PERMAFROST TECHNOLOGY FOUNDATION

FINAL REPORT

FOUNDATION STABILITY RESEARCH ON 4720 STANFORD DRIVE FAIRBANKS, ALASKA

JUNE 1998

Final Report
on
Foundation Stabilization Research Studies on

4720 Stanford Drive
Fairbanks, Alaska

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Introduction

This property entered the Alaska Housing Finance Corporation's (AHFC) inventory in 1989 due to a number of problems noted in the house (i.e. sagging garage ceiling beam, severely cracked garage floor, and failing floor support beams and posts). In 1990 an engineering report prepared by Stutzmann Engineering Inc. (see appendix) concluded that the foundation of this house may be unstable due to underlying permafrost soil or unconsolidated soils left from receding permafrost. The house was subsequently deeded to the Permafrost Technology Foundation (PTF) by AHFC for the purpose of research to develop economic techniques for stabilizing the foundations of permafrost-sited houses.

Permafrost underlying the foundation was suspected due to cracks found in the garage floor. Three test holes were drilled and revealed loose silty-sand and gravel to depths of 35 feet. Two of the test holes were outside the house, while one was drilled in the garage using a mobile drill. The test holes were inconclusive as to the presence of frozen soil (permafrost). The underlying soils exhibited very loose characteristics during drilling, indicating less than desirable compaction of the soils. Loose soils may settle during an earthquake or other dynamic event.

When PTF received the house, two additional permafrost exploration holes were drilled. These holes were located south of the southeast corner of the garage and midway along the west wall. These holes were drilled by Shannon and Wilson Inc. under contract to the Permafrost Technology Foundation. The holes were drilled to a depth of over 50 feet. No frozen soil was found to that depth, although the sampling spoon was noted to be "very cold to the touch." Once again the soils were found to be very loose throughout the entire depth of the drill hole.

Because the house showed no sign of permafrost and settlement damage was minimal, it was decided to monitor the structure for a period of time to see if any settlement or danger signs of settlement occurred. When no evidence of settlement was found after a year of monitoring the structure, the decision was made to continue the monitoring to determine the ultimate stability of the foundation and to gain data on what can be expected at a site with such very loose soils at depth.

Structure Description

The house is a single story, three bedroom, two bath structure with an attached two car garage. See Figure 1 which shows the floor plan. A crawl space approximately 3½ ft deep extends under the house except for the garage which has a concrete floor. The crawl space is accessible from a covered opening in the floor of one of the bedroom closets. The structure sits several feet above the street level and has a rather steep driveway. The elevation may have been required by the North Star Borough for flood protection in this location. Several neighboring houses are also built above the street in the same manner. A deck extends across the back of the house behind the kitchen and dining room.

Level Measurements

Level measurements were taken to determine the relative elevation of the floor. The level measurements were made using a small precise telescopic level (sometime referred to as a "contractor's level") mounted on a tripod and a surveyor's rod calibrated in millimeters. The millimeter rod was used instead of a standard surveyor's rod to give more precision to the measurements. Since the distance from the level to the rod was rarely over 5 meters (15 feet), the rod could easily be read to the nearest millimeter (0.04 in.).

It should be noted, however, that when level measurement are this precise, that perturbations can and do occur. These small changes are due to the placement of the rod from one measurement set to the next. Often the rod had to be placed behind furniture, and it was impossible to determine if it was sitting on the same spot as the previous measurement or if an electrical cord or a magazine etc. happened to be under the rod (even the thickness of several sheets of paper will show up at this precision). There was also the possibility for a gross error in reading the rod, since the level had the standard three cross hairs (center, upper and lower) used for measuring distances in surveying. If the operator was inexperienced (student labor was used for these measurements), a reading could be made using either the upper or lower cross hair instead of the center one. This error would yield an elevation that was in error by several tens of millimeters to as much as a few inches. These errors however are readily discernible when the data is plotted as a function of time (see the appendix).

Level data on the concrete slab floor in the basement was collected several times a year and accumulated for a period of six years. The level data plotted as a function of time are shown in the appendix of this report. Each measurement location is designated on the floor plan by a letter. Different groups of letters were plotted together on the charts to show relevant comparisons such as the south wall or the diagonal across the structure. In each chart, all levels are referenced to a single reference point "A". This allows the elevation of each point to be compared as a relative elevation on the floor plan with respect to point A. From this data, differential elevations between different parts of the floor can be easily seen and tracked with time.

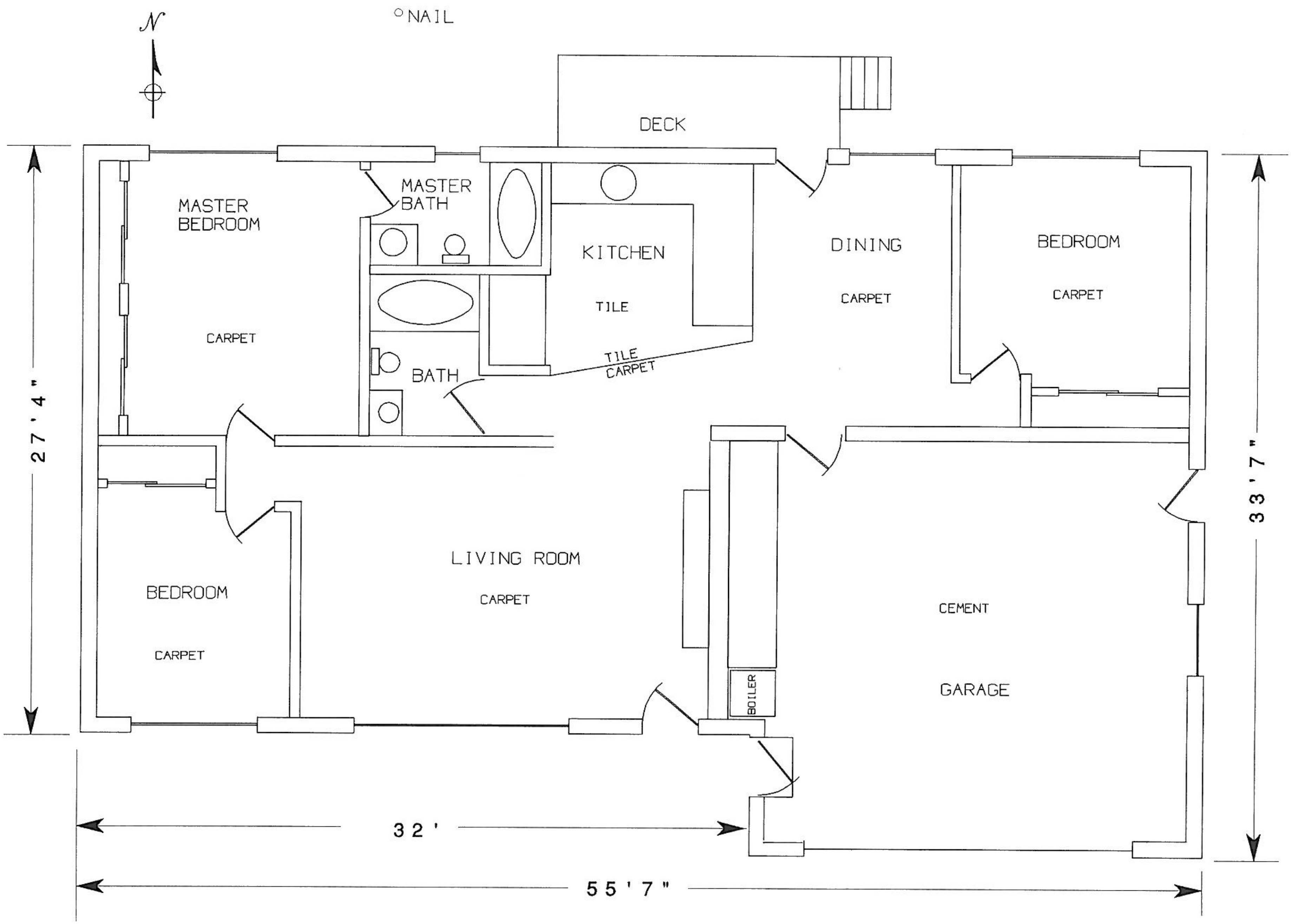

FIGURE 1 Floor Plan of 4720 STANFORD Drive

This system, however does not give information as to the absolute elevation of the house with respect to the ground outside, and therefore any elevation variation of point A is also reflected in all other points. Determining absolute elevations requires a stable surveyor's benchmark or other stable reference outside of the structure. At this location a nail was driven into a large tree to attempt to provide a stable reference, however this did not prove to be reliably stable. Nevertheless, the relative elevations allow differential settlement to be tracked, and that is the most important information for these studies.

