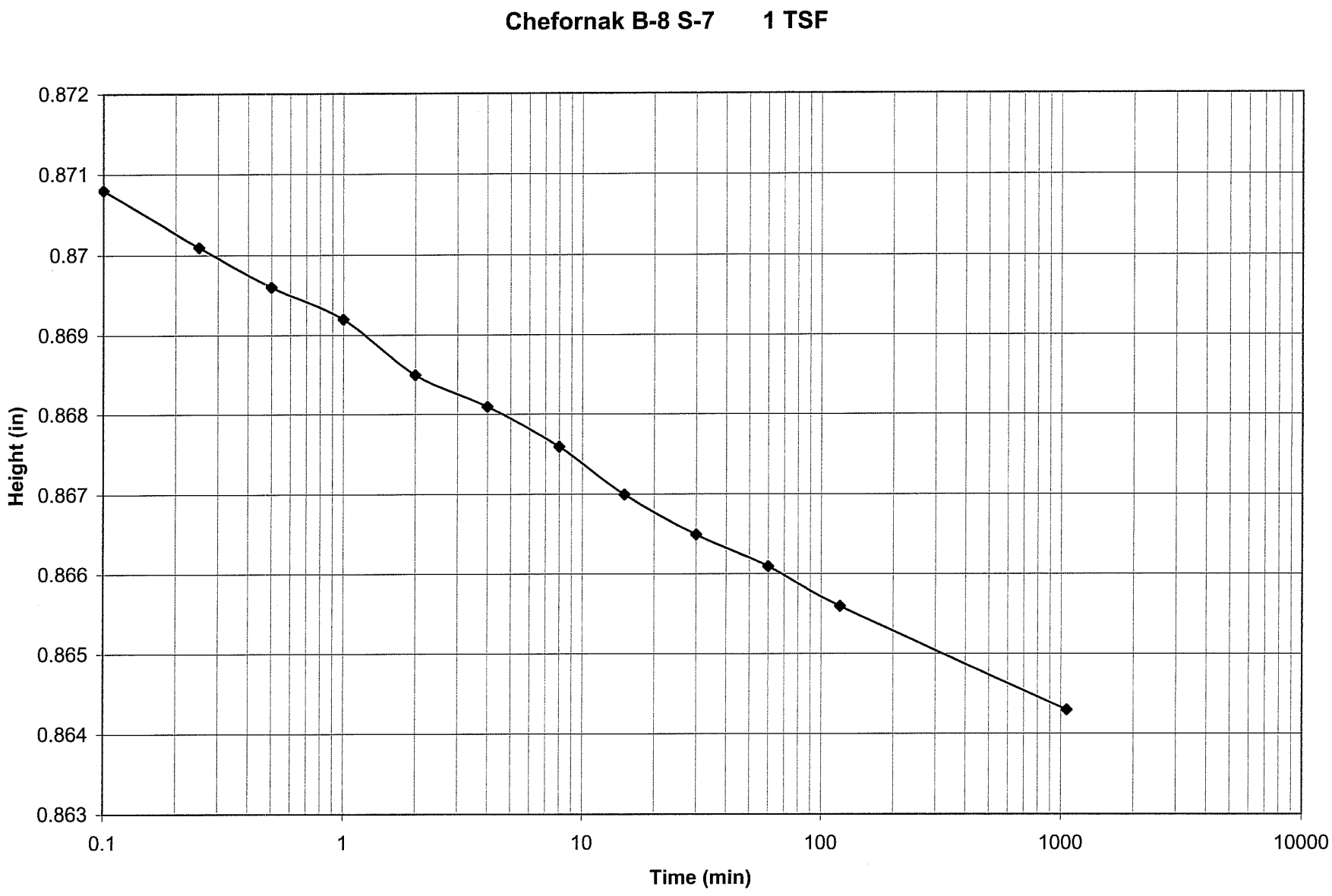
Chefornak B-8 S-7 Void Ratio

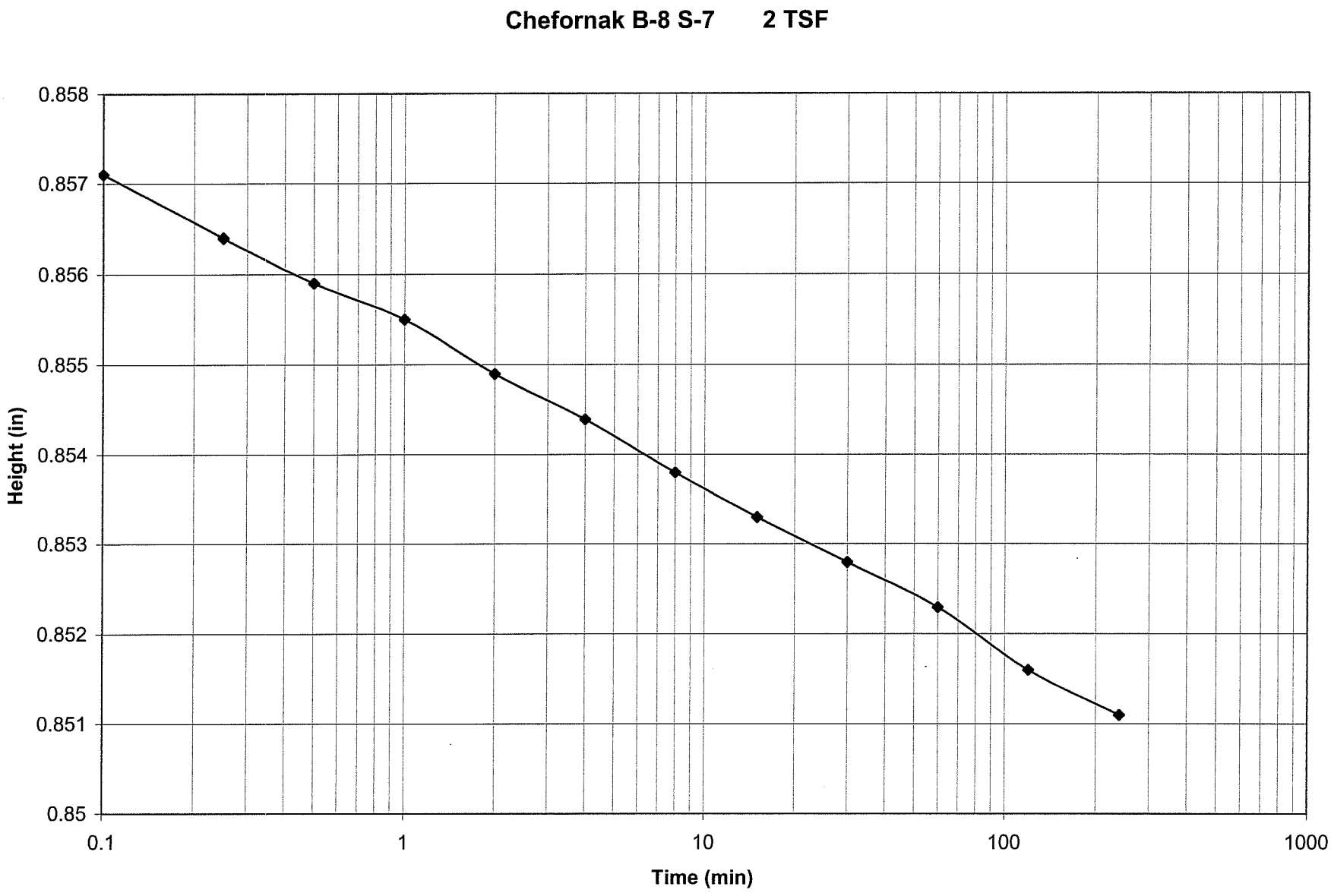



Chefornak B-8 S-7 1/8 TSF
0.936
0.934
0.932
0.93
0.928
0.926
0.924
Height (in)
0.1
1
10
100
1000
Time (min)

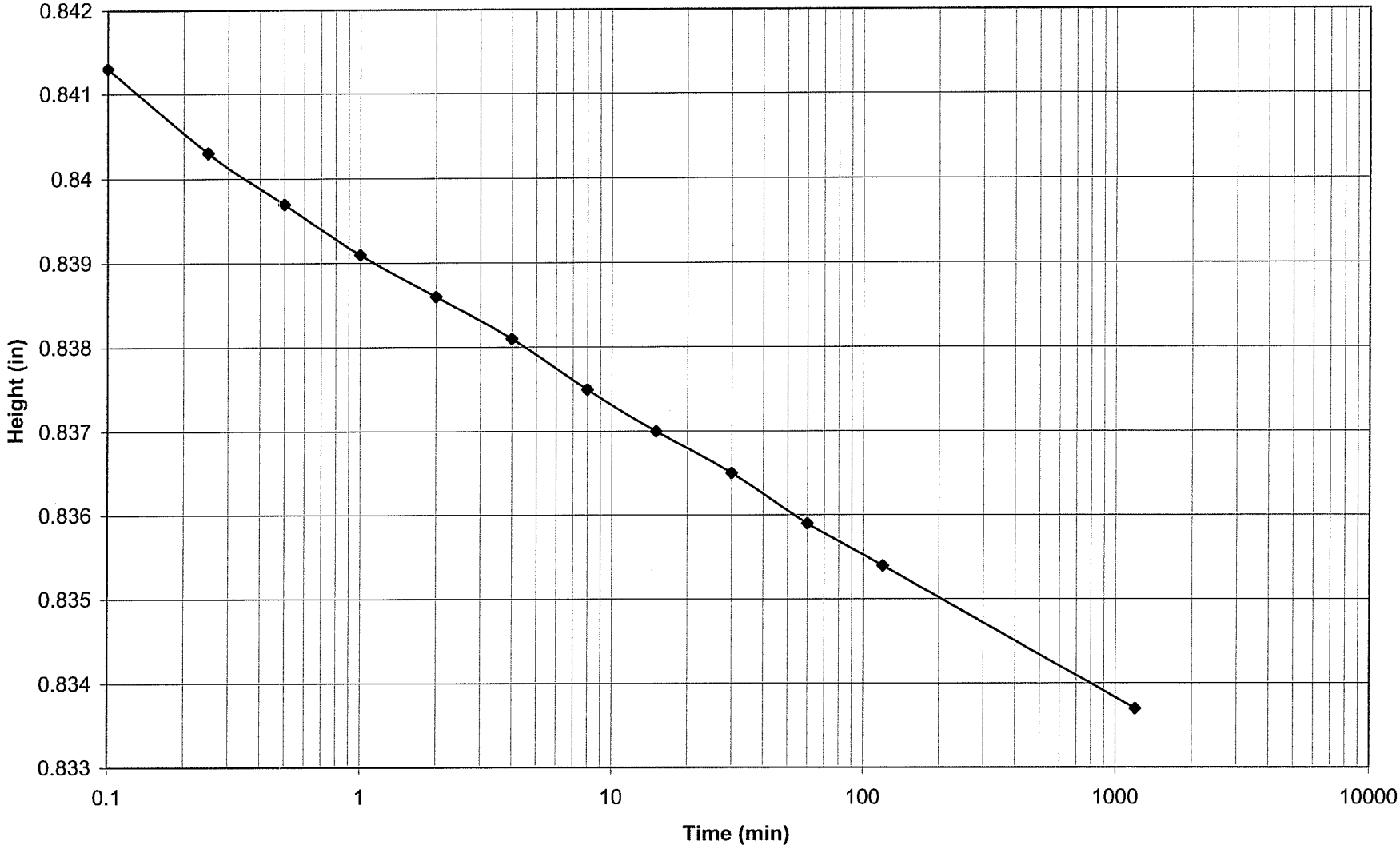

Chefornak B-8 S-7 1/4 TSF
0.92
0.919
0.918
0.917
0.916
0.915
0.914
Height (in)
0.1
1
10
100
1000
Time (min)


Chefornak B-8 S-7 1/2 TSF
0.908
0.906
0.904
0.902
0.9
0.898
0.896
0.894
0.892
Height (in)
0.1
1
10
100
1000
Time (min)

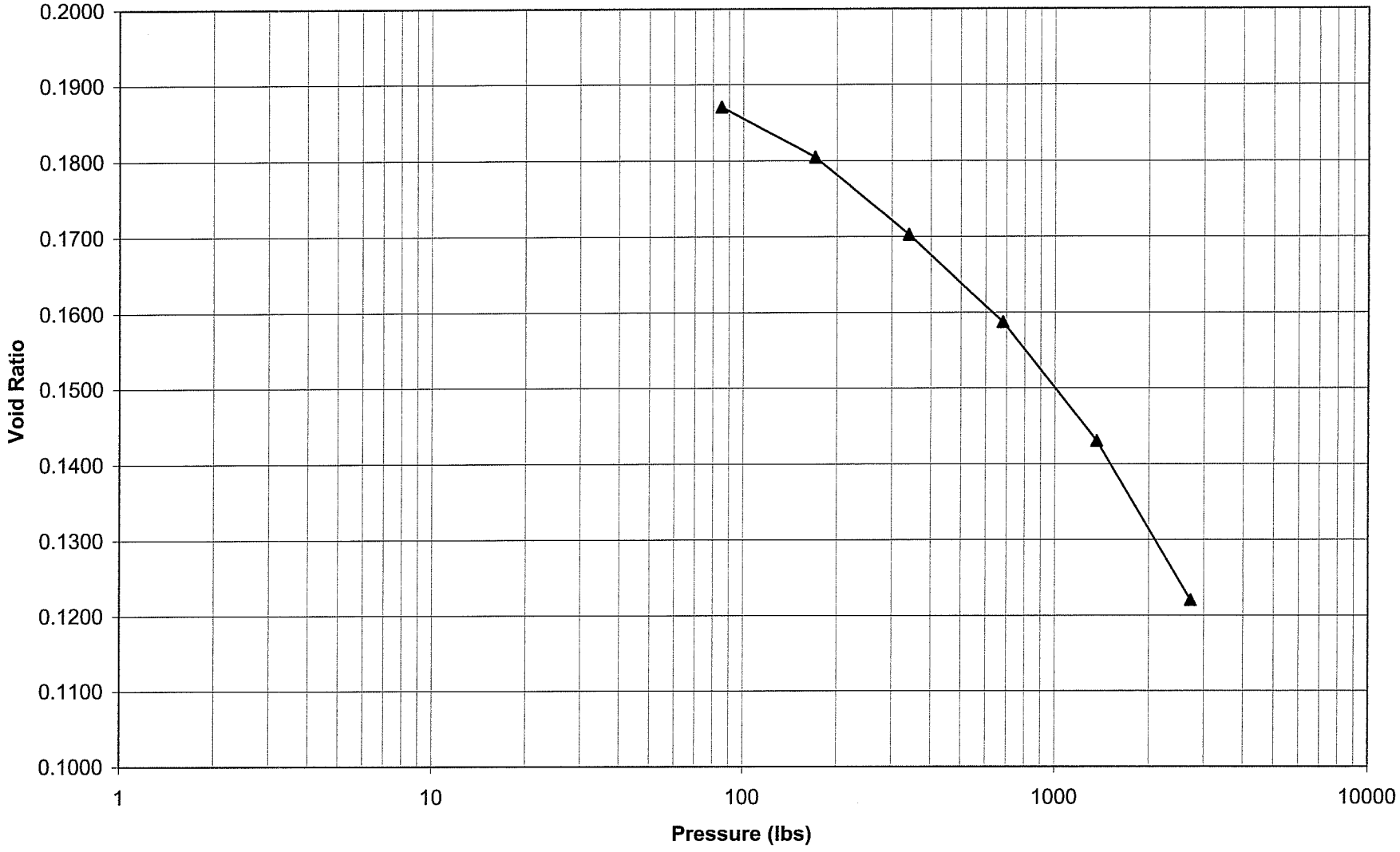

Chefornak B-8 S-7 1 TSF
0.872
0.871
0.87
0.869
0.868
0.867
0.866
0.865
0.864
0.863
Height (in)
0.1
1
10
100
1000
10000
Time (min)

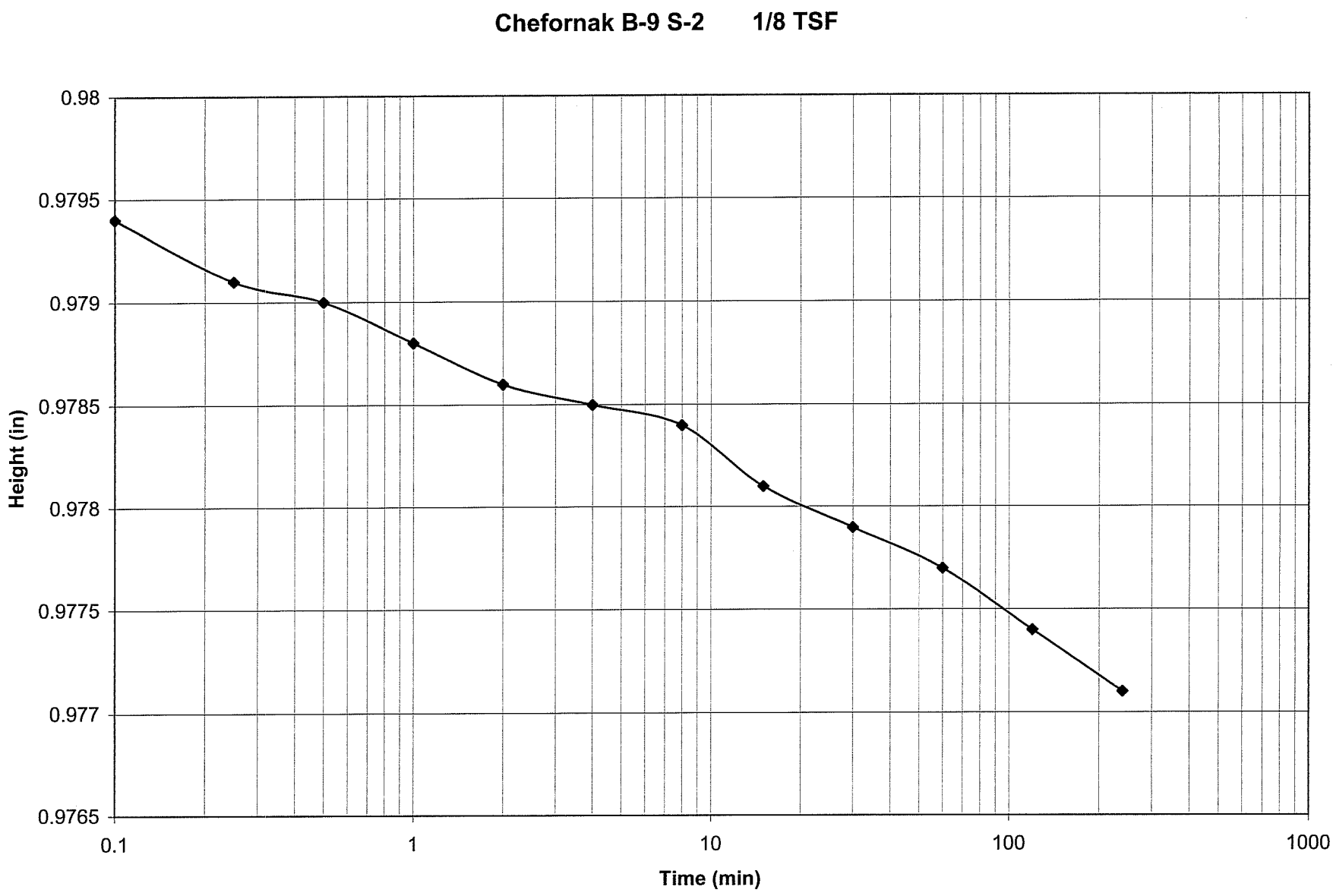

Chefornak B-8 S-7 2 TSF
0.858
0.857
0.856
0.855
0.854
0.853
0.852
0.851
0.85
Height (in)
0.1
1
10
100
1000
Time (min)