For perspective, a differential floor elevation of one to two inches (25 mm to 50 mm) is not noticeable to the unaided eye, and up to four inches (100 mm) over the distance across a normal room, although noticeable, is not an overly unpleasant condition with which to live.

Temperature Measurement

When the permafrost test borings were drilled, a thermistor string with 12 thermistors was placed in each hole. In addition, three thermistor strings were placed in pipes that were driven into the soil at three locations in the crawl space beneath the structure. The thermistor strings were positioned to measure temperatures at various depths from the surface to 54 ft (see Temperature Measurements in the appendix). These temperatures were monitored periodically at the same time the level measurements were taken (and sometimes more often) resulting in a data base of six years of soil temperatures for the site. The temperature data was plotted with respect to time to give a graphic indication of the trends over the duration of the study. These plots are included in the appendix of this report.

Thermistors are capable of measuring temperature to the nearest one thousandth of a °C. However, the nearest one tenth of a degree is probably satisfactory for our purposes for everything except the location of the actual freezing front. Thermistors are more accurate than thermocouples; however, they have the disadvantage of being more fragile, and they can drift a few thousands of a degree over time. To obtain the maximum accuracy, the strings must be calibrated in a reference bath both before and after their use. These thermistor strings were calibrated before placing them in the hole, but since once installed they are buried, it is impractical to remove them without destroying them, therefore the secondary calibration cannot be made. The temperatures, therefore, cannot be relied upon to more than about a tenth of a degree.

Thermistors located at various depths allow us to track the temperatures at those depths to determine if the permafrost is getting deeper, remaining stable, or actually rising. The data also alerts us to any anomalies in temperature that may occur due to outside influences such as new construction nearby, landscaping modifications, or damage or deterioration of protective insulation. Since no permafrost was found at this location, the temperature data here is not as important as in sites underlain by permafrost. However, the temperature trends over the years of measurement are valuable data to be used for control and reference to other sites that do have permafrost.

Geotechnical Exploration

In order to determine the condition of the soils below the structure, two boreholes were drilled to a depth of over 50 feet. Twenty soil samples were taken at regular intervals of depth during the drilling of each hole. Figure 2 shows the boring log of the hole near the southwest corner of the house. Samples were collected by driving a split-spoon sample core barrel through the hollow stem using a 300 pound hammer and a 30 inch drop. The number of hammer blows required to drive the core barrel gives information on the competency of the soil at each sample depth. These samples are considered "disturbed samples." However, since they are retrieved essentially intact in their natural state, they provide useful information about the soil. This method of sampling was continued until frozen ground was encountered. Below this, the soils were sampled with a dry core barrel. This brings to the surface a five-foot-long, three-inch-diameter, intact soil sample. Representative soil samples were then sent to the laboratory for analysis of grain size and water content. With this data, a model of the soil conditions and types was constructed for the hole. This model does not necessarily apply to the soils under the structure since soil conditions can, and often do, change radically over short distances, but if boreholes on both sides of the structure are similar in nature, then the soils beneath the house can be inferred.

Results and Conclusions

Temperature data from the site indicates that even at the 50 foot depth the temperature of the soils is undergoing a gradual increase. Temperature on the southeast corner rose from 1.4 to 2.3°C from October 1992 to January 1997, and on the west side of the house temperature rose from 1.9°C in August 1992 to 2.5°C in January 1997. A similar upward trend in the temperature was obvious at shallower depths. Even at the 20 ft depth, temperature rose 0.4°C and 0.2°C in the west and southeast holes respectively. If permafrost did underlie this location (and obviously it did at some time in the past even if it was not present at the time of construction), it has receded to below the 50 ft depth. At this depth, further melting takes place very slowly and will not be a significant factor with respect to settlement of the house. The loose soils left behind by the melting permafrost, however, is another matter that must be assessed.

Loose soils can allow settlement due to a number of conditions: the increased load placed on the soil at the time of construction, increases in the soil moisture due to watering of the lawn or snow melt from the roof, additional loads from later construction, etc. Any of these can cause the soil to compact allowing the surface and anything sitting on it to subside. The subsidence normally occurs very slowly over several months or a few years causing a slow wracking of the structure. Subsidence in this house appears to be very slow, the maximum being 5/8 in. over nearly six years in the northeast corner. The garage appears to be moving somewhat more, with 1½ in. of elevation change occurring. However, the garage floor slab has risen with respect to the rest of the house by that much and appears to be somewhat cyclic suggesting a frost heave effect. The question then becomes one of will the house continue to subside or has it reached stability. Only continued long-term monitoring can answer this question. In any case, nothing in the data suggests that the settlement, if it does continue, will be anything but very slow making it easy to compensate for the elevation changes before any structural damage could occur.

Loose soils also raise the concern of settlement during a dynamic event such as an earthquake. During the period over which the level measurements were made on this house there were 15 earthquakes over Richter 4.0. and, of those, one was 5.0 on Nov 1, 1992 and one was 6.2 on October 6, 1995. This last one was the most significant event, since it was not only the largest but also it was the shallowest at only 9 km below the surface. It was felt very strongly by residents of Fairbanks. However, reviewing the data on level measurements shows that no significant measurable settlement can be identified in our data during any of these events. This suggests that either settlement into the loose soils beneath the structure was not triggered by a dynamic event of this magnitude or that settlement into the loose soils was already complete before the Permafrost Technology Foundation started monitoring the structure. These circumstances and observations do not preclude the possibility of settlement during a more severe earthquake or other type of dynamic event.

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Appendix

Bore Hole Log

BORING LOG

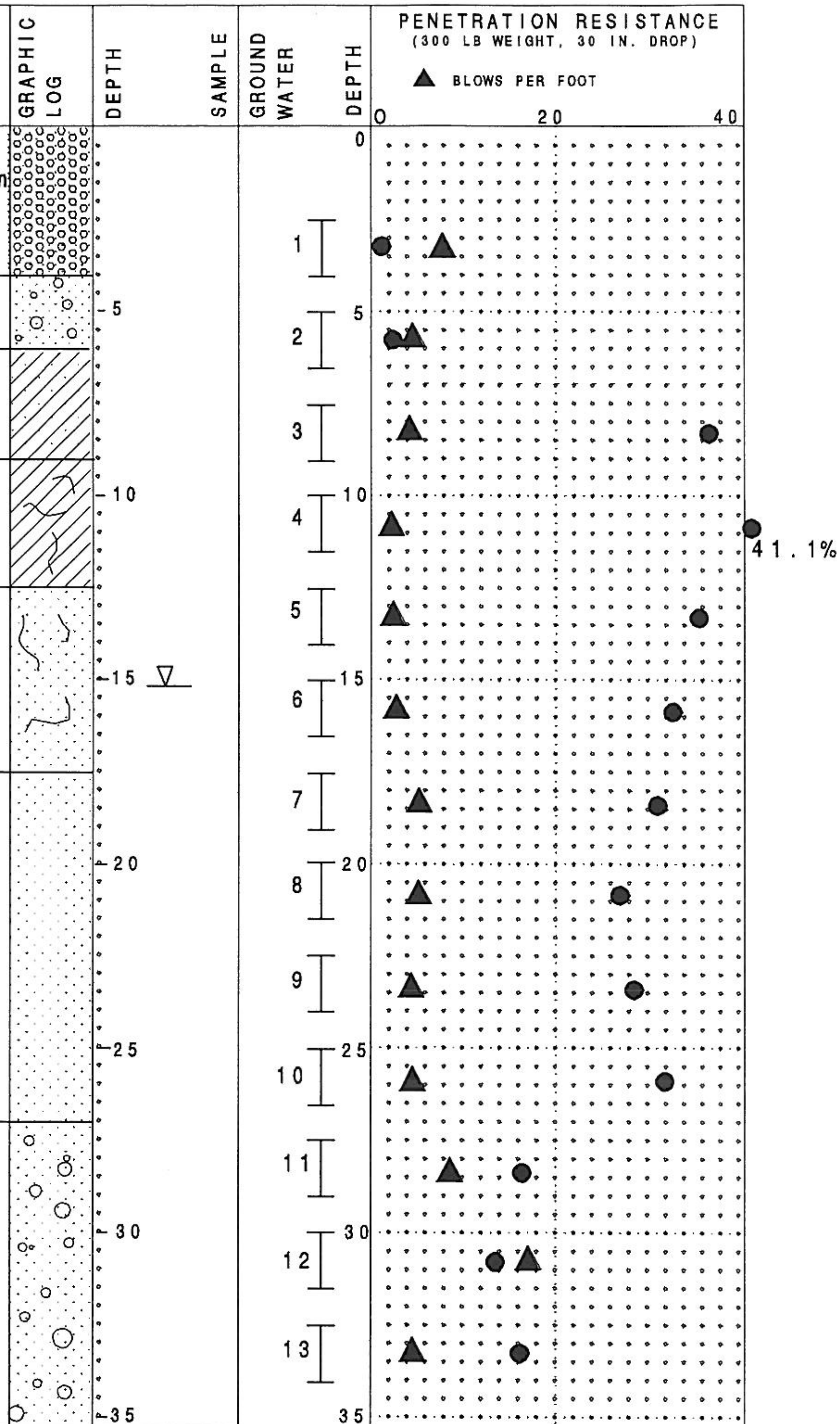
NAME: 4720 STANFORD DR.
LOCATION: 5'S OF SW CORNER

PAGE: ONE OF TWO
DATE: JULY 27, 1992

PERMAFROST TECHNOLOGY FOUNDATION

SURFACE ELEVATION:

SOIL DESCRIPTION
Brown to grey sandy gravel Gravel-rounded fineto medium sand-meium
Brown gravelly sand-slightly moist. Gravel-fine to coarse
Brown silt w/ trace of sand
Brown to grey silt: moist to wet. Trace of organics
Grey silty sand. wet. Sand-med to fine. Trace of organics
Grey silty sand: wet. Sand-fine to coarse.
grey gravelly sand: wet medium to fine grained



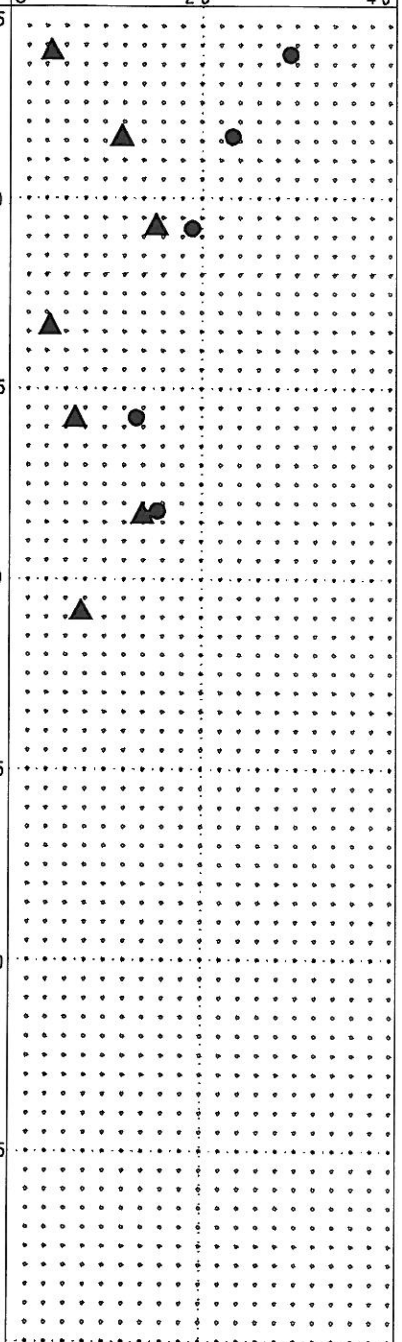
LEGEND

SILT
GRAVEL
SAND
CLAY
PEAT
ORGANIC CONTENT
FROZEN GROUND

IMPERVIOUS SEAL
WATER LEVEL
SCREENED INTERVAL
THERMISTOR
3 IN O.D. SPLIT SPOON SAMPLE
GRAB SAMPLE
3 IN. O.D. THIN-WALL SAMPLE
3 IN. O.D. DRY CORE RUN

SOIL DESCRIPTION SURFACE ELEVATION:	GRAPHIC LOG	DEPTH	SAMPLE	GROUND WATER
Grey sand; wet. Medium to fine grained.		35	14, 15	
Grey sandy gravel; wet. Sand-med coarse. Gravel-fine to coarse.		40	16	
Medium Sand coated gravel. Spoon cool to touch.			17	
Grey sandy gravel;wet. Sand-fine to coarse; gravel-medium. Spoon very cold to touch.		45	18, 19, 20	
		50		
		55		
		60		
		65		
		70		

PENETRATION RESISTANCE
(300 LB WEIGHT, 30 IN. DROP)



LEGEND

SILT
GRAVEL
SAND
CLAY
PEAT
ORGANIC CONTENT
FROZEN GROUND

IMPERVIOUS SEAL
WATER LEVEL
SCREENED INTERVAL
THERMISTOR
3 IN O.D. SPLIT SPOON SAMPLE
GRAB SAMPLE
3 IN. O.D. THIN-WALL SAMPLE
3 IN. O.D. DRY CORE RUN