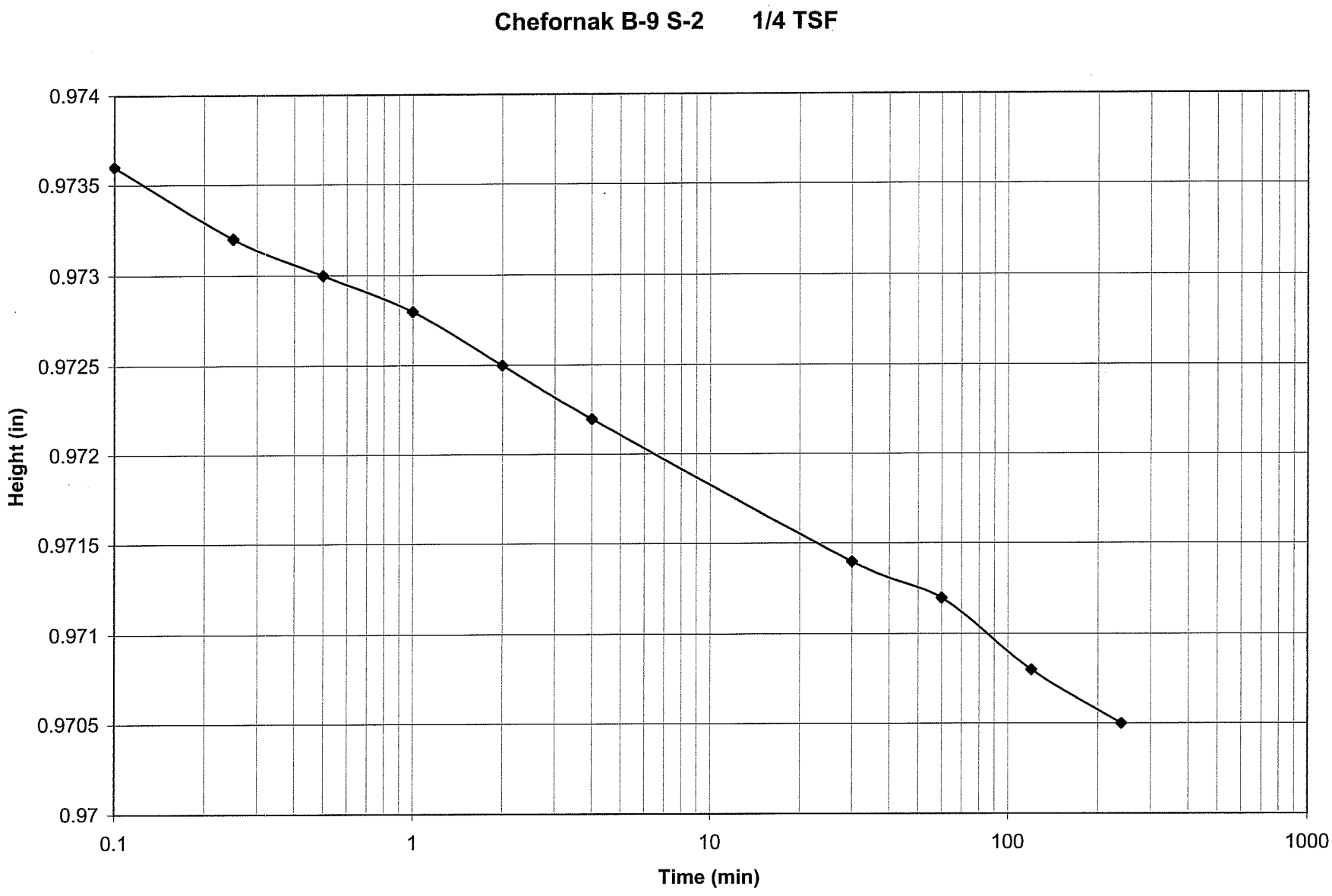
Chefornak B-8 S-7 4 TSF

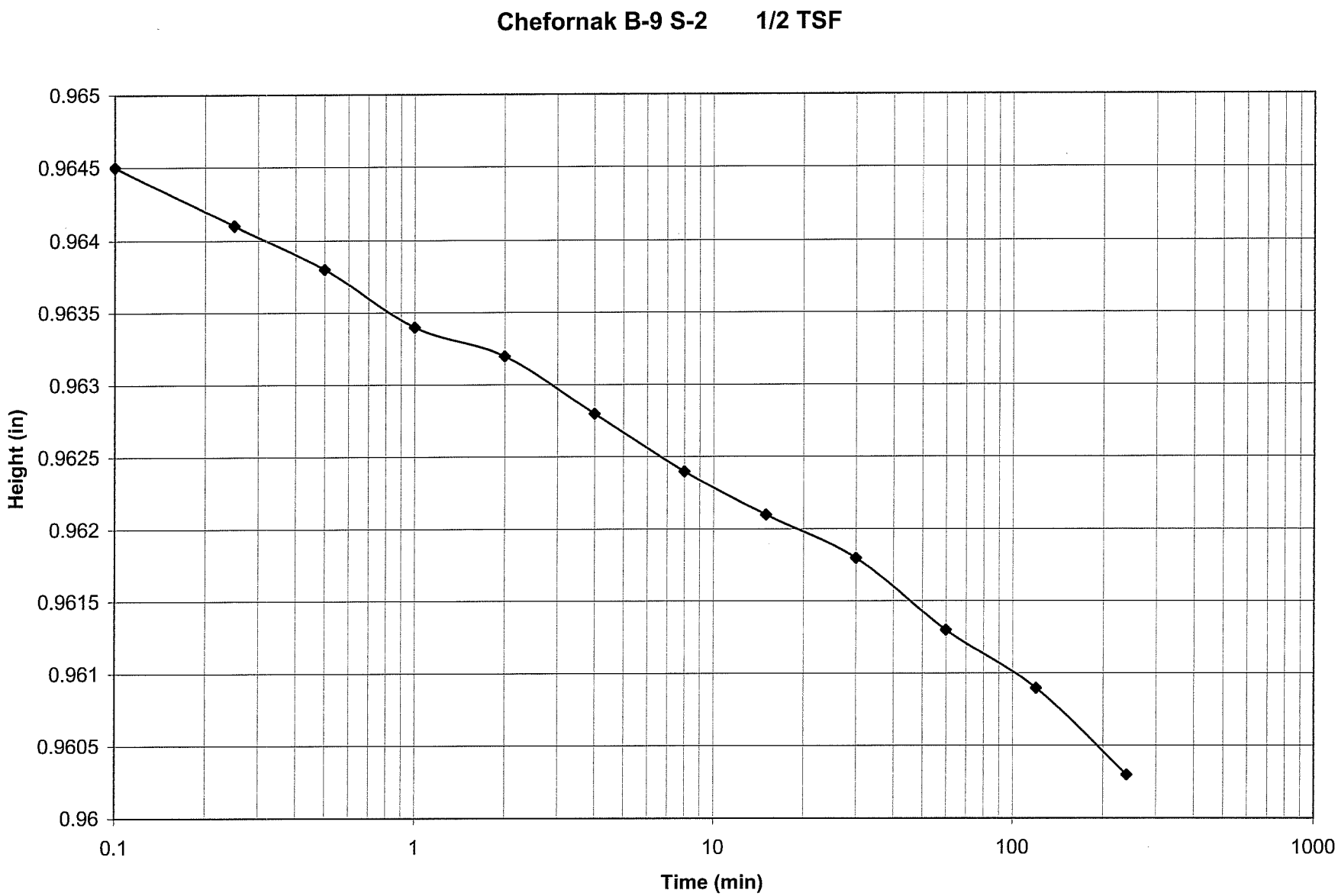


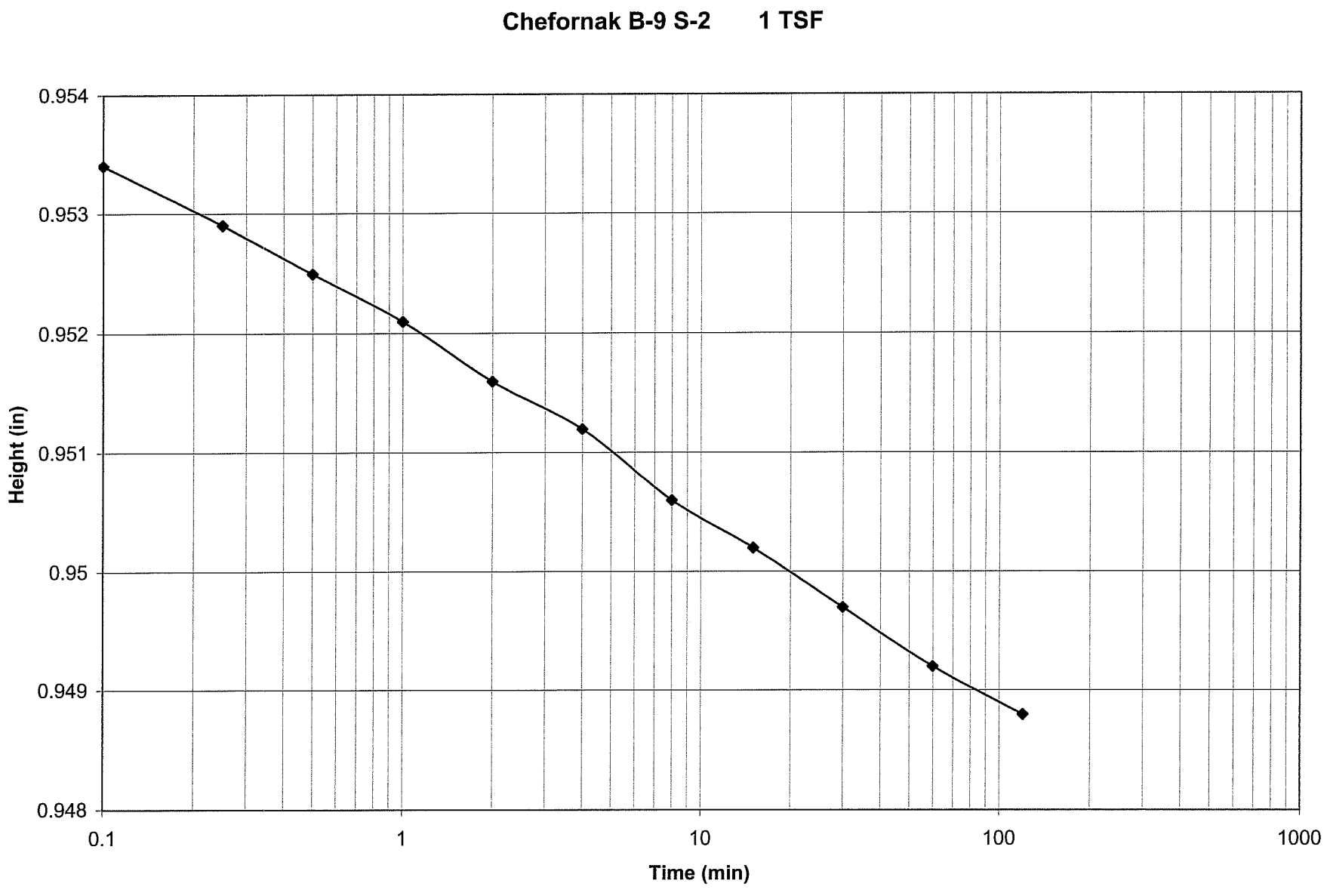
Chefornak B-9 S-2 Void Ratio

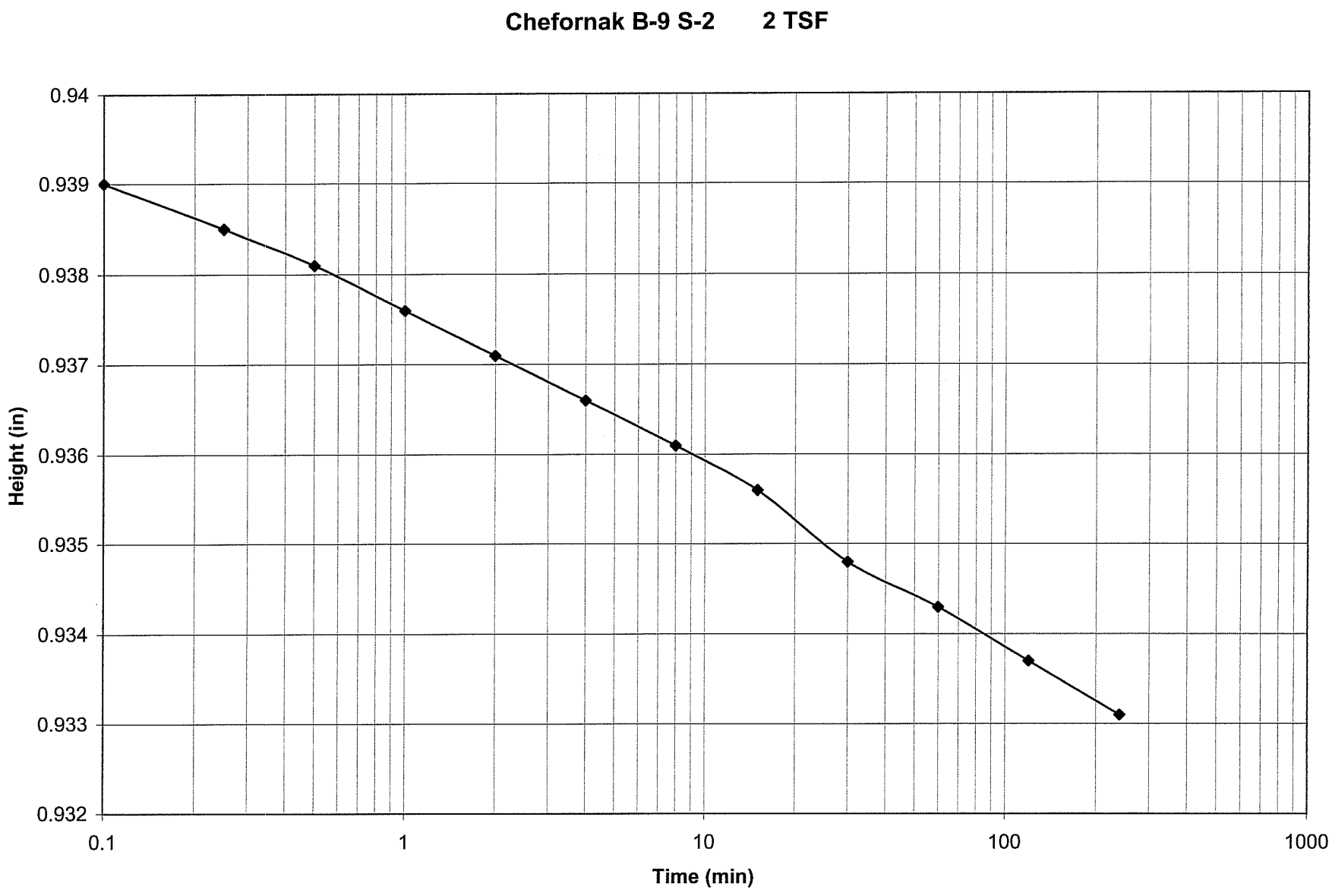


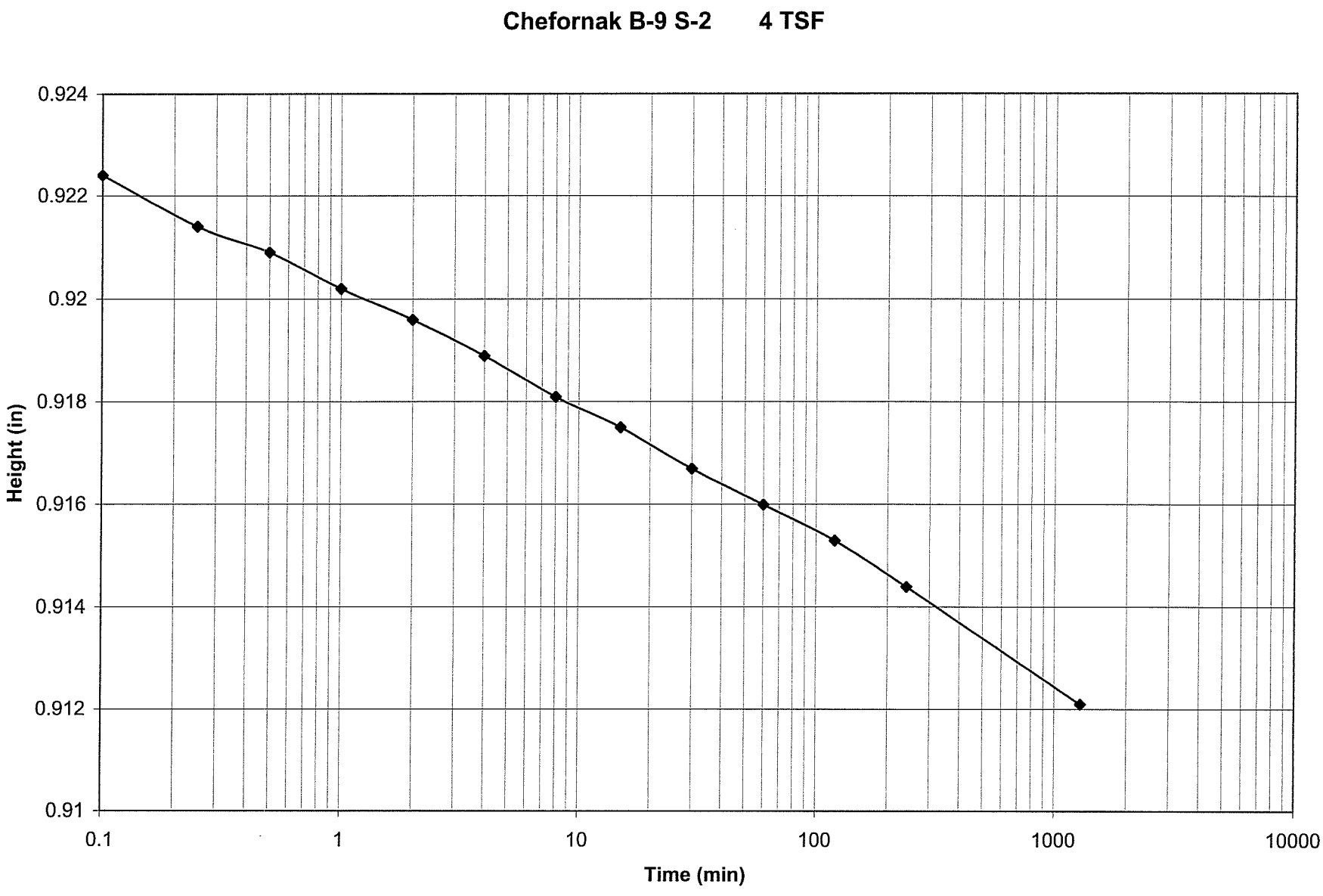

Chefornak B-9 S-2 1/8 TSF
0.98
0.9795
0.979
0.9785
0.978
0.9775
0.977
0.9765
Height (in)
0.1
1
10
100
1000
Time (min)