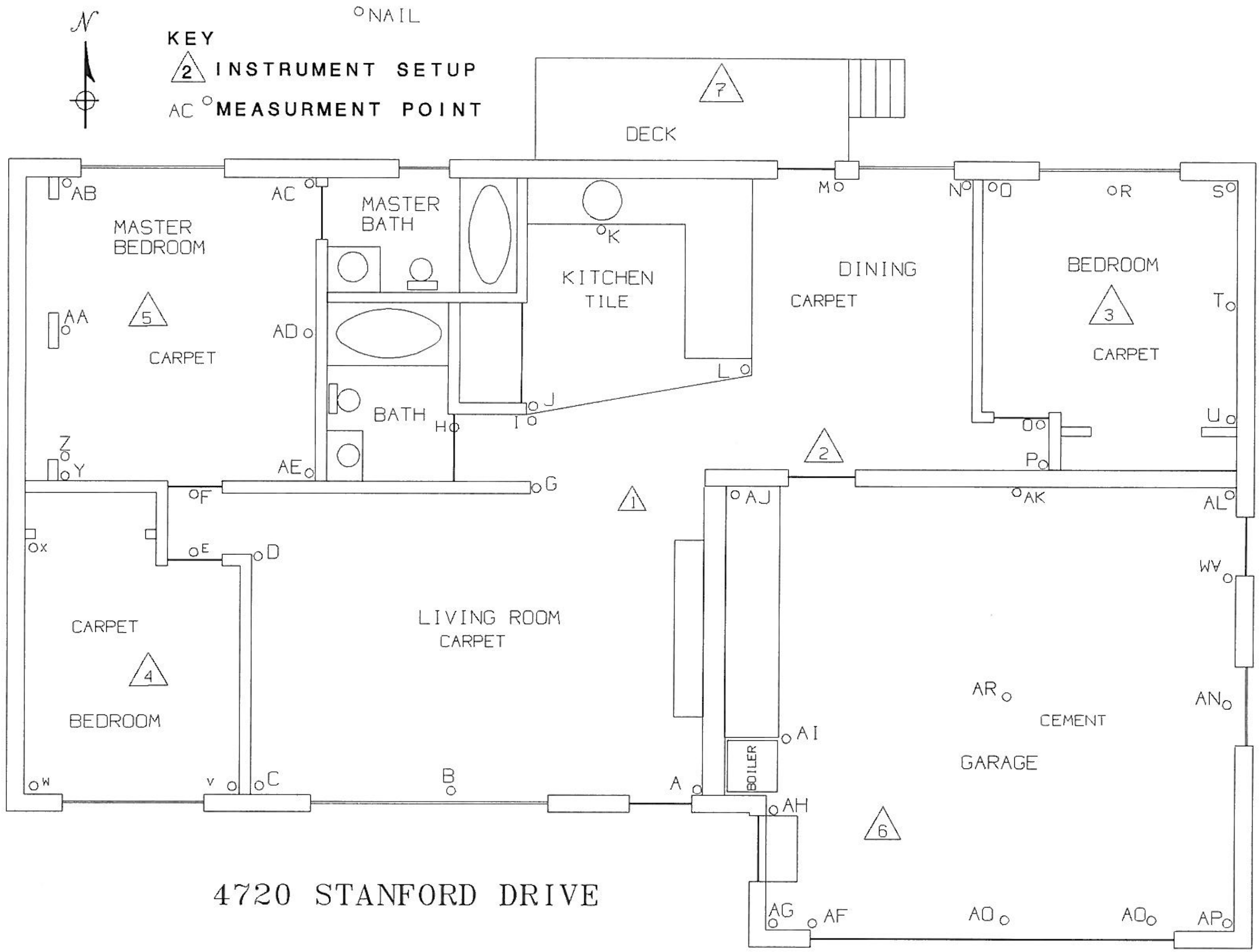
% WATER CONTENT

BORING LOG

NAME: 4720 STANFORD DRIVE
LOCATION: 5'S of SW CORNER
PAGE: TWO OF TWO
DATE: JULY 27, 1992

PERMAFROST TECHNOLOGY FOUNDATION

Level Measurements



4720 STANFORD DRIVE

FIGURE 2 Locations of Level Measurement Points and Instrument Setups.

Stanford Level Data
Operator : sara/b-o

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	1/13/97	1/13/97	1/13/97	(mm)
A (1)*	0	389	0	0
B (1)	5	394	5	0
C (1)	0	389	0	0
D (1)	-14	375	-14	0
E (1)	-9	380	-9	0
F (1)	-7	382	-7	0
G (1)	-21	368	-21	0
H (1)	-18	371	-18	0
I (1)	-15	374	-15	0
J (1)	-31	358	-31	0
K (1)	-1	388	-1	0
L (1)	-4	385	-4	0
M (1)	22	411	22	0
N (1)	12	401	12	0
M (2)**	\	691	\	\
O (2)	-40	629	-40	0
P (2)	-47	622	-47	0
AF (2)	-421	248	-421	0
O (3)**	\	386	\	\
Q (3)	3	429	3	0
R (3)	-11	415	-11	0
S (3)	-35	391	-35	0
T (3)	-54	372	-54	0
U (3)	-74	352	-74	0
E (4)**	\	365	\	\
V (4)	-3	371	-3	0
W (4)	2	376	2	0
X (4)	4	378	4	0
F (5)**	\	365	\	\
Y (5)	-3	369	-3	0
Z (5)	1	373	1	0
AA (5)	7	379	7	0
AB (5)	18	390	18	0
AC (5)	20	392	20	0
AD (5)	0	372	0	0
AE (5)	-21	351	-21	0
AF (6)**	-421	431	-421	\
AG (6)	-410	442	-410	0
AH (6)	-422	430	-422	0
AI (6)	-426	426	-426	0

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (6)	-409	443	-409	0
AK (6)	-488	364	-488	0
AL (6)	-558	294	-558	0
AM (6)	-561	291	-561	0
AN (6)	-567	285	-567	0
AO (6)	-457	395	-457	0
AP (6)	-448	404	-448	0
AQ (6)	-416	436	-416	0
AR (6)	-485	367	-485	0

M (7)	\	1607	\	\
NAIL (7)	82	1667	82	0

E(1) - E(4)= 15
F(1) - F(5)= 17
M(1) - M(2)= -280
O(2) - O(3)= 243
AF(2) - AF(6)= -183
M(1) - M(2)] + [O(2) - O(3)]= -37
M(1) - M(2)] + [AF(2) - AF(6)]= -463

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Points "E", "F", "M", "O" & "AF" are the common points used to correlate data from all points to point "A (1)".

Elevation of Garage Only
With respect to Point AF

Points	Difference
AF	0
AG	11
AH	-1
AI	-5
AJ	12
AK	-67
AL	-137
AM	-140
AN	-146
AO	-36
AP	-27
AQ	5
AR	-64

Stanford Level Data
Operator : fu,wang

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	10/17/94	12/27/94	12/27/94	(mm)
A (1)*	0	586	0	0
B (1)	0	589	3	3
C (1)	0	591	5	5
D (1)	-18	570	-16	2
E (1)	-10	574	-12	-2
F (1)	0	577	-9	-9
G (1)	-25	562	-24	1
H (1)	-20	563	-23	-3
I (1)	-19	571	-15	4
J (1)	-36	553	-33	3
K (1)	-5	584	-2	3
L (1)	-10	580	-6	4
M (1)	18	602	16	-2
N (1)	7	593	7	0
M (2)**	\	615	\	\
O (2)	-40	558	-41	-1
P (2)	-48	553	-46	2
AF (2)	-422	170	-429	-7
O (3)**	\	558	\	\
Q (3)	2	604	5	3
R (3)	-18	582	-17	1
S (3)	-20	578	-21	-1
T (3)	-51	560	-39	12
U (3)	-74	524	-75	-1
E (4)**	\	563	\	\
V (4)	7	580	5	-2
W (4)	-3	578	3	6
X (4)	7	579	4	-3
F (5)**	\	554	\	\
Y (5)	-3	557	-6	-3
Z (5)	1	561	-2	-3
AA (5)	9	569	6	-3
AB (5)	22	579	16	-6
AC (5)	22	583	20	-2
AD (5)	7	555	-8	-15
AE (5)	-14	545	-18	-4
AF (6)**	-422	412	-429	\
AG (6)	-409	429	-412	-3
AH (6)	-404	426	-415	-11
AI (6)	-427	408	-433	-6

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (6)	-109	822	-19	90
AK (6)	-457	333	-508	-51
AL (6)	-555	254	-587	-32
AM (6)	-558	354	-487	71
AN (6)	-573	n/a	#VALUE!	#VALUE!
AO (6)	-452	365	-476	-24
AP (6)	-446	372	-469	-23
AQ (6)	-421	411	-430	-9
AR (6)	-488	340	-501	-13

M (7)	\	632	\	\
NAIL (7)	-487	130	-486	1

E(1) - E(4)= 11
F(1) - F(5)= 23
M(1) - M(2)= -13
O(2) - O(3)= 0
AF(2) - AF(6)= -242
[M(1) - M(2)] + [O(2) - O(3)]= -13
[M(1) - M(2)] + [AF(2) - AF(6)]= -255

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Points "E", "F", "M", "O" & "AF" are the common points used to correlate data from all points to point "A (1)".

Elevation of Garage Only
With respect to Point AF

Points	Difference
AF	0
AG	17
AH	14
AI	-4
AJ	410
AK	-79
AL	-158
AM	-58
AN	#VALUE!
AO	-47
AP	-40
AQ	-1
AR	-72

Stanford Level Data
Operator : Mcfadden/ma

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	6/23/93	9/24/93	9/24/93	(mm)
A (1)*	0	552	0	0
B (1)	3	556	4	1
C (1)	0	549	-3	-3
D (1)	-15	537	-15	0
E (1)	-9	543	-9	0
F (1)	-4	546	-6	-2
G (1)	-22	529	-23	-1
H (1)	-33	531	-21	12
I (1)	-16	538	-14	2
J (1)	-33	517	-35	-2
K (1)	-2	546	-6	-4
L (1)	-6	543	-9	-3
M (1)	17	571	19	2
N (1)	5	558	6	1
M (2)**	\	831	\	\
O (2)	-41	775	-37	4
P (2)	-46	772	-40	6
AF (2)	-424	392	-420	4
O (3)**	\	537	\	\
Q (3)	-5	576	2	7
R (3)	-12	567	-7	5
S (3)	-24	555	-19	5
T (3)	-60	536	-38	22
U (3)	-71	505	-69	2
E (4)**	\	429	\	\
V (4)	5	442	4	-1
W (4)	3	437	-1	-4
X (4)	5	473	35	30
F (5)**	\	528	\	\
Y (5)	-1	527	-7	-6
Z (5)	2	530	-4	-6
AA (5)	6	533	-1	-7
AB (5)	20	542	8	-12
AC (5)	21	548	14	-7
AD (5)	-5	523	-11	-6
AE (5)	-16	514	-20	-4
AF (6)**	-424	557	-420	\
AG (6)	-406	574	-403	3
AH (6)	-408	574	-403	5
AI (6)	-430	550	-427	3

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (6)	-380	602	-375	5
AK (6)	-475	508	-469	6
AL (6)	-555	427	-550	5
AM (6)	-565	414	-563	2
AN (6)	-577	422	-555	22
AO (6)	-459	525	-452	7
AP (6)	-448	528	-449	-1
AQ (6)	-421	558	-419	2
AR (6)	-489	492	-485	4

M (7)	\	1070	\	\
NAIL (7)	-492	564	-487	5

E(1) - E(4)= 114
F(1) - F(5)= 18
M(1) - M(2)= -260
O(2) - O(3)= 238
AF(2) - AF(6)= -165
[M(1) - M(2)] + [O(2) - O(3)]= -22
[M(1) - M(2)] + [AF(2) - AF(6)]= -425

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Points "E", "F", "M", "O" & "AF" are the common points used to correlate data from all points to point "A (1)".

Elevation of Garage Only
With respect to Point AF

Points	Difference
AF	0
AG	17
AH	17
AI	-7
AJ	45
AK	-49
AL	-130
AM	-143
AN	-135
AO	-32
AP	-29
AQ	1
AR	-65

Stanford Level Data
Operator : TM, TK

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date		8/91	8/91	
A (1)*		138	0	0
B (1)		138	0	0
C (1)		137	1	1
D (1)		154	-16	-16
E (1)		150	-12	-12
E (4)**		151	\	\
F (1)		146	-8	-8
F (5)**		155	\	\
G (1)		160	-22	-22
H (1)		194	-56	-56
I (1)		150	-12	-12
J (1)		194	-56	-56
K (1)		155	-17	-17
L (1)		160	-22	-22
M (1)		123	15	15
M (2)**		147	\	\
N (1)		133	5	5
O (2)		199	-37	-37
O (3)**		144	\	\
P (2)		203	-41	-41
Q (3)		102	5	5
R (3)		117	-10	-10
S (3)		125	-18	-18
T (3)		151	-44	-44
U (3)		176	-69	-69
V (4)		135	4	4
W (4)		136	3	3
X (4)		137	2	2
Y (5)		159	-12	-12
Z (5)		150	-3	-3
AA (5)		149	-2	-2
AB (5)		135	12	12
AC (5)		134	13	13
AD (5)		153	-6	-6
AE (5)		167	-20	-20
AF (2)		619	-457	-457
AF (6)**		145	\	\
AG (6)		129	-441	-441
AH (6)		133	-445	-445
AI (6)		153	-465	-465

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (6)		100	-412	-412
AK (6)		191	-503	-503
AL (6)		271	-583	-583
AM (6)		285	-597	-597
AN (6)		294	-606	-606
AO (6)		172	-484	-484
AP (6)		160	-472	-472
AQ (6)		139	-451	-451
AR (6)		209	-521	-521

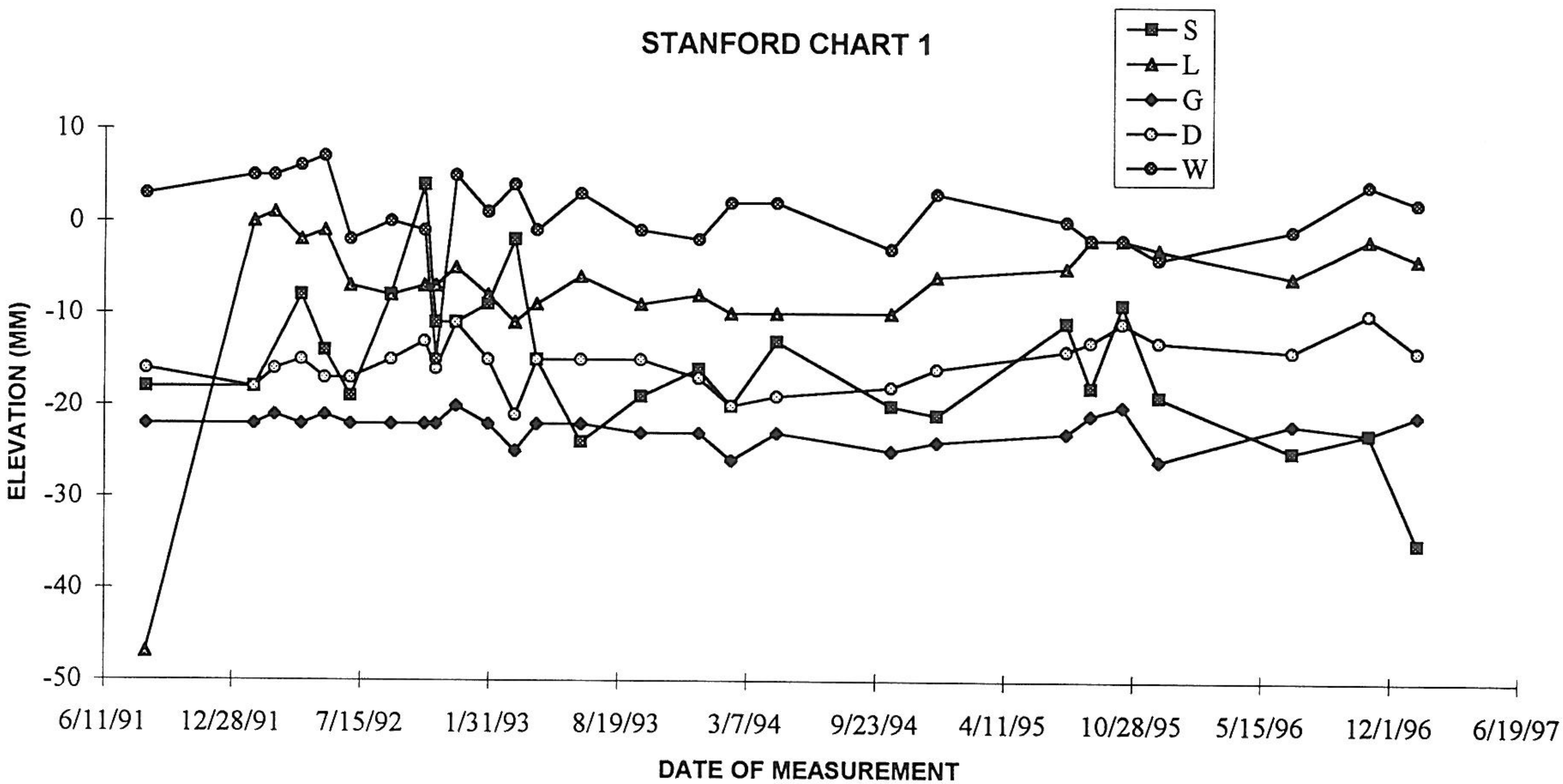
E(1) - E(4)= -1
F(1) - F(5)= -9
M(1) - M(2)= -24
O(2) - O(3)= 55
AF(2) - AF(6)= 474
M(1) - M(2) + O(2) - O(3)= 31
M(1) - M(2) + AF(2) - AF(6)= 450