Chefornak B-9 S-2 1/4 TSF
0.974
0.9735
0.973
0.9725
0.972
0.9715
0.971
0.9705
0.97
Height (in)
0.1
1
10
100
1000
Time (min)


Chefornak B-9 S-2 1/2 TSF
0.965
0.9645
0.964
0.9635
0.963
0.9625
0.962
0.9615
0.961
0.9605
0.96
Height (in)
0.1
1
10
100
1000
Time (min)

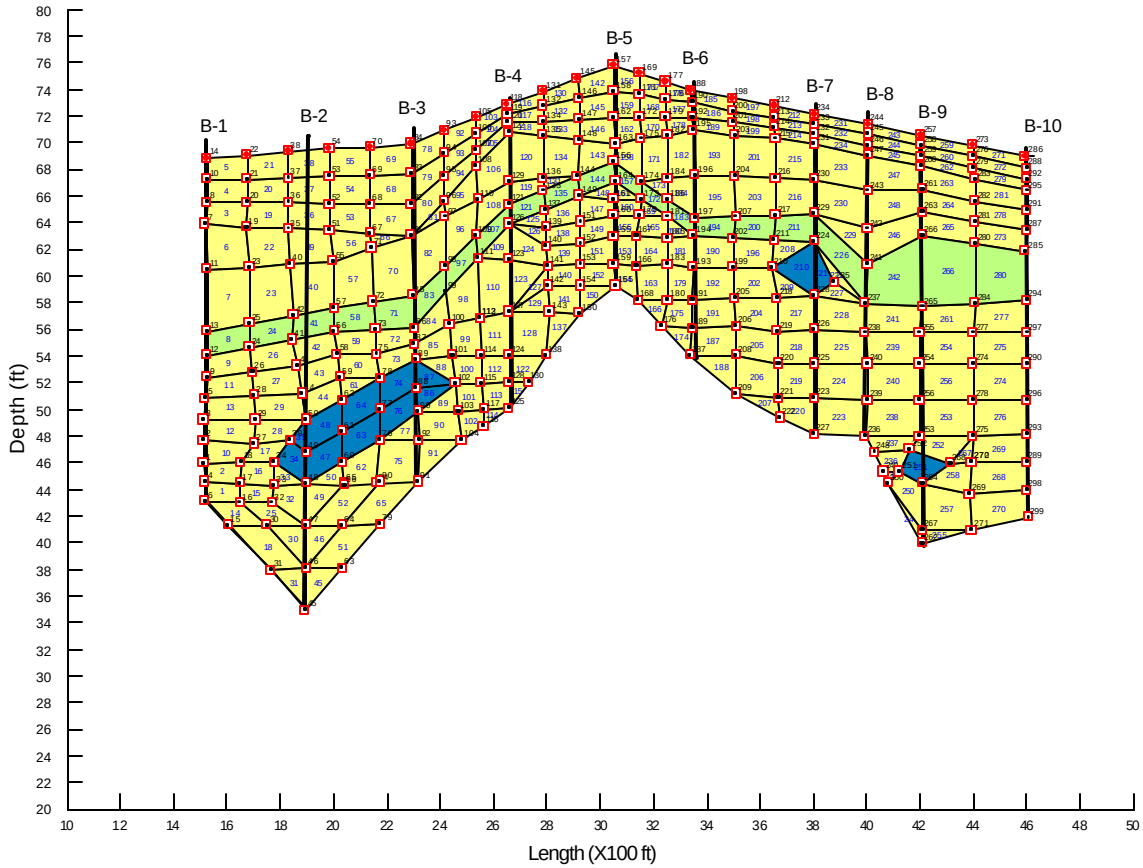

Chefornak B-9 S-2 1 TSF
0.954
0.953
0.952
0.951
0.95
0.949
0.948
Height (in)
0.1
1
10
100
1000
Time (min)


Chefornak B-9 S-2 2 TSF
0.94
0.939
0.938
0.937
0.936
0.935
0.934
0.933
0.932
Height (in)
0.1
1
10
100
1000
Time (min)


Chefornak B-9 S-2 4 TSF
0.924
0.922
0.92
0.918
0.916
0.914
0.912
0.91
Height (in)
0.1
1
10
100
1000
10000
Time (min)

APPENDIX D

Thermal Models
Model 1: Base Model
Model 2: 6-inches of Insulation
Model 3: 24-inches of Insulation

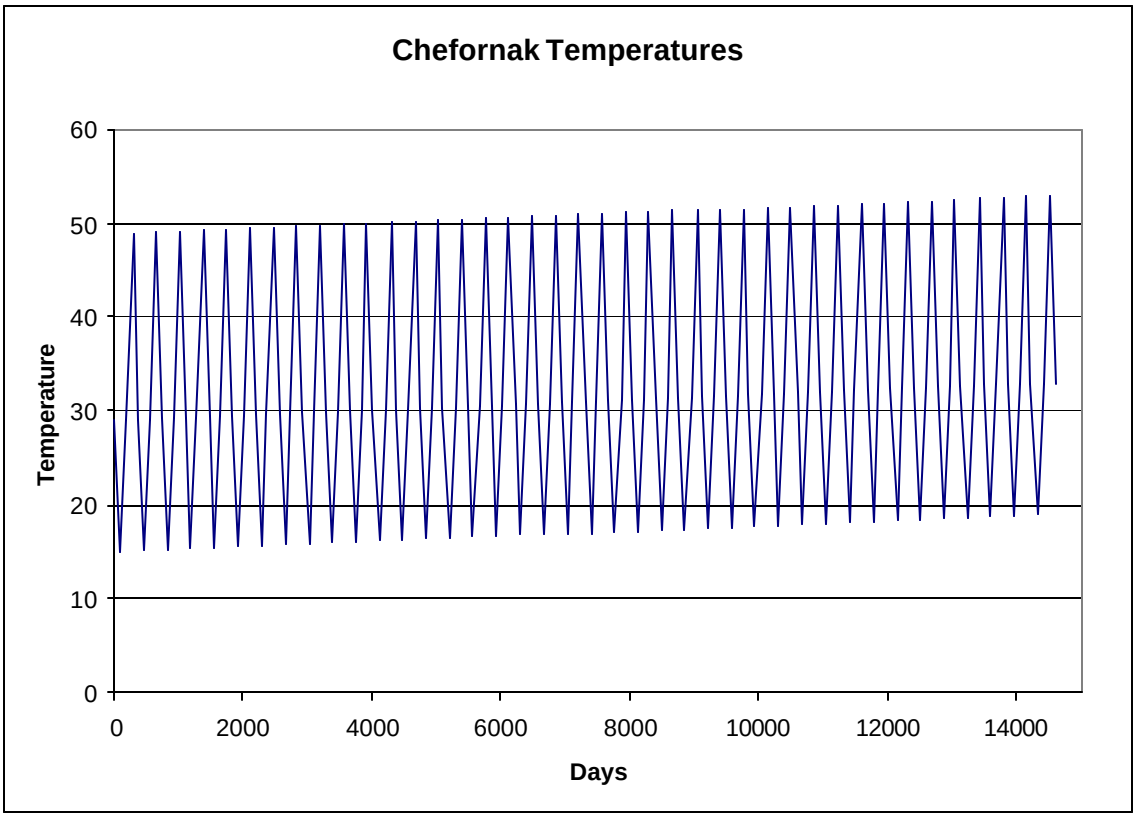


NOTE: Two-dimensional profile is shown. Colors correspond to soil units as defined below: Nodes are shown in red at the corner of each finite element.

- Sandy Silts
- Ice-Rich, Silty Sands
- Vegetation/Organic Layer

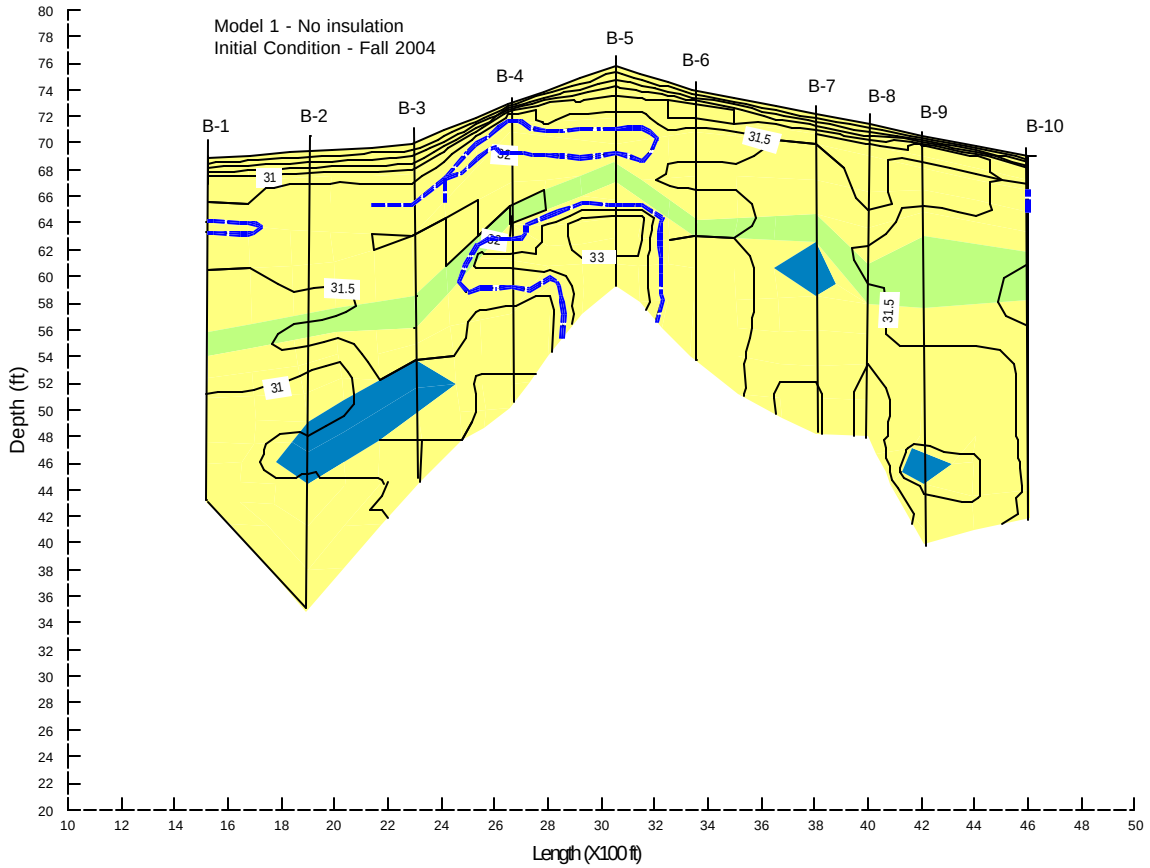
Additional unit for insulation (pink) is shown in Models 2 and 3.

Figure D1: Thermal Model for Chefornak



NOTE: Temperature is the average annual temperature as explained in text. Data obtained from the Alaska Climate Center – University of Alaska Fairbanks, 2003. The graph was used in all models.

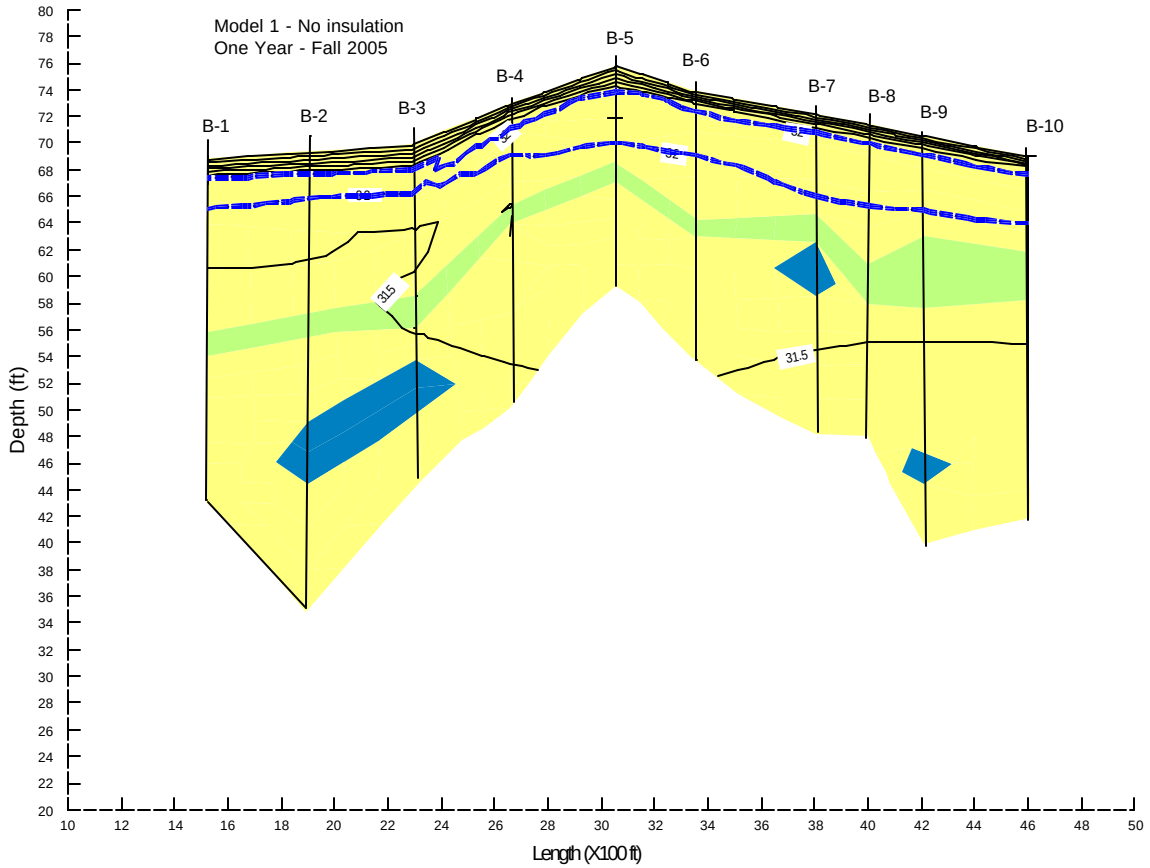
Figure D2 : Boundary Condition Function



NOTE: Two-dimensional temperature profile is shown for Model #1. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined below:

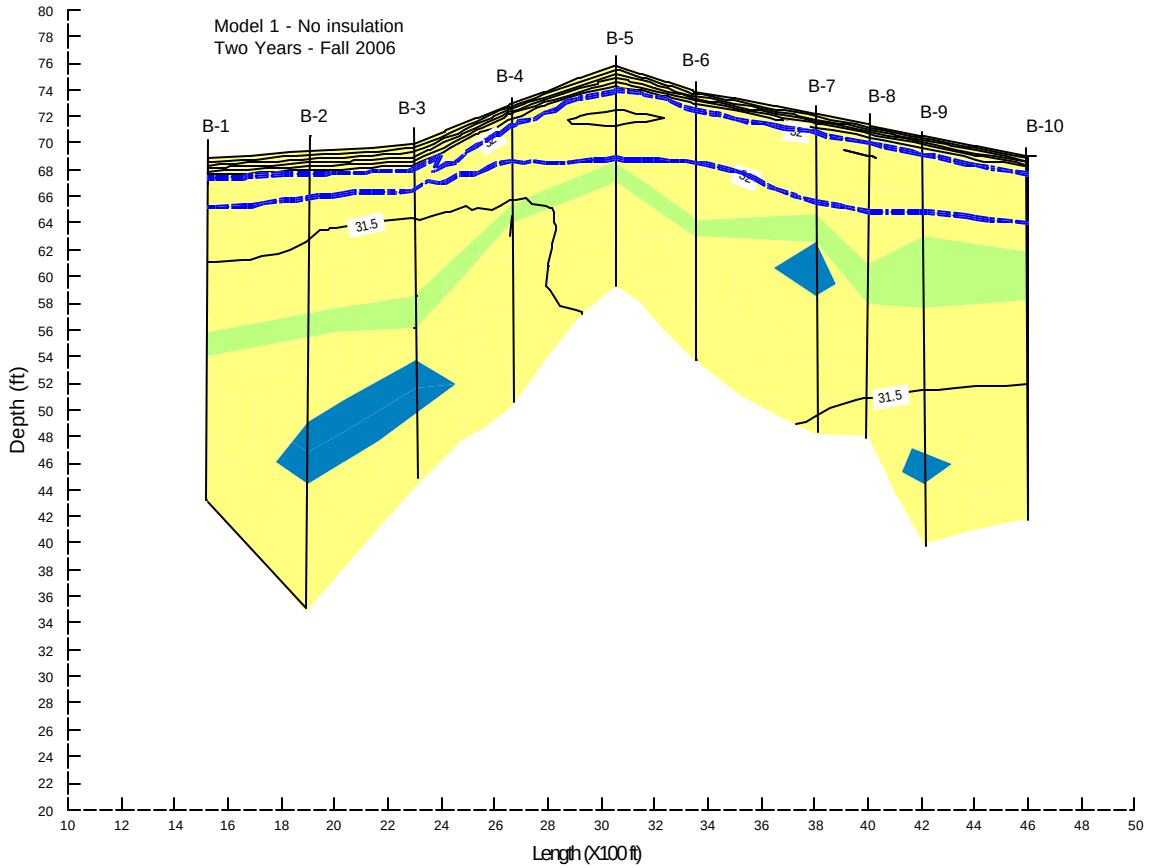
- Sandy Silts
- Ice-Rich, Silty Sands
- Vegetation/Organic Layer