* Point "A (1)" should be the first point measured in the house. This point then becomes the datum from which all other points are referenced.

** Points "E", "F", "M", "O" & "AF" are the common points used to correlate data from all points to point "A (1)".

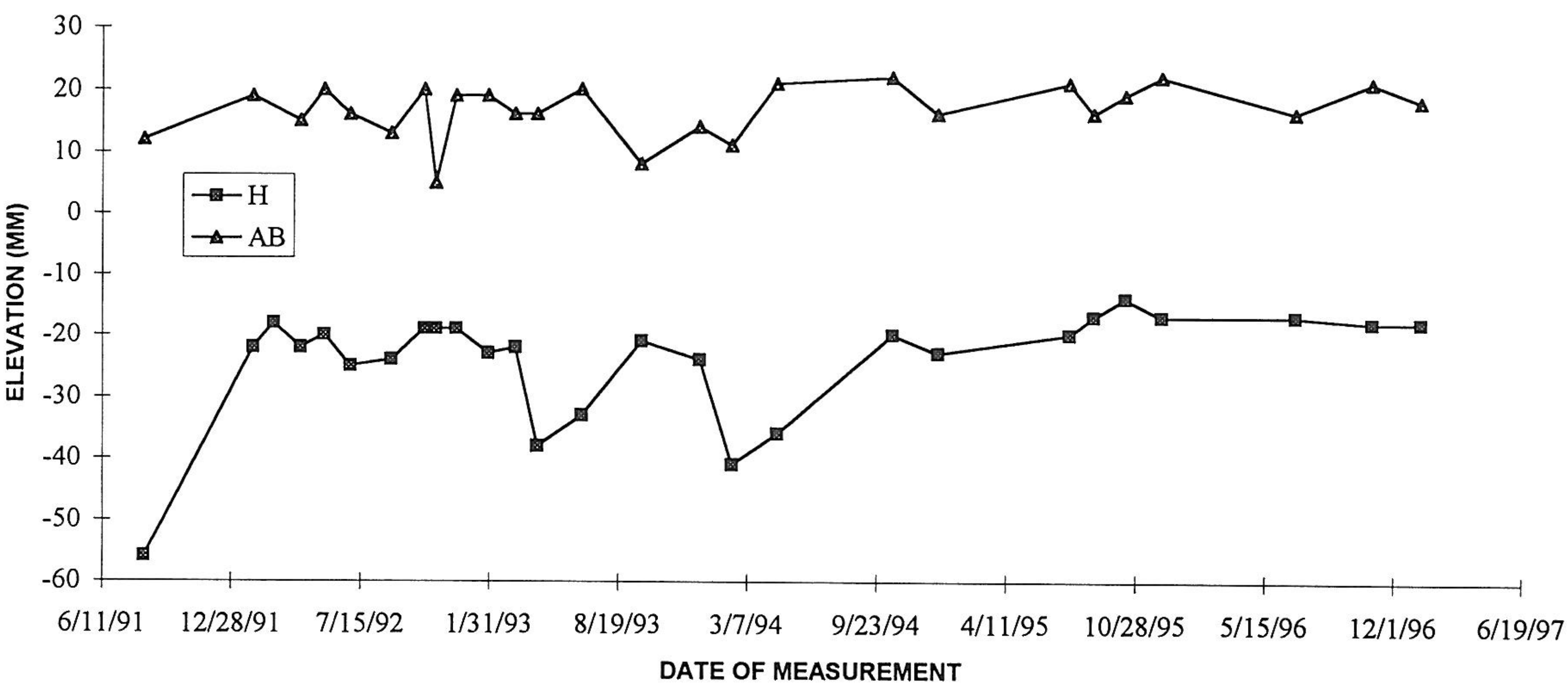
Elevation of Garage Only
<u>With respect to Point AF</u>

Points	Difference
AF	0
AG	16
AH	12
AI	-8
AJ	45
AK	-46
AL	-126
AM	-140
AN	-149
AO	-27
AP	-15
AQ	6
AR	-64