Figure D3(a): Model 1 - Fall 2004



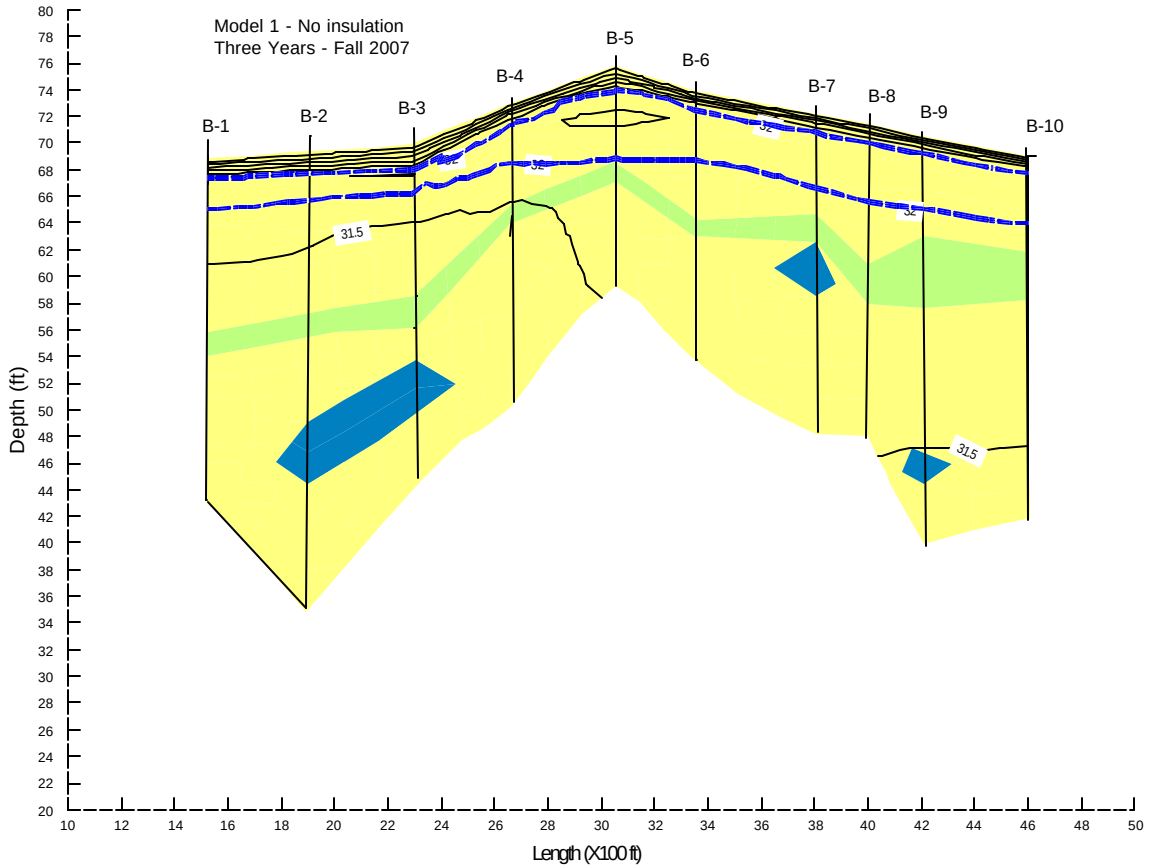
NOTE: Two-dimensional temperature profile is shown Model #1. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(b): Model 1 - Fall 2005



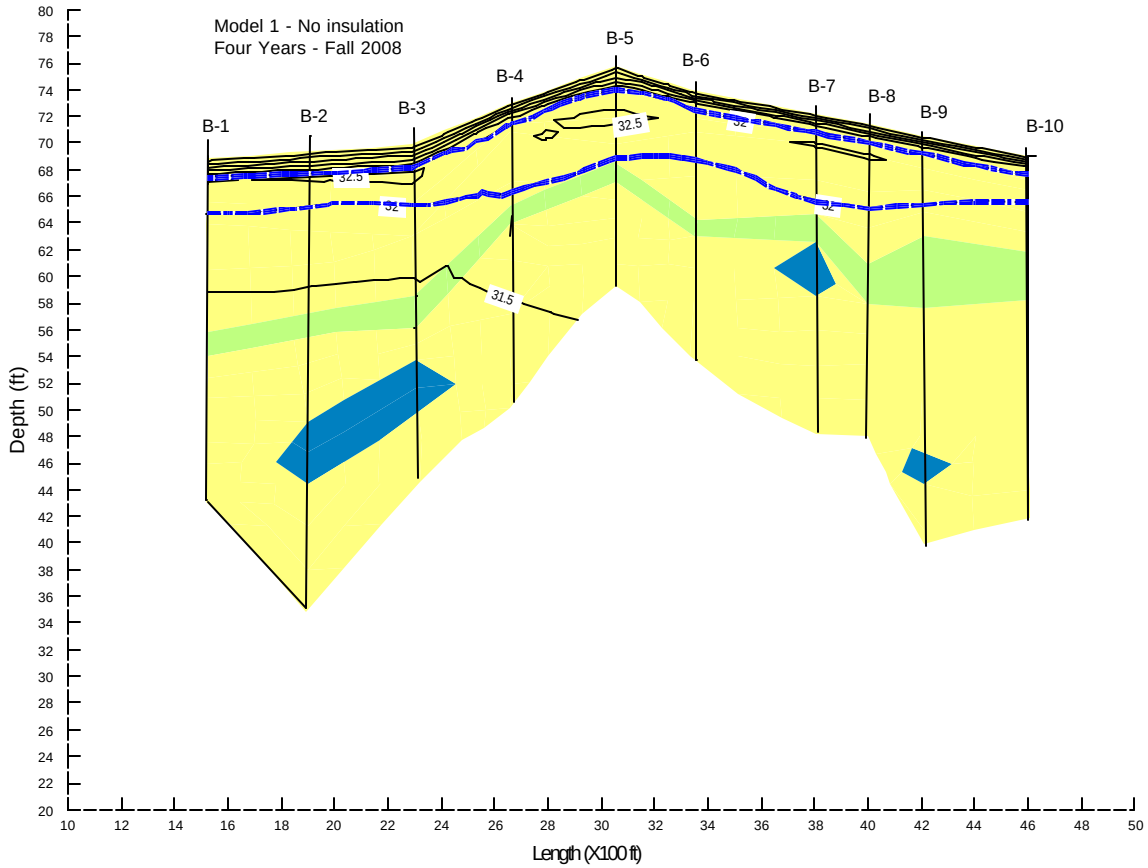
NOTE: Two-dimensional temperature profile is shown Model #1. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D3(c): Model 1 - Fall 2006



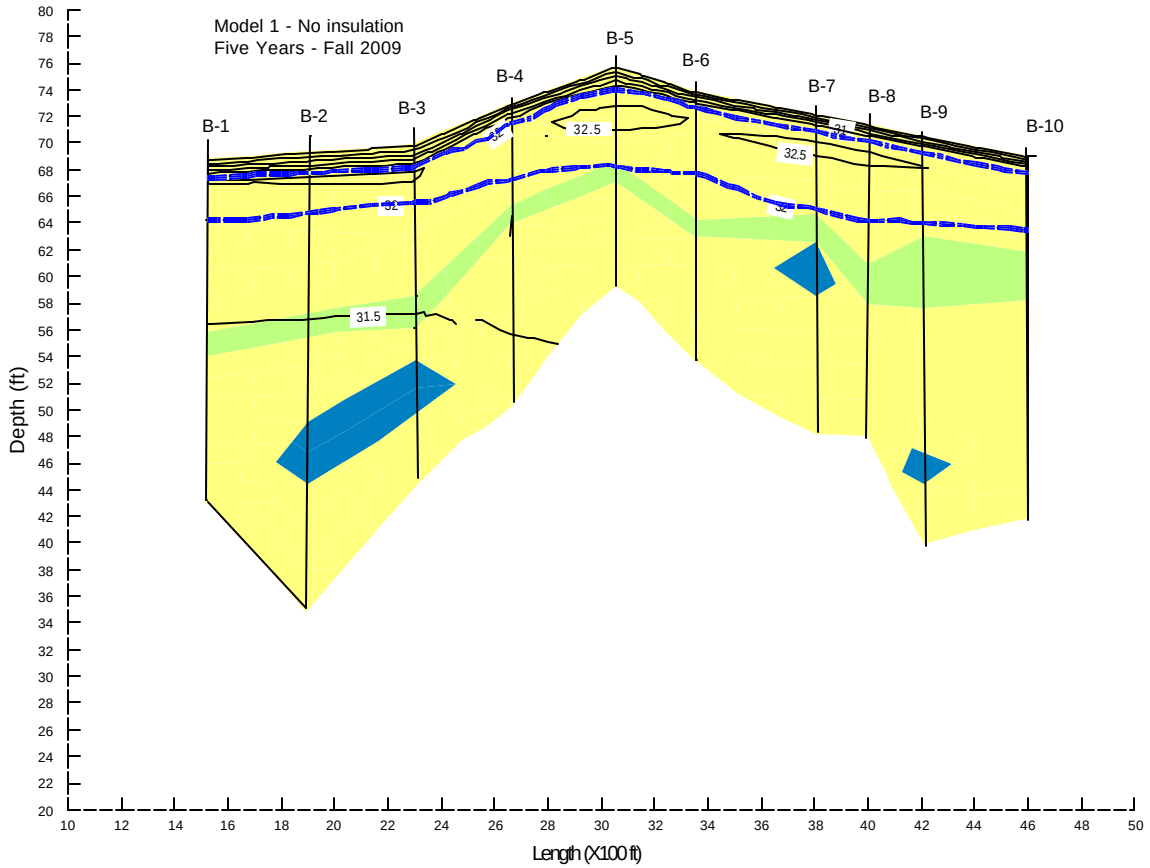
NOTE: Two-dimensional temperature profile is shown Model #1 . Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(d): Model 1 - Fall 2007



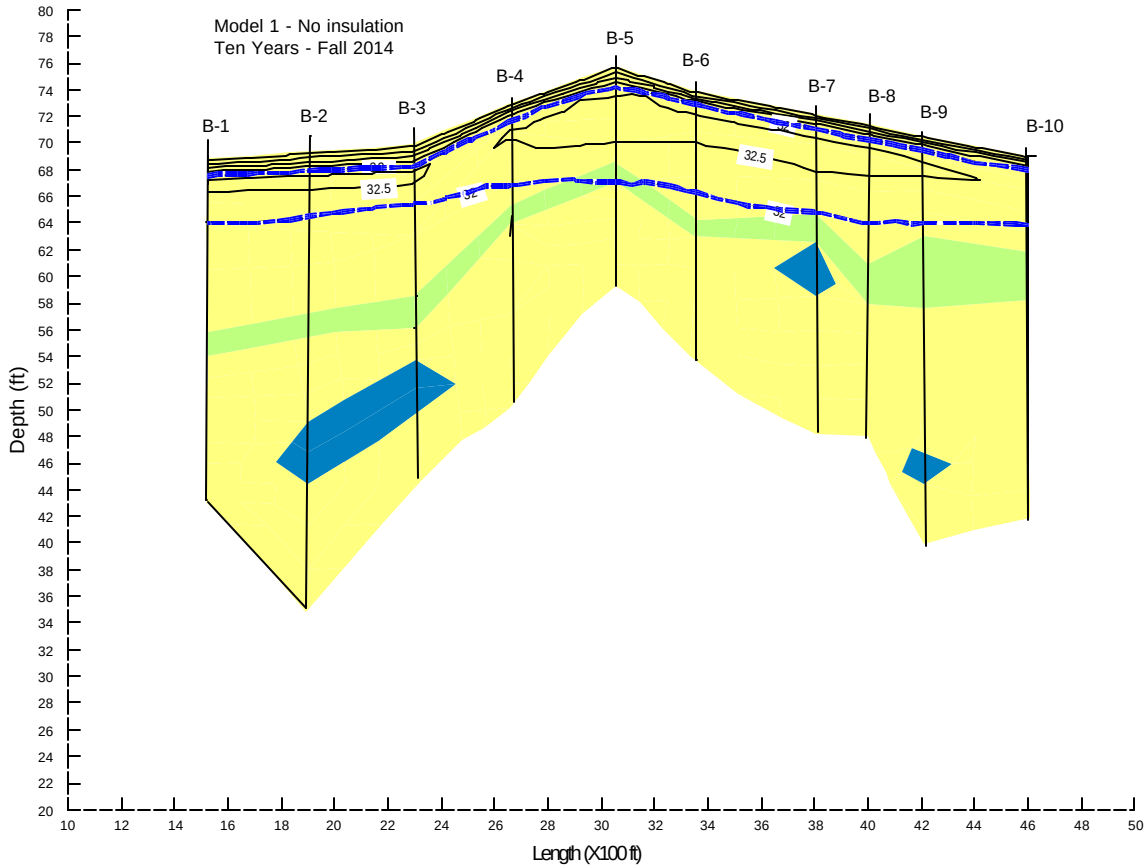
NOTE: Two-dimensional temperature profile is shown Model #1 . Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(e): Model 1 - Fall 2008



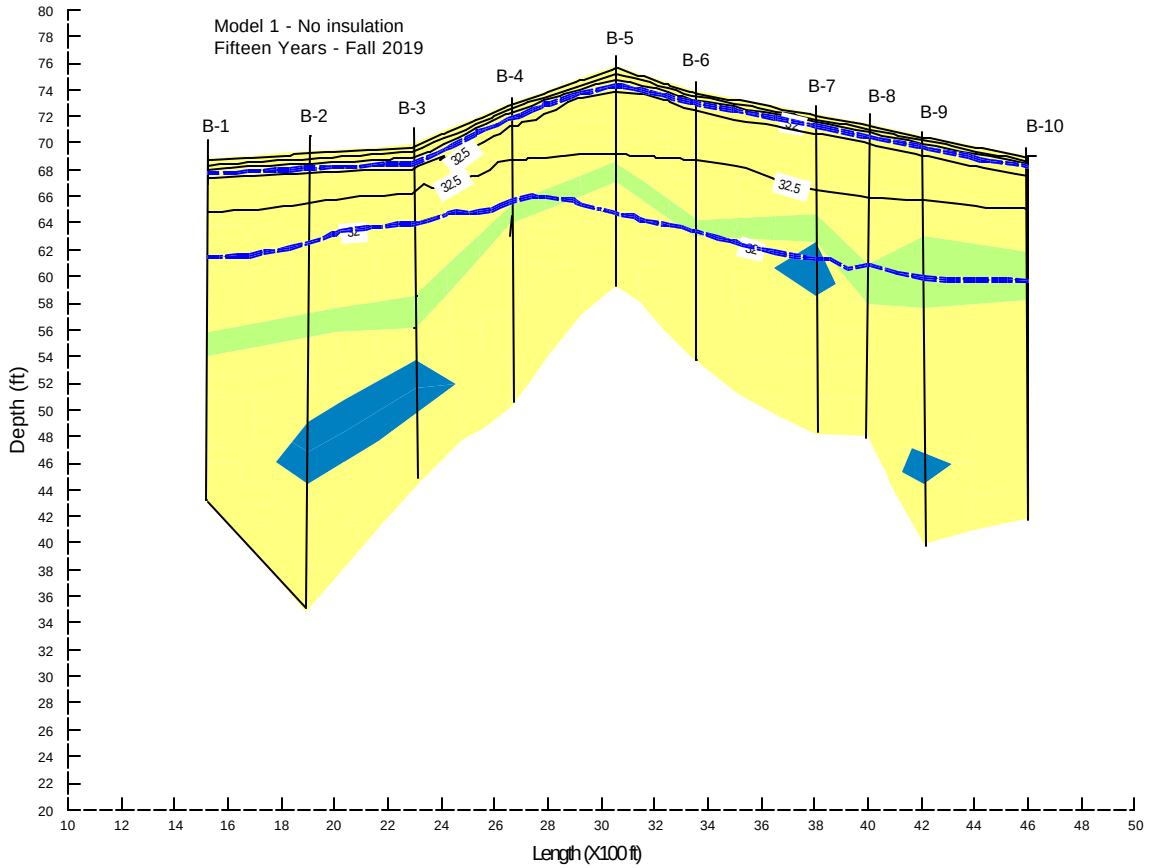
NOTE: Two-dimensional temperature profile is shown Model #1 . Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(f): Model 1 - Fall 2009



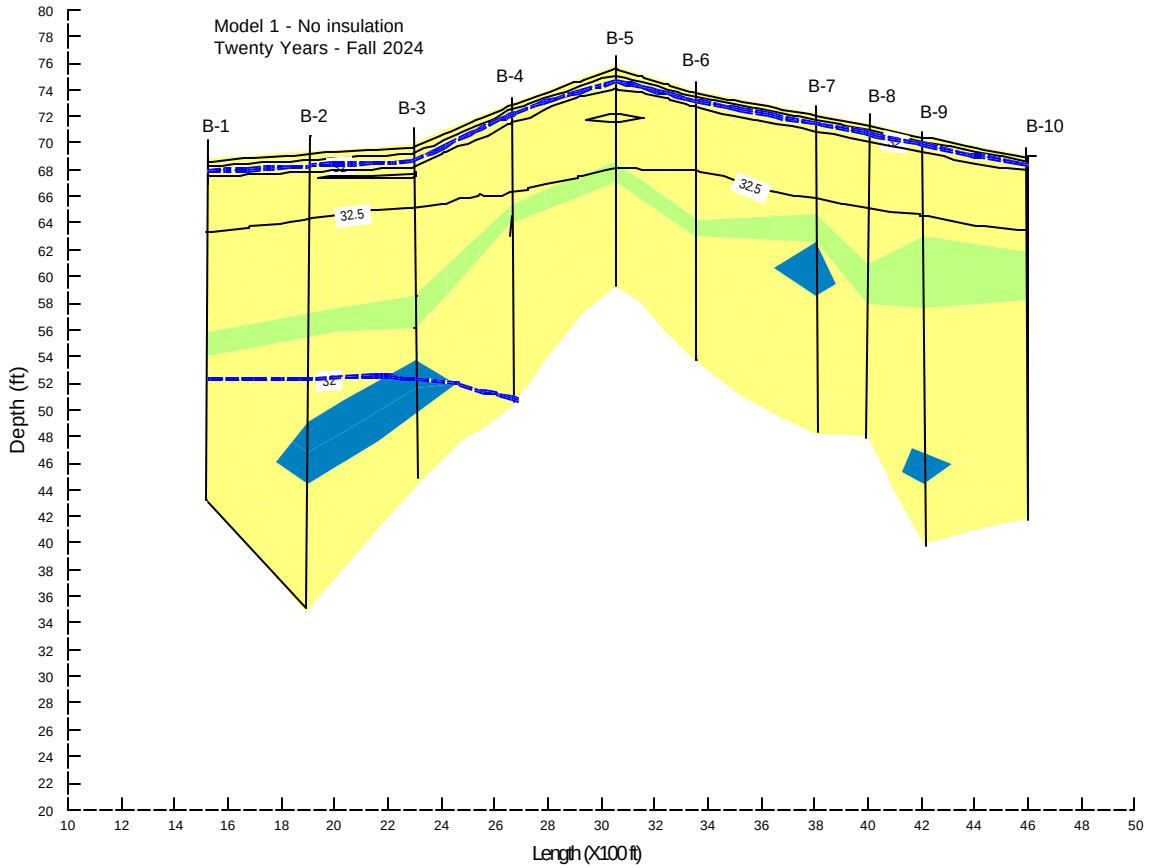
NOTE: Two-dimensional temperature profile is shown Model #1. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(g): Model 1 - Fall 2014