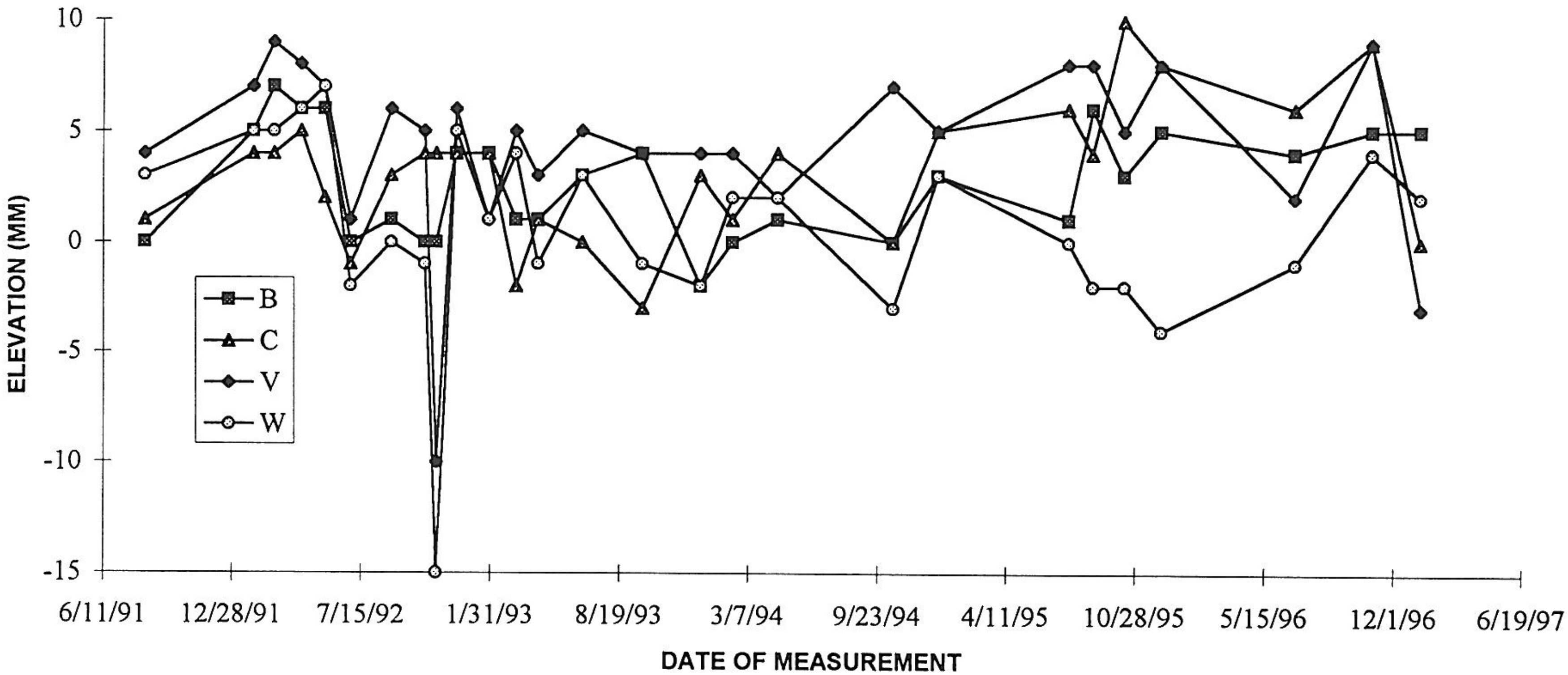


STANFORD CHART 1
S
L
G
D
W
10
0
-10
-20
-30
-40
-50
ELEVATION (MM)
6/11/91
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT