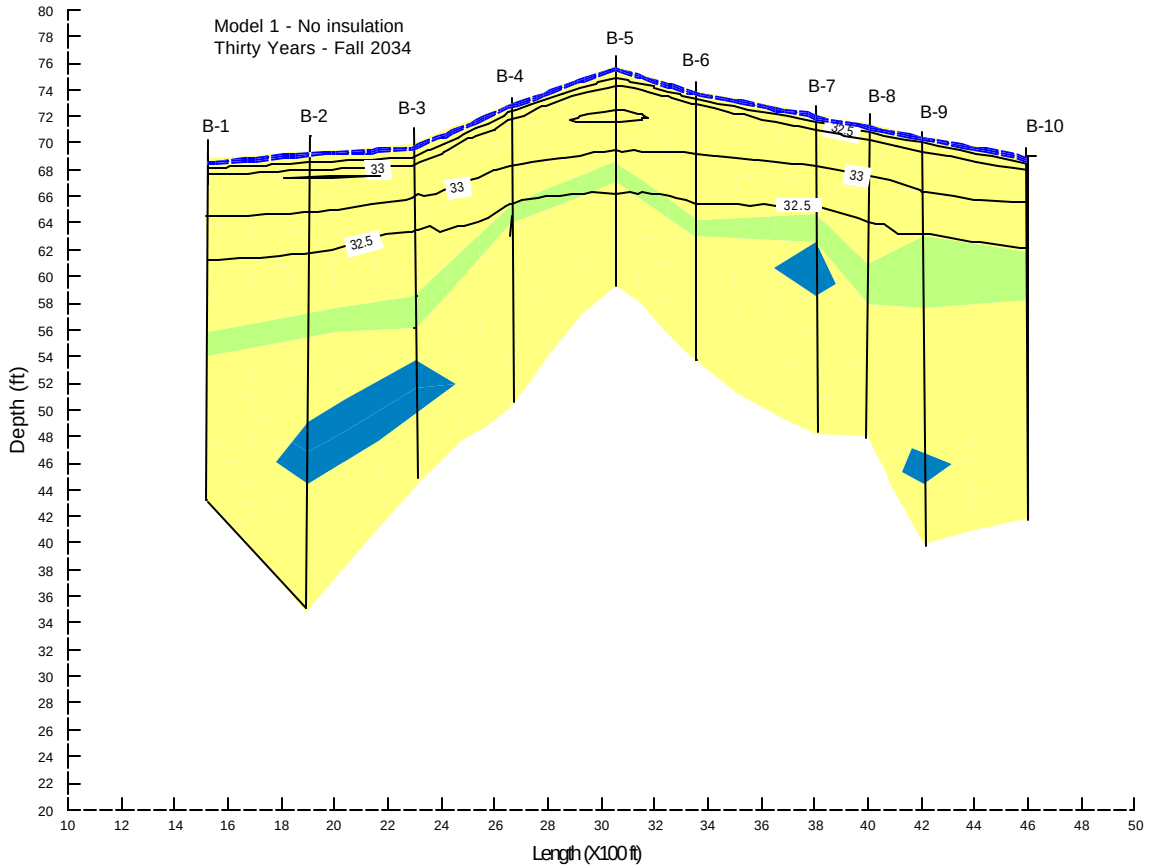
NOTE: Two-dimensional temperature profile is shown Model #1. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(h): Model 1 - Fall 2019



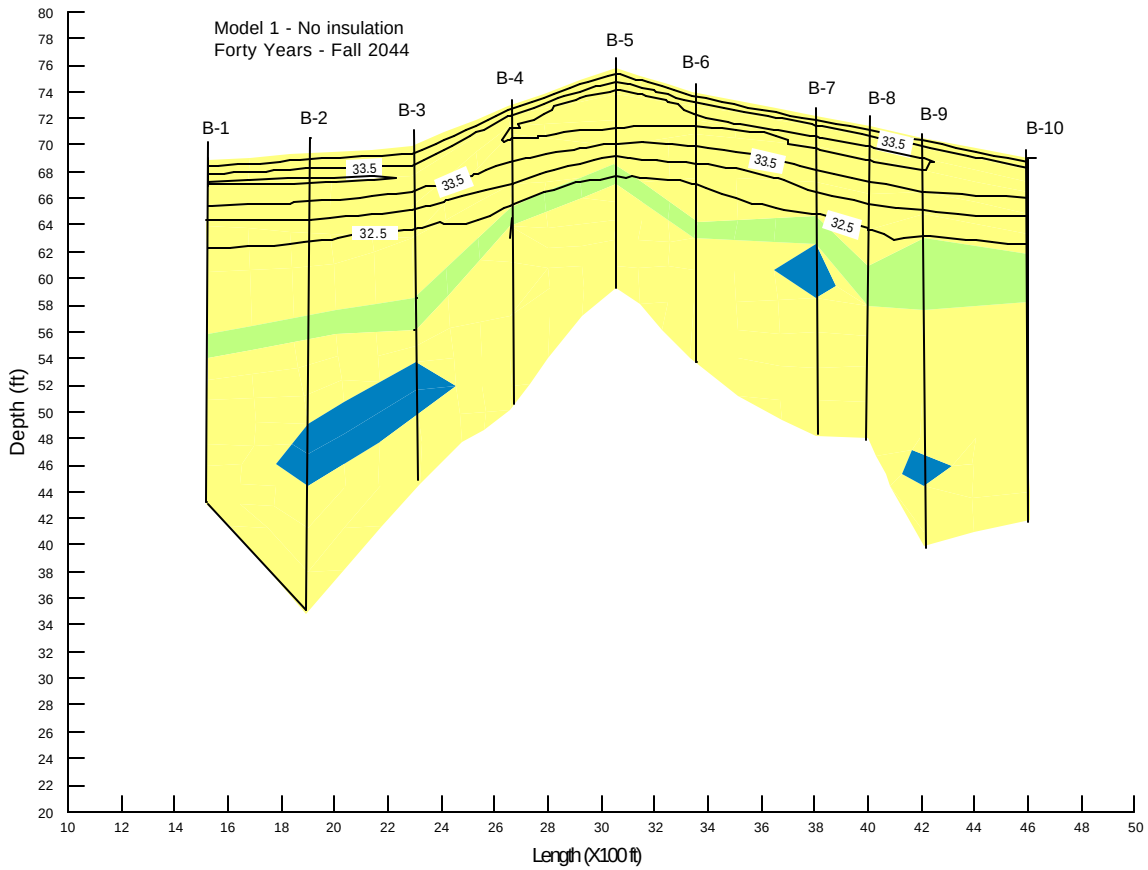
NOTE: Two-dimensional temperature profile is shown Model #1 . Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(i): Model 1 - Fall 2024



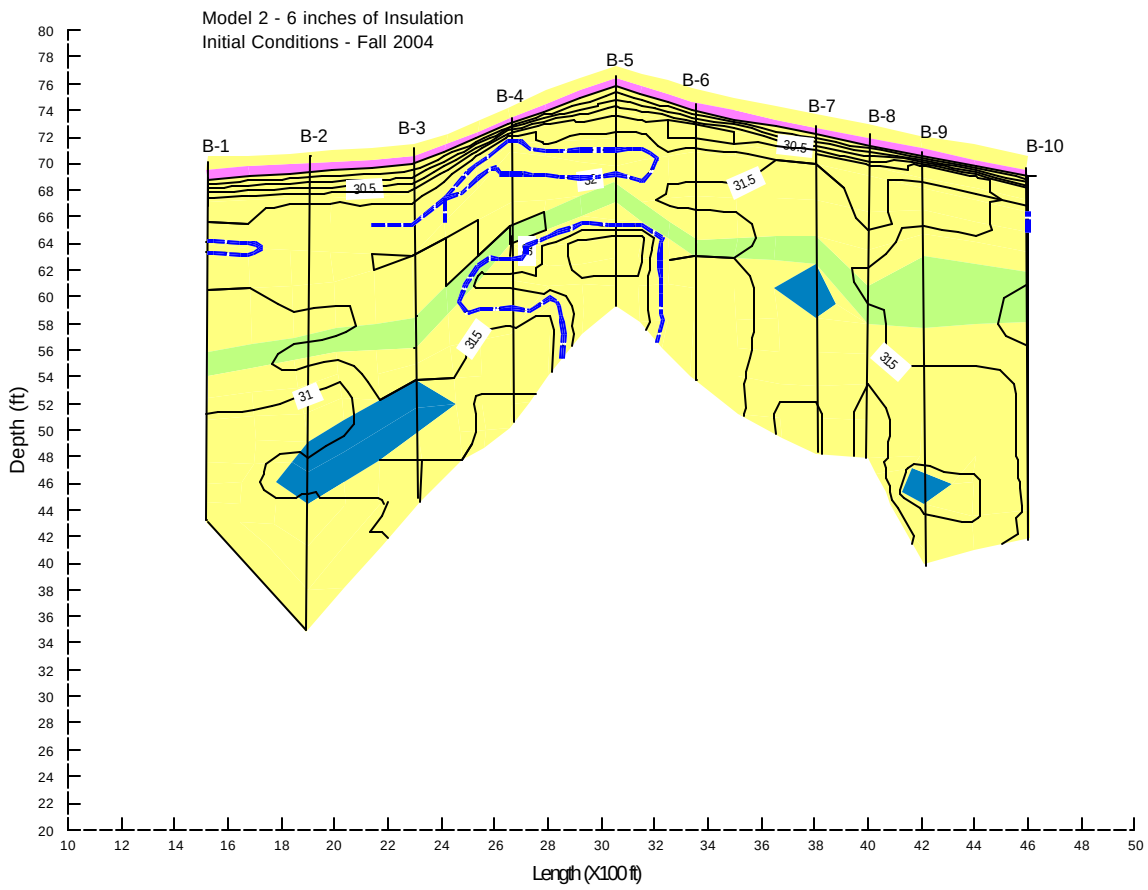
NOTE: Two-dimensional temperature profile is shown Model #1 . Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(j): Model 1 - Fall 2034



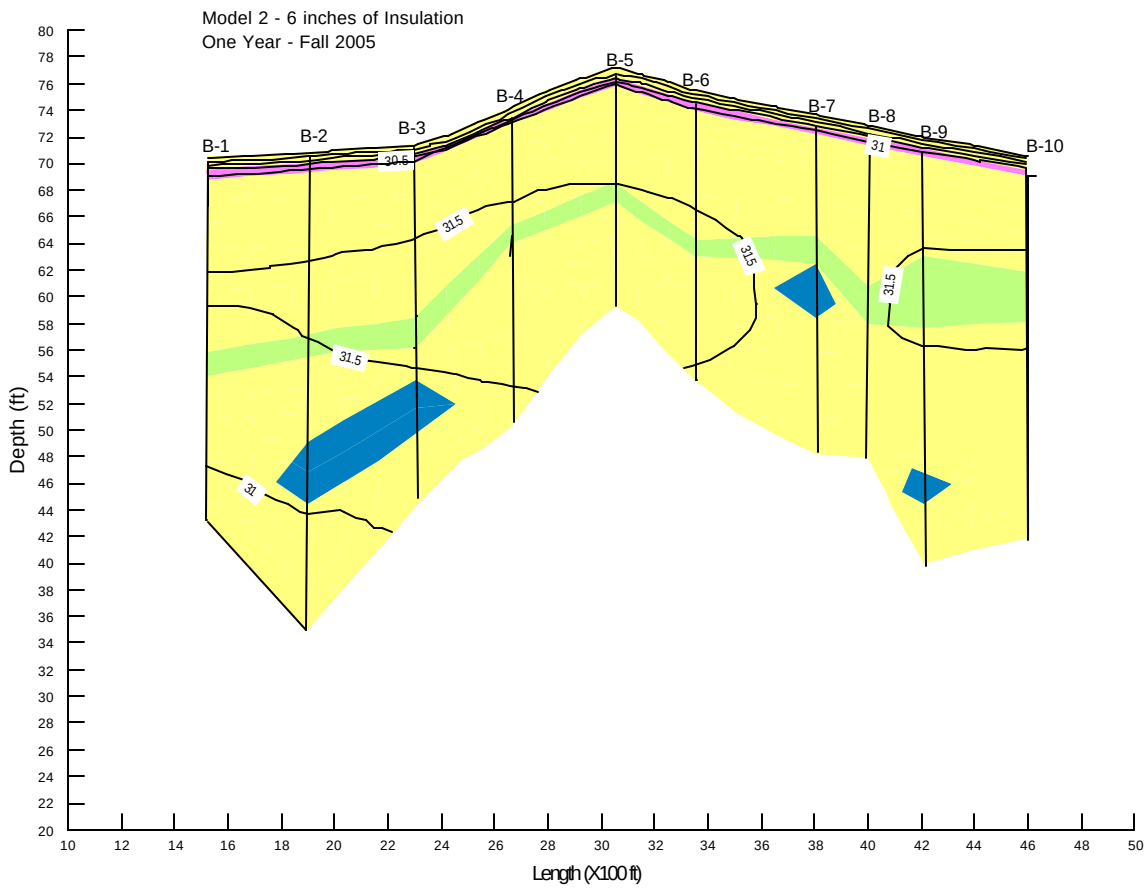
NOTE: Two-dimensional temperature profile is shown Model #1 . Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3 (a).

Figure D3(k): Model 1 - Fall 2044



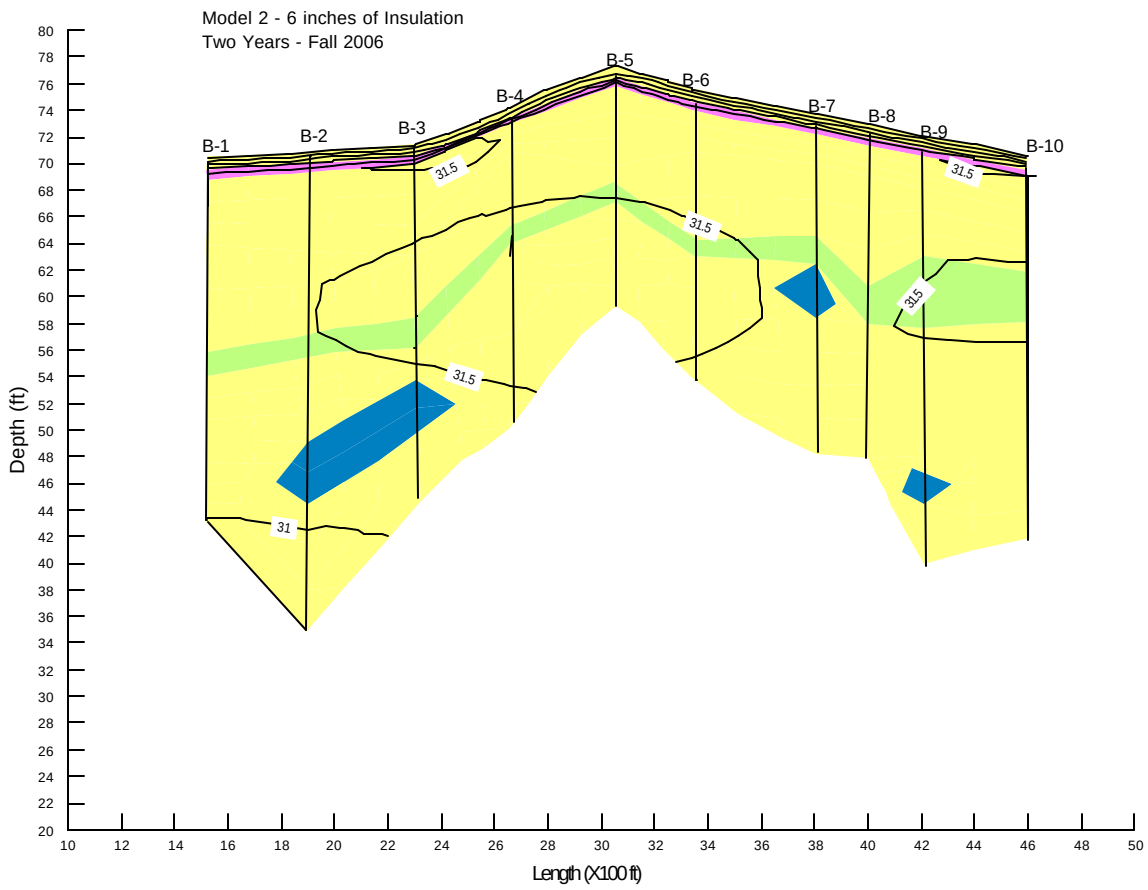
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(a): Model 2, 6-inches of insulation - Fall 2004



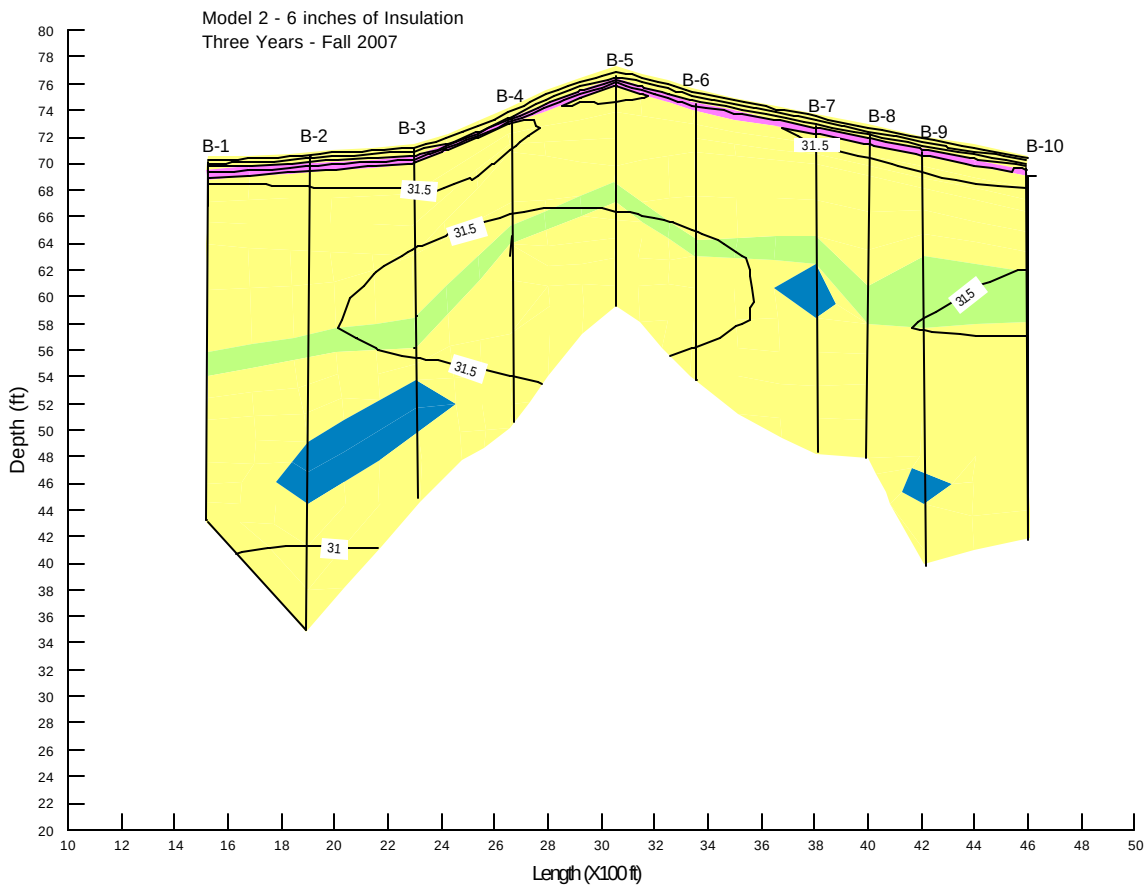
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(b): Model 2, 6-inches of insulation - Fall 2005



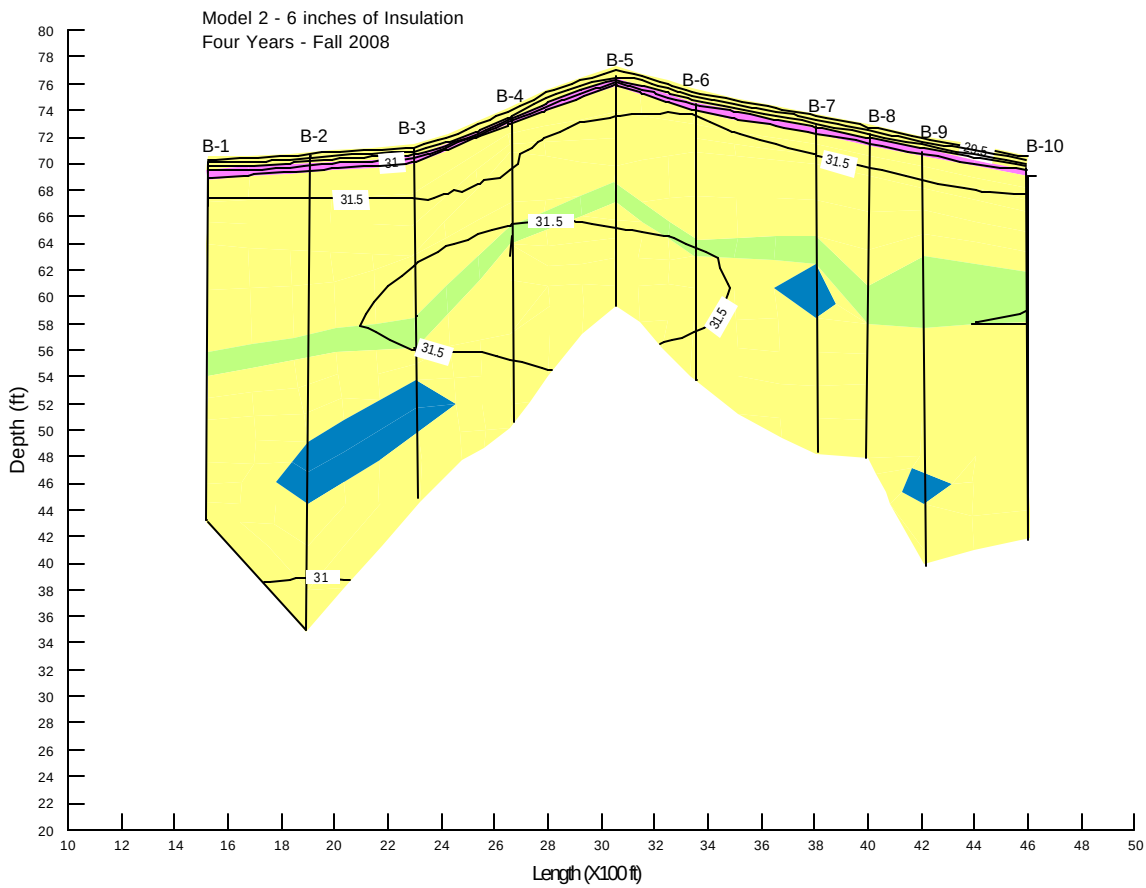
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(c): Model 2, 6-inches of insulation - Fall 2006



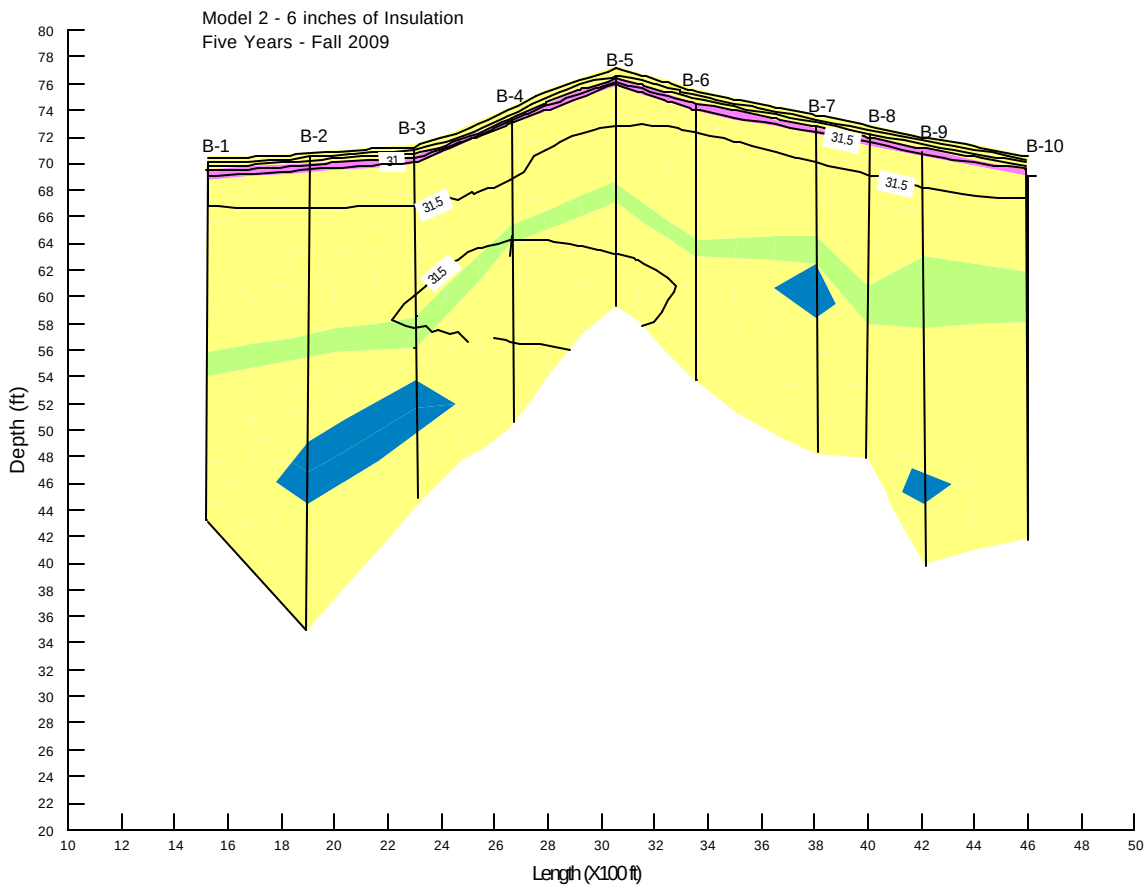
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(d): Model 2, 6-inches of insulation - Fall 2007



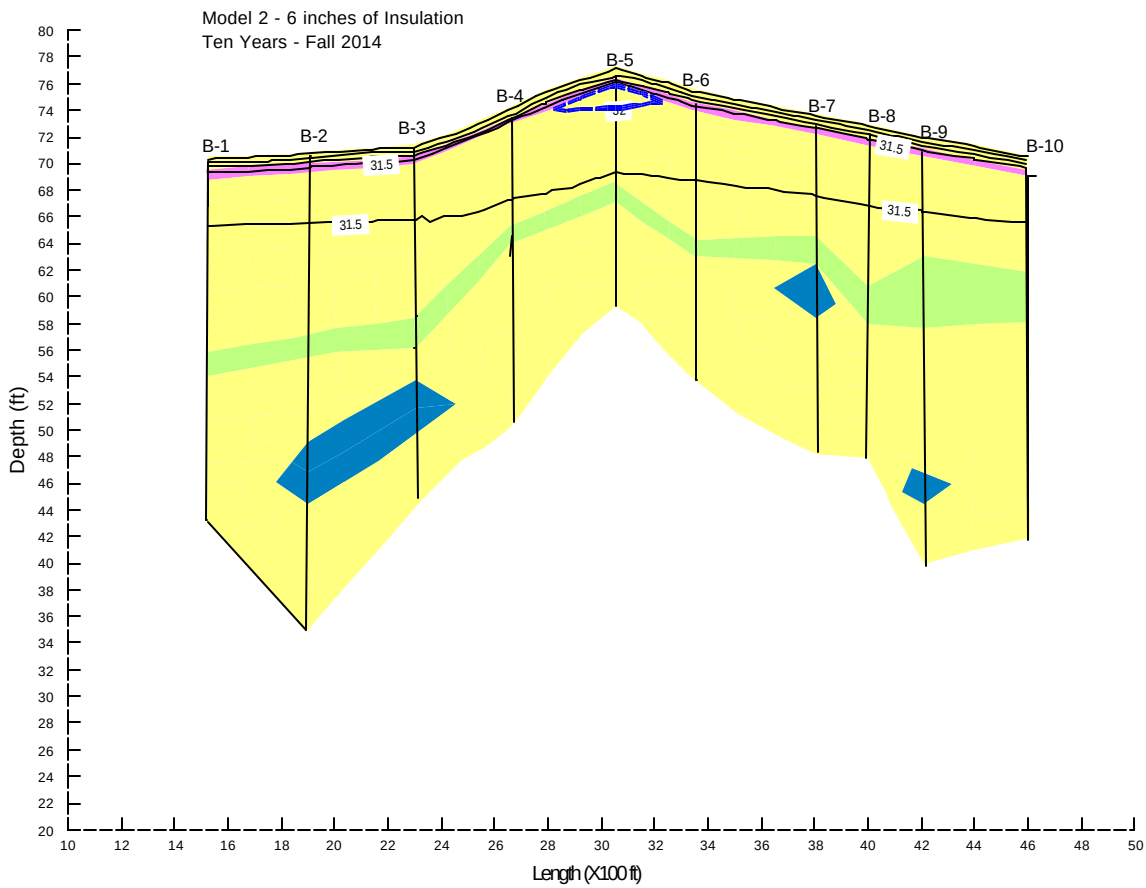
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(e): Model 2, 6-inches of insulation - Fall 2008



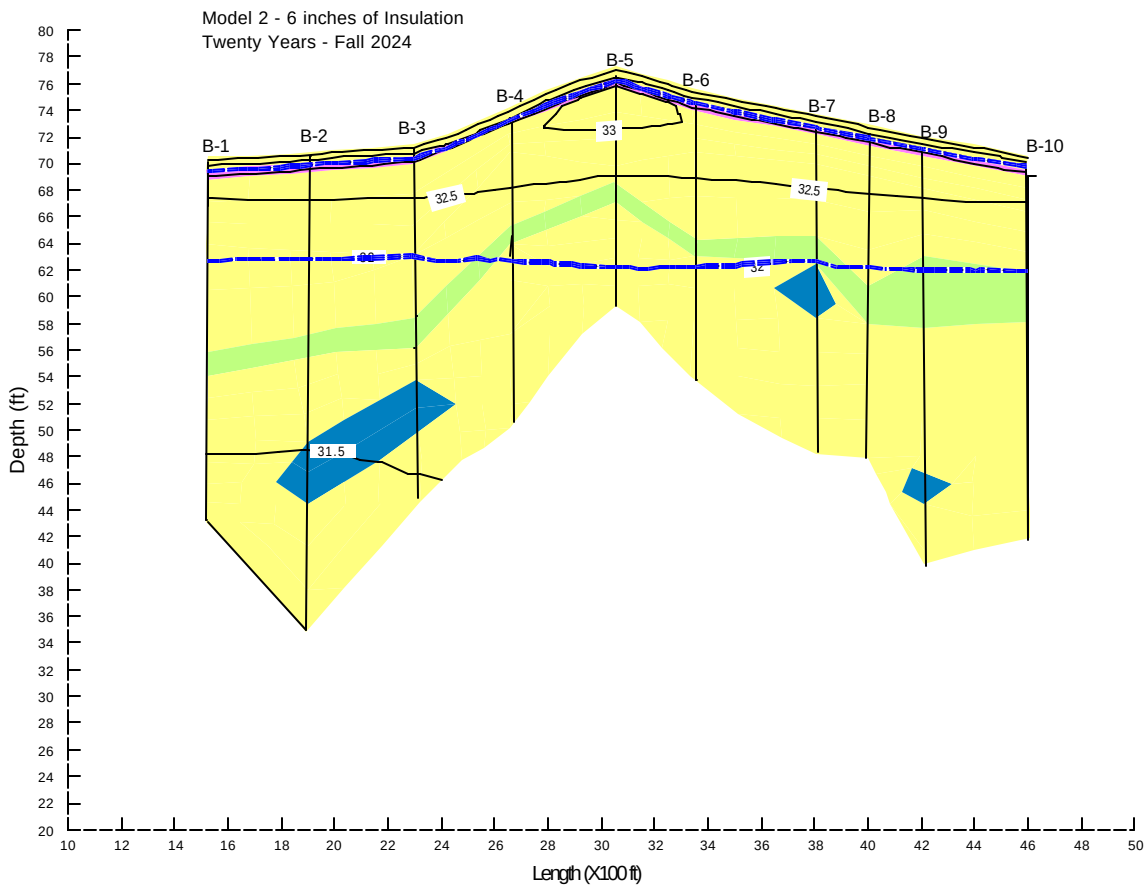
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(f): Model 2, 6-inches of insulation - Fall 2009



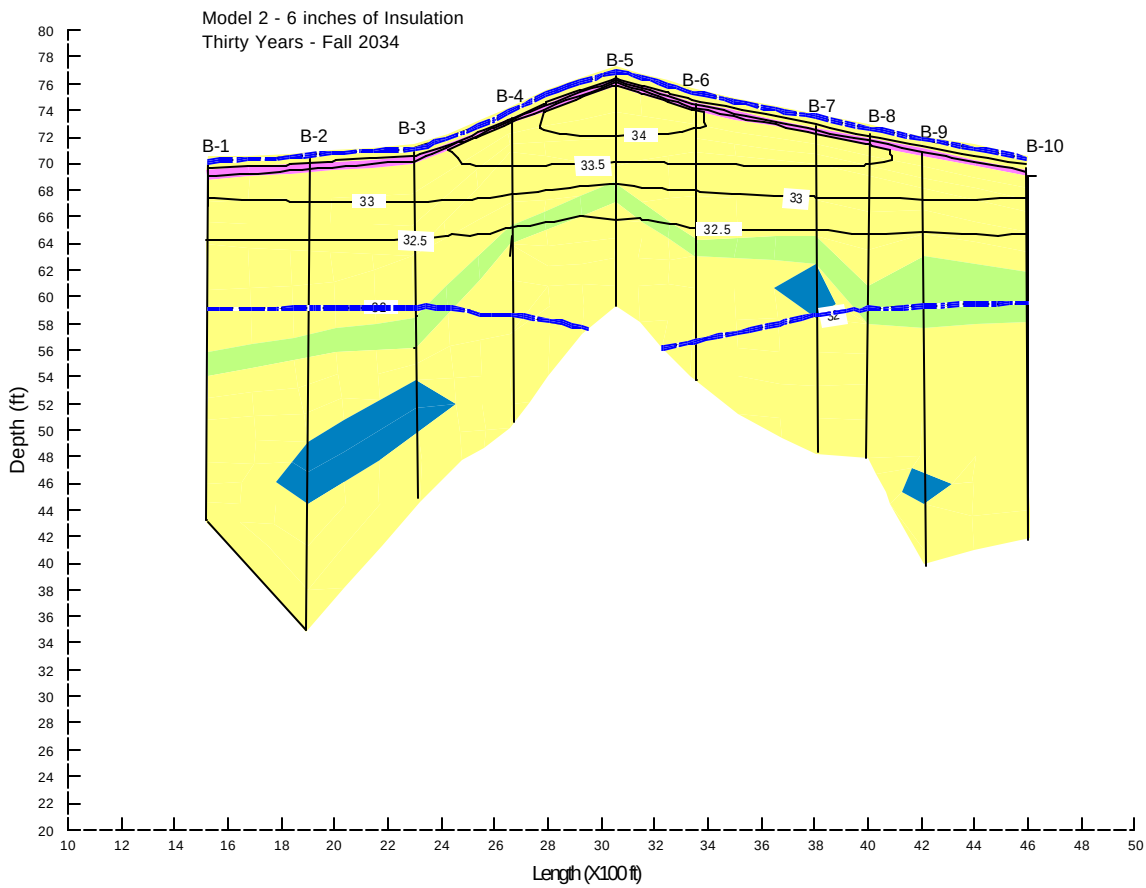
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(g): Model 2, 6-inches of insulation - Fall 2014



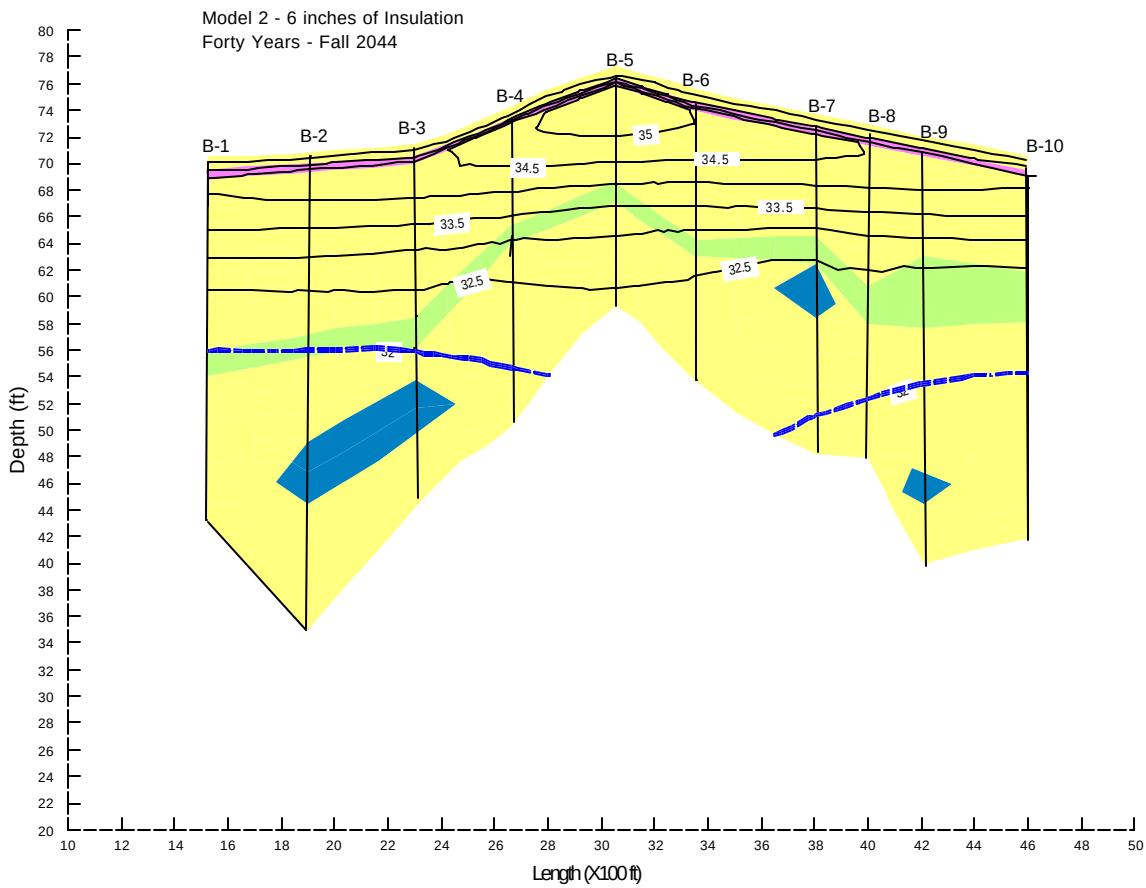
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(h): Model 2, 6-inches of insulation - Fall 2024



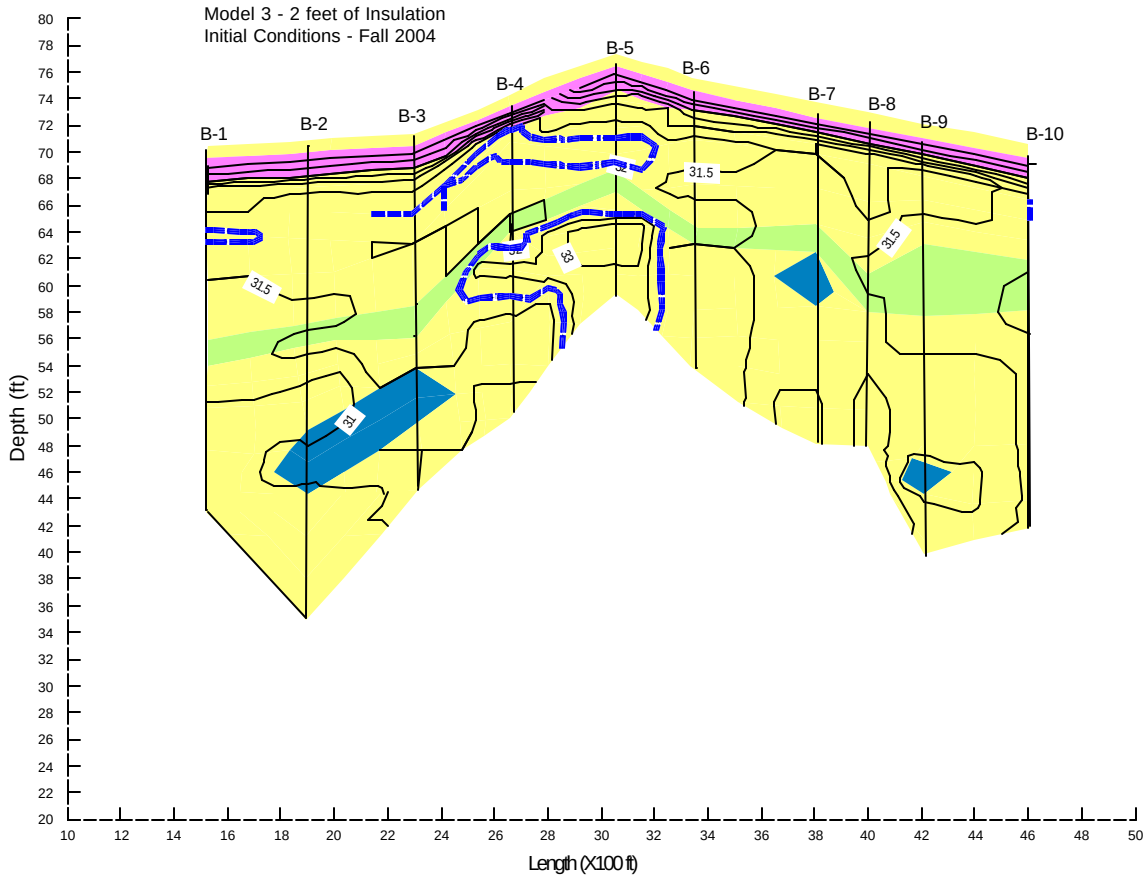
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(i): Model 2, 6-inches of insulation - Fall 2034



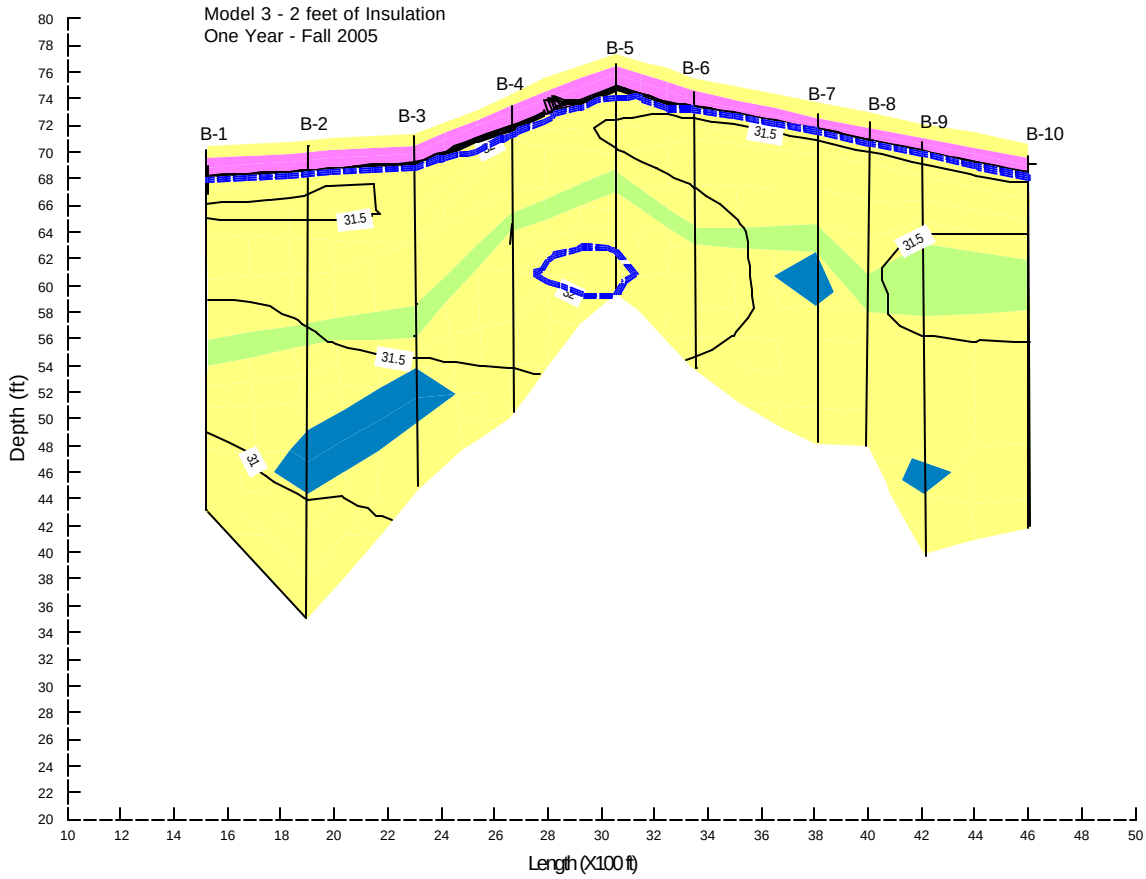
NOTE: The temperature profile shown above is for Model #2. In Model #2, 6-inches of insulation (shown in pink) are placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is show as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D4(j): Model 2, 6-inches of insulation - Fall 2044



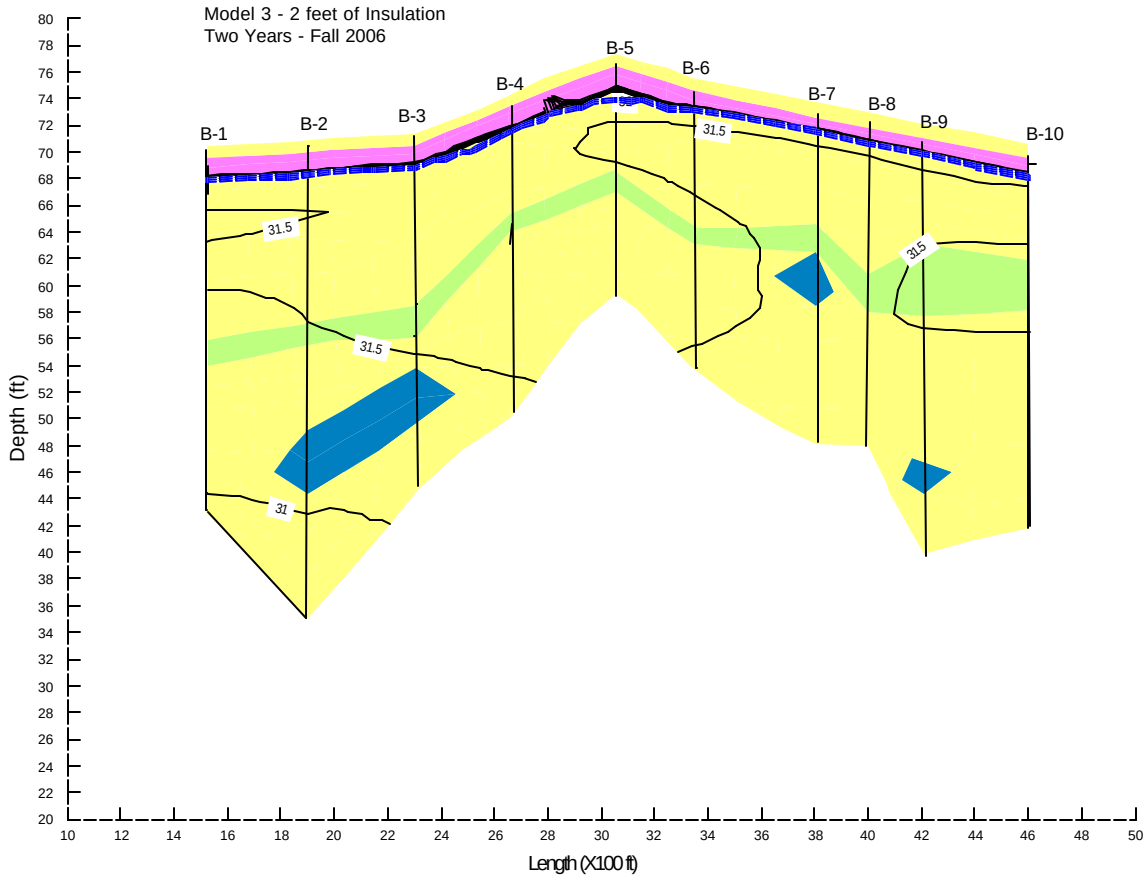
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(a): Results of Model 3, 2 feet of insulation, Fall 2004



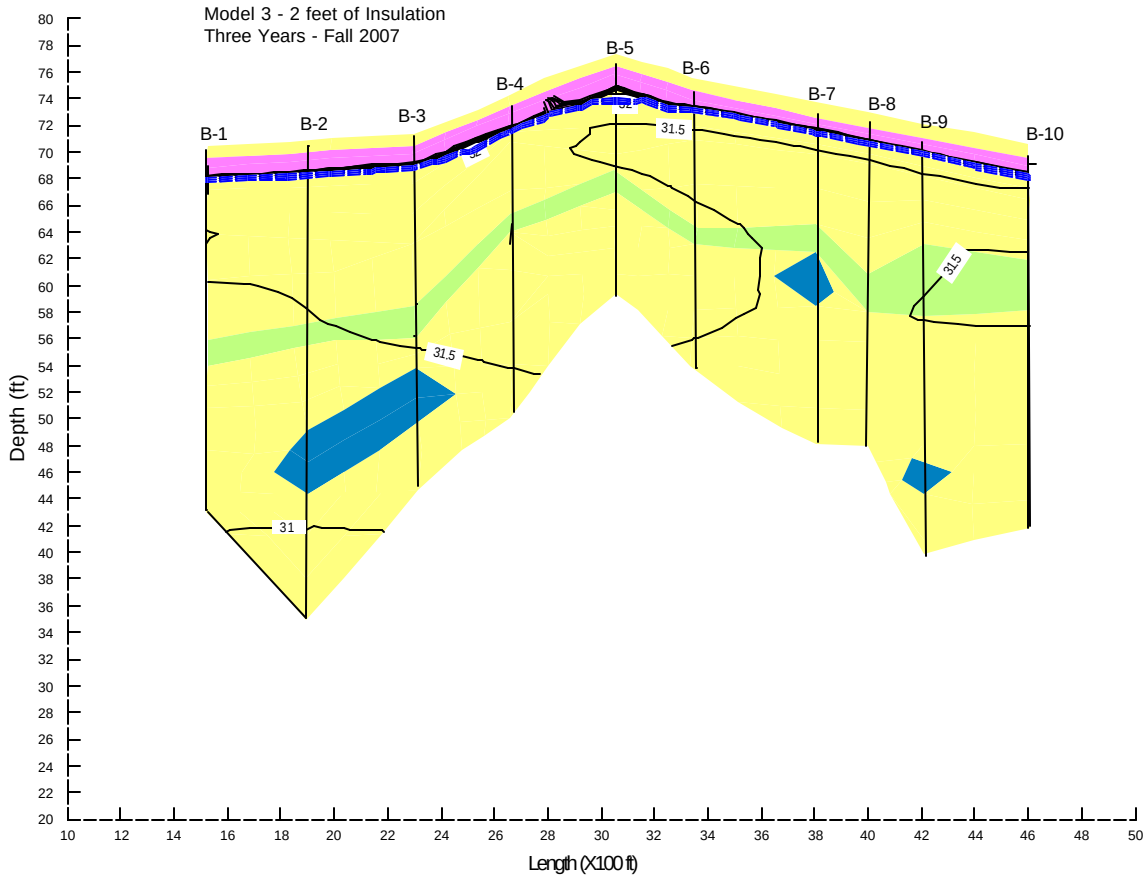
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(b): Results of Model 3, 2 feet of insulation, Fall 2005



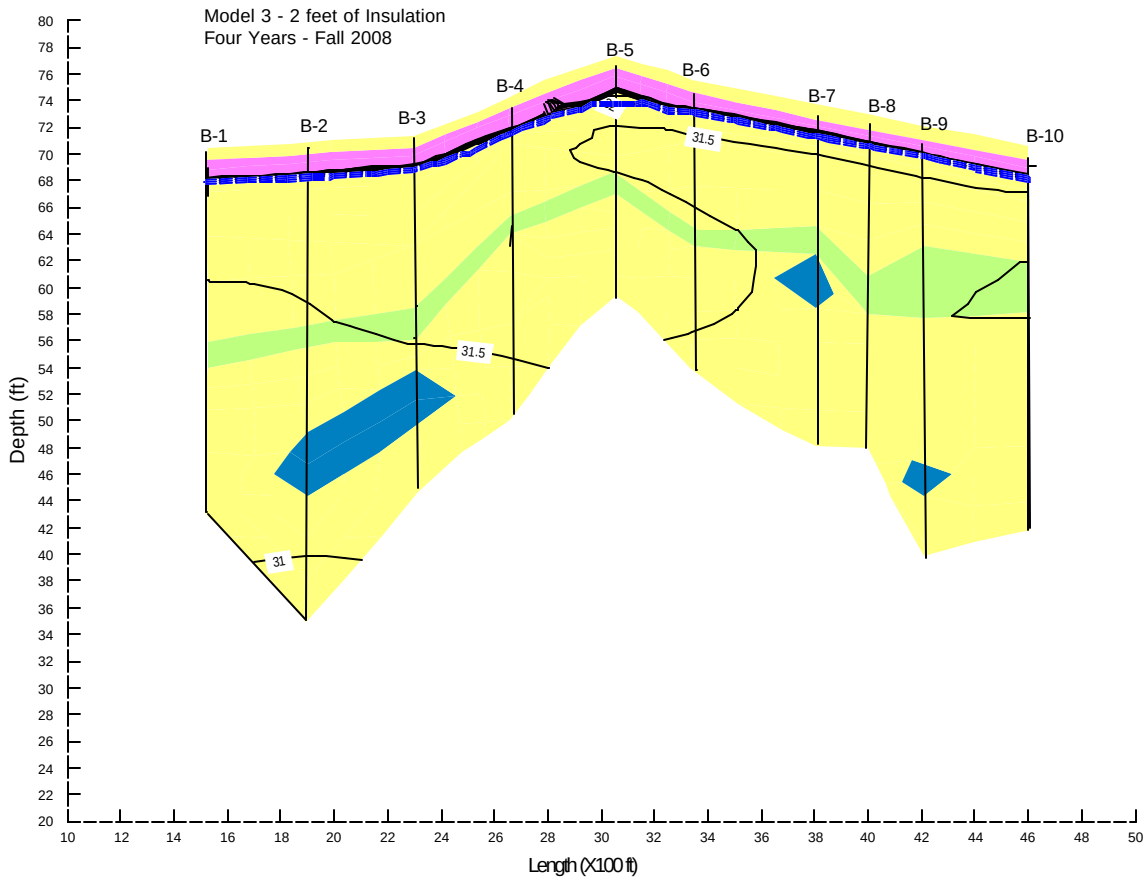
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(c): Results of Model 3, 2 feet of insulation, Fall 2006



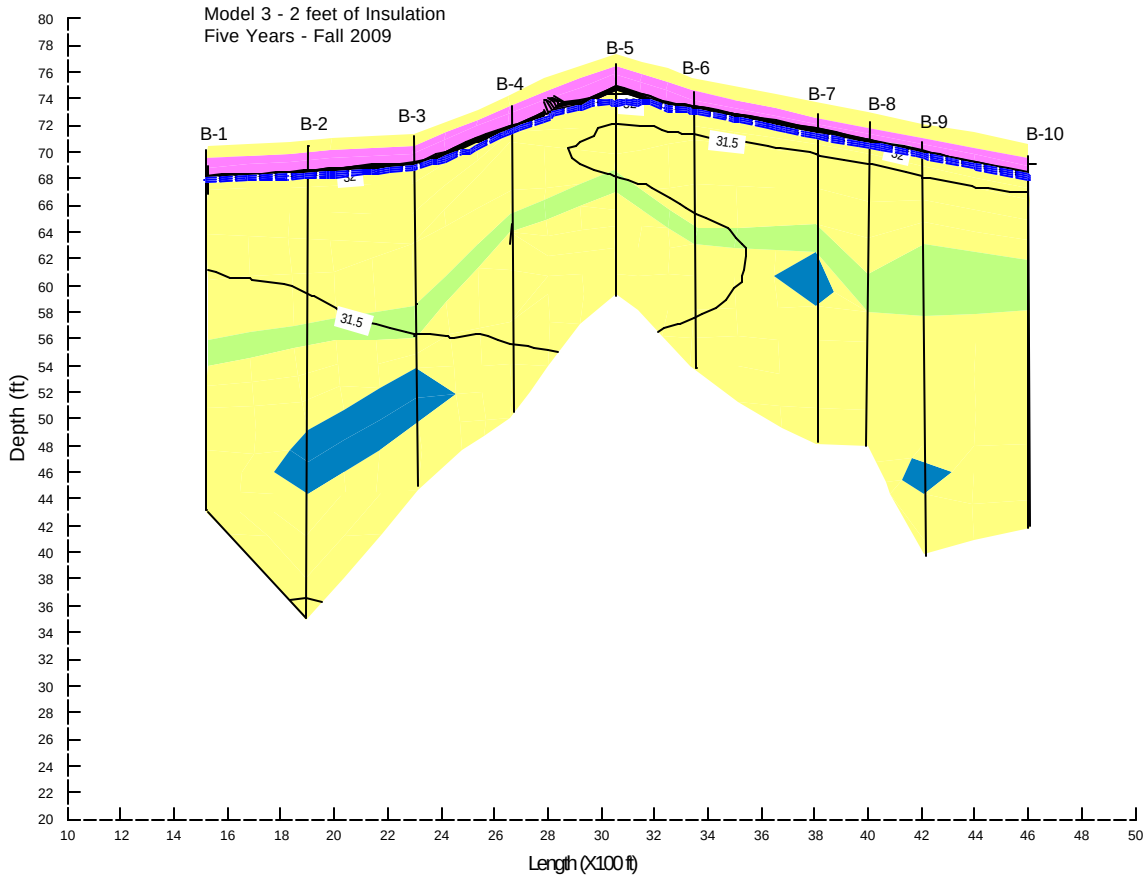
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(d): Results of Model 3, 2 feet of insulation, Fall 2007



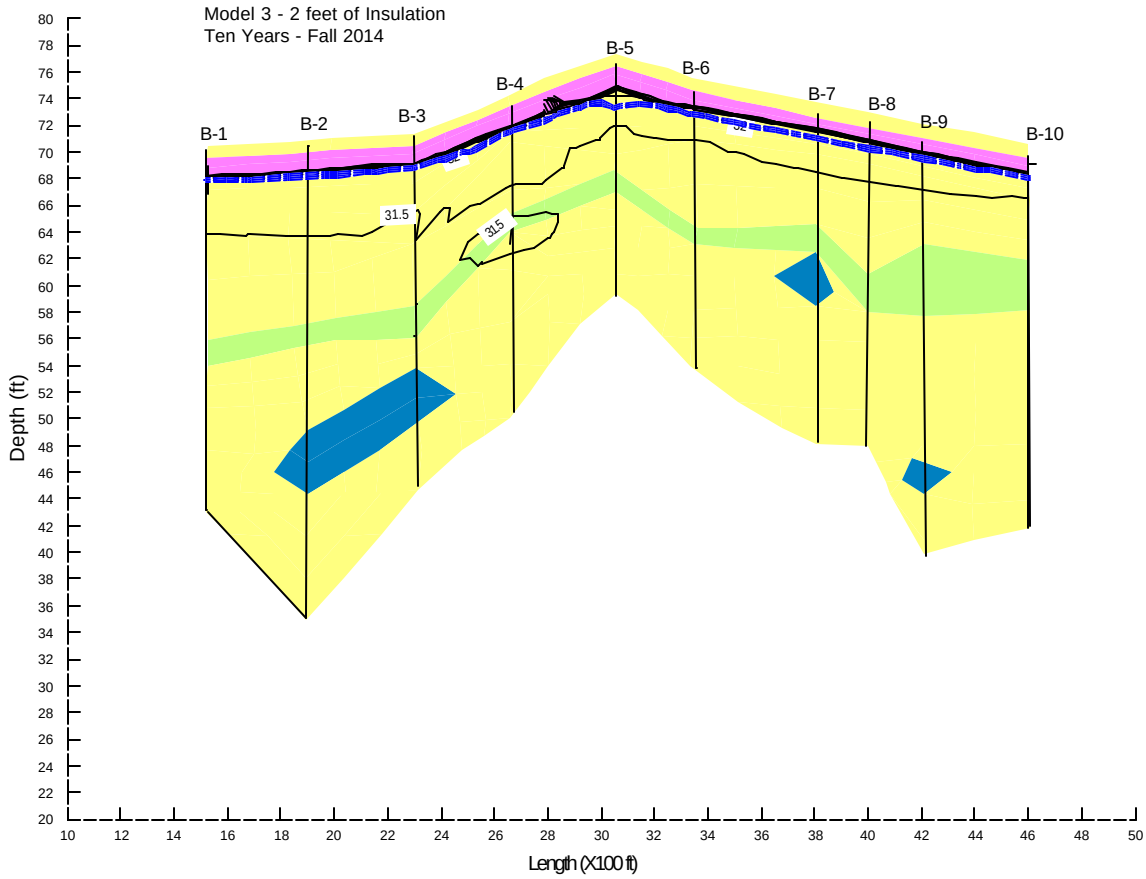
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(e): Results of Model 3, 2 feet of insulation, Fall 2008



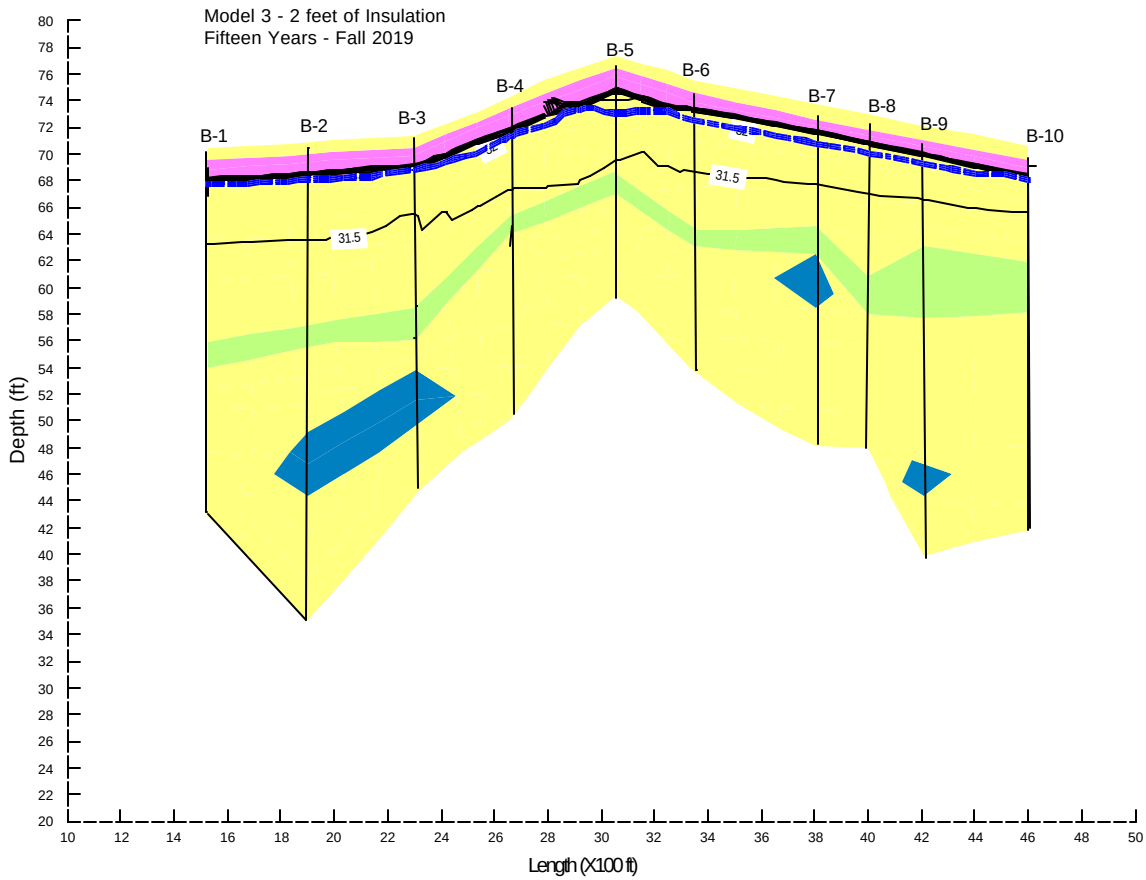
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(f): Results of Model 3, 2 feet of insulation, Fall 2009



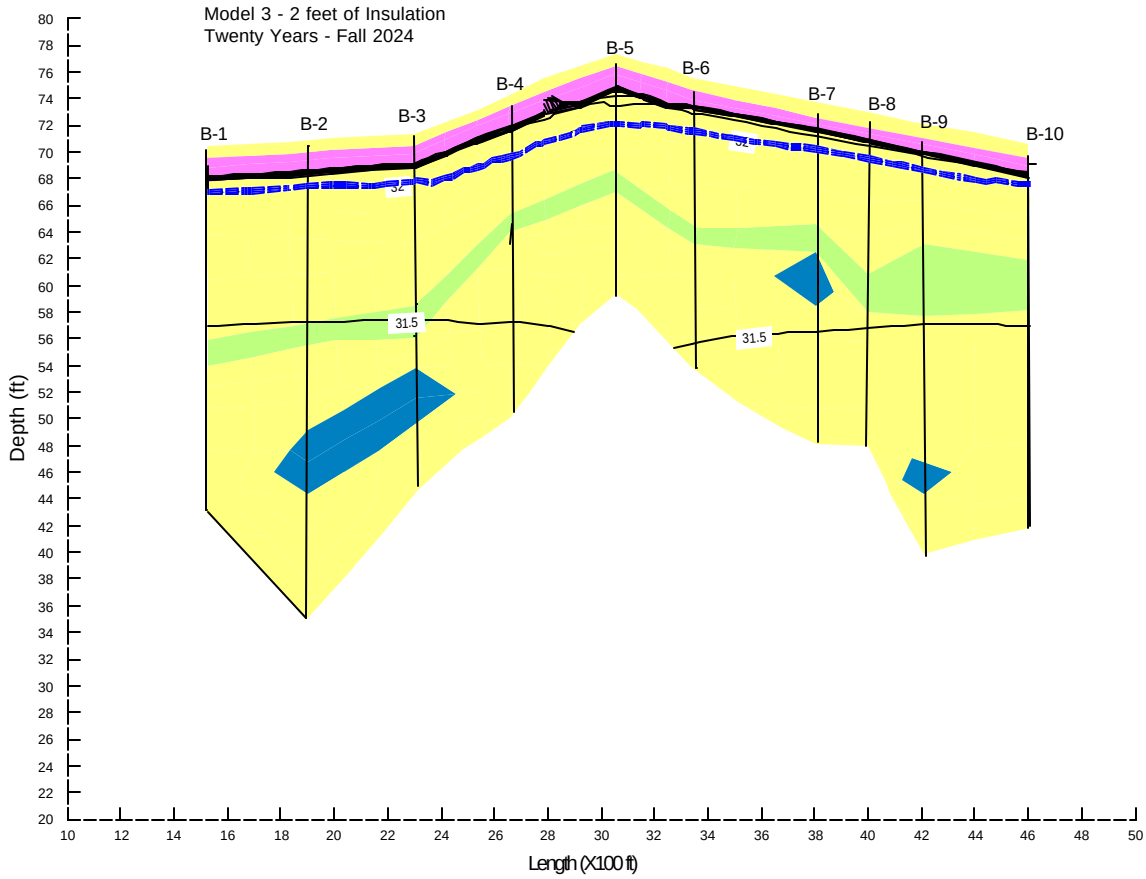
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(g): Results of Model 3, 2 feet of insulation, Fall 2014



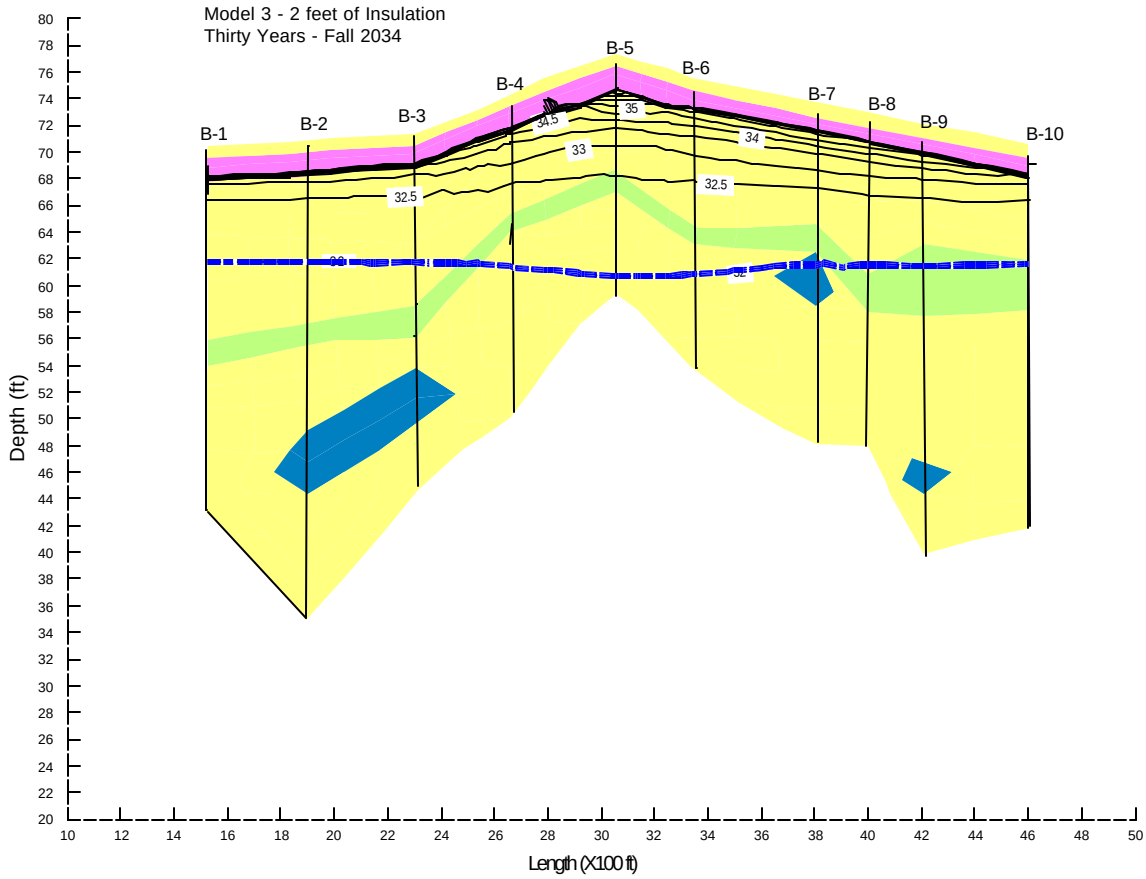
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(h): Results of Model 3, 2 feet of insulation, Fall 2019



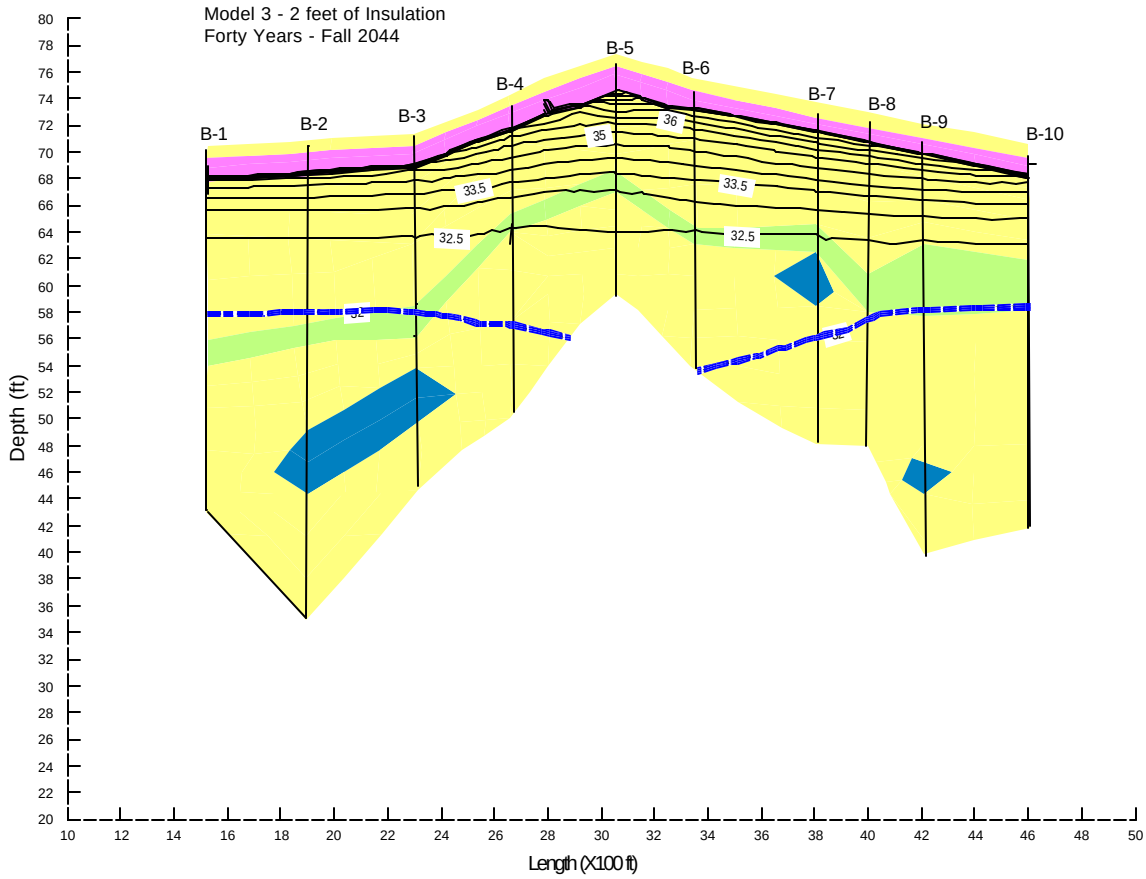
NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(i): Results of Model 3, 2 feet of insulation, Fall 2024



NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(j): Results of Model 3, 2 feet of insulation, Fall 2034



NOTE: The temperature profile shown above is for Model #3. In Model #3, there is 2 feet of insulation (shown in pink) placed in the embankment. Contours are of soil temperatures predicted by the model. Contour interval is 0.5 °F. The 32 degree isotherm is shown as a blue contour. Colors correspond to soil units as defined in Figure D3(a).

Figure D5(k): Results of Model 3, 2 feet of insulation, Fall 2044