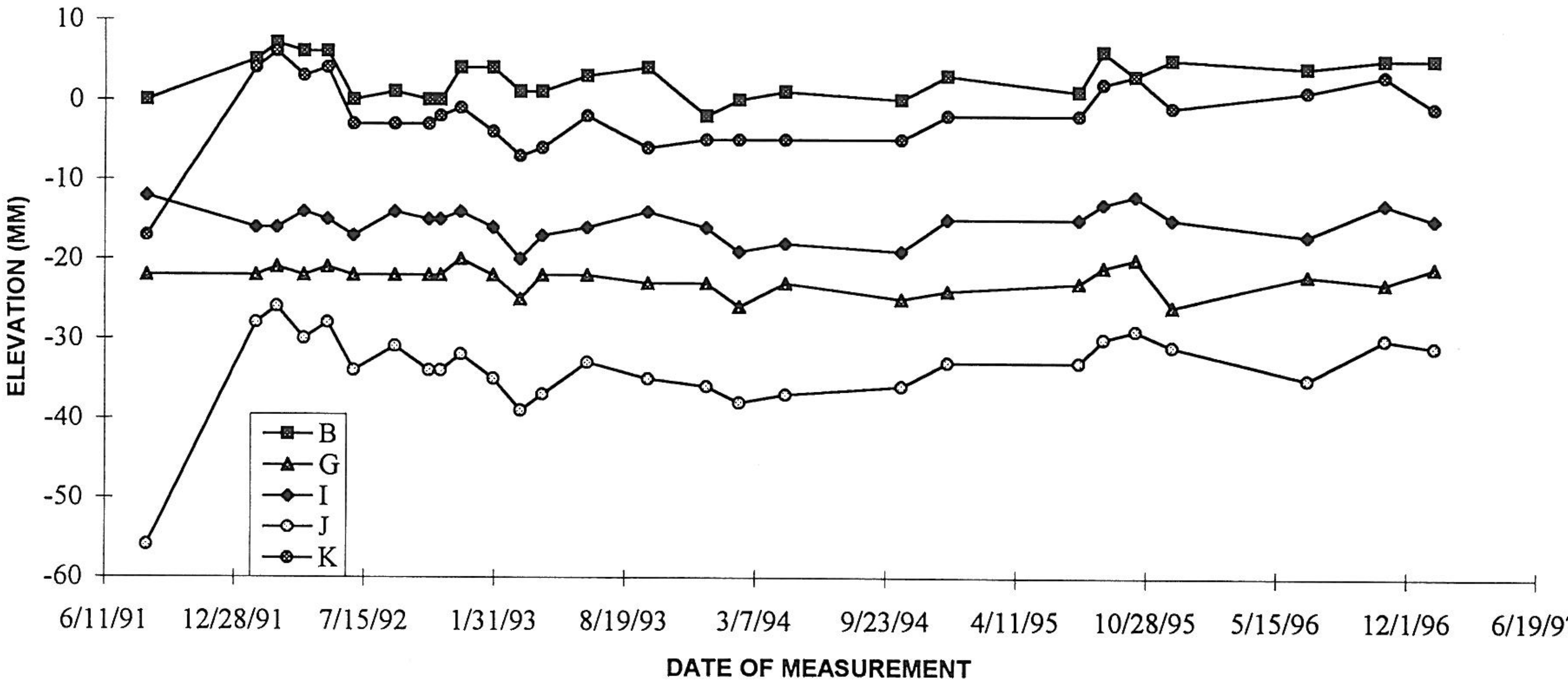
STANFORD CHART 2



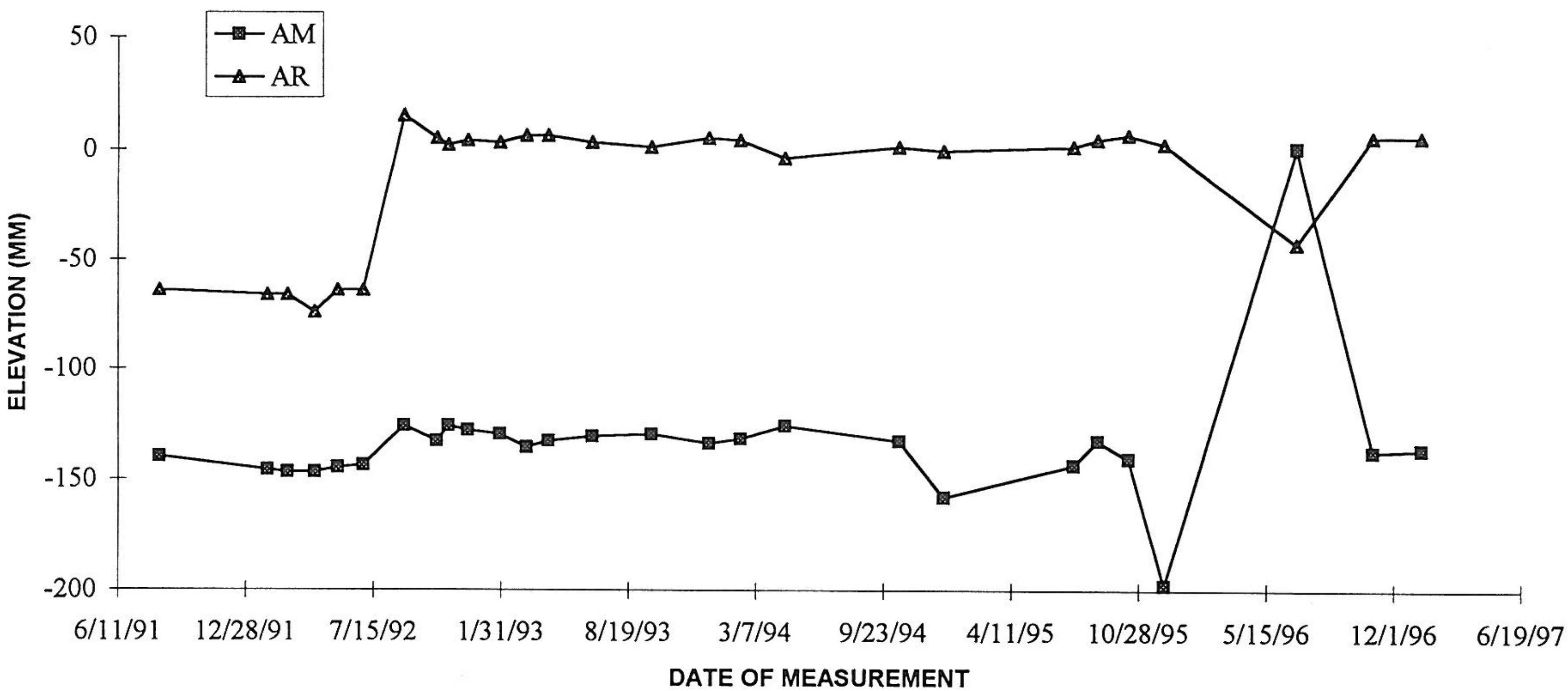
STANFORD CHART 3



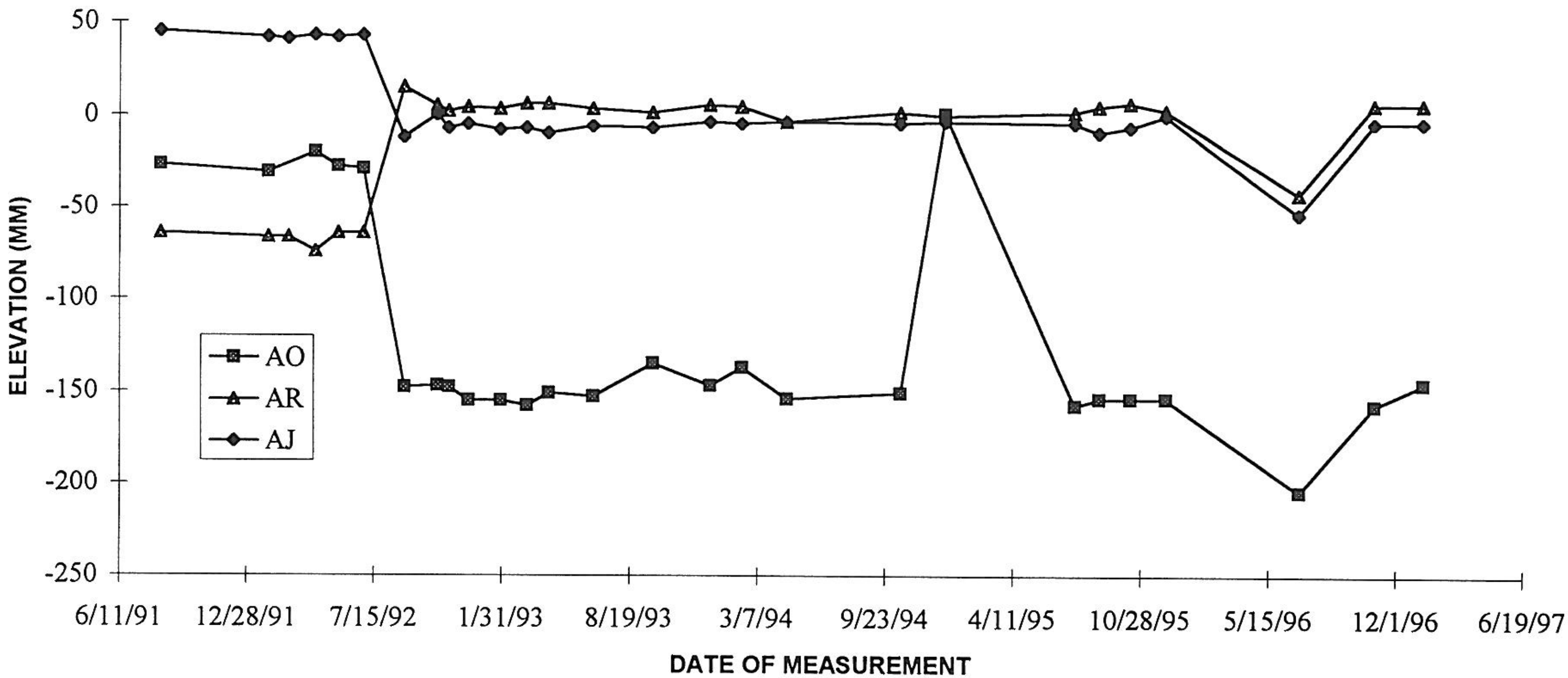
STANFORD CHART 4



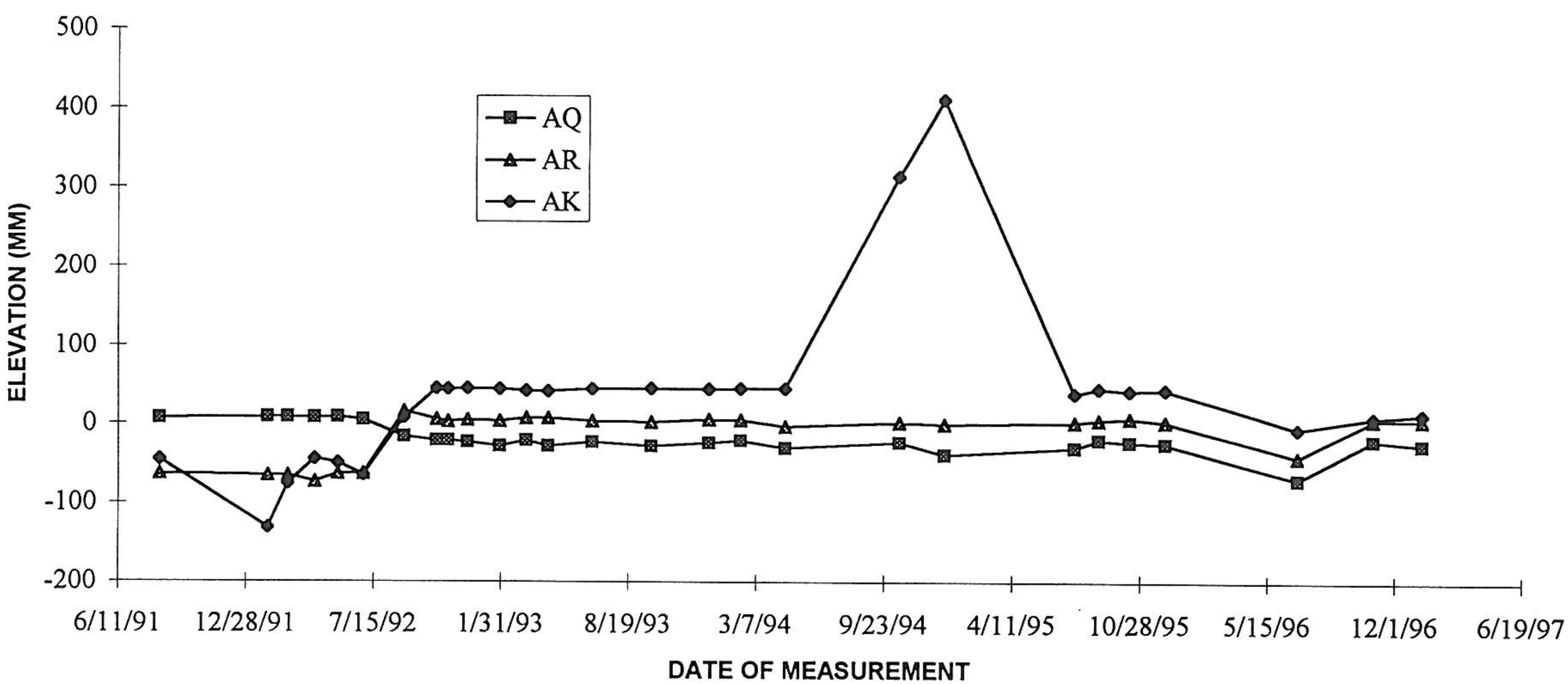
STANFORD CHART 5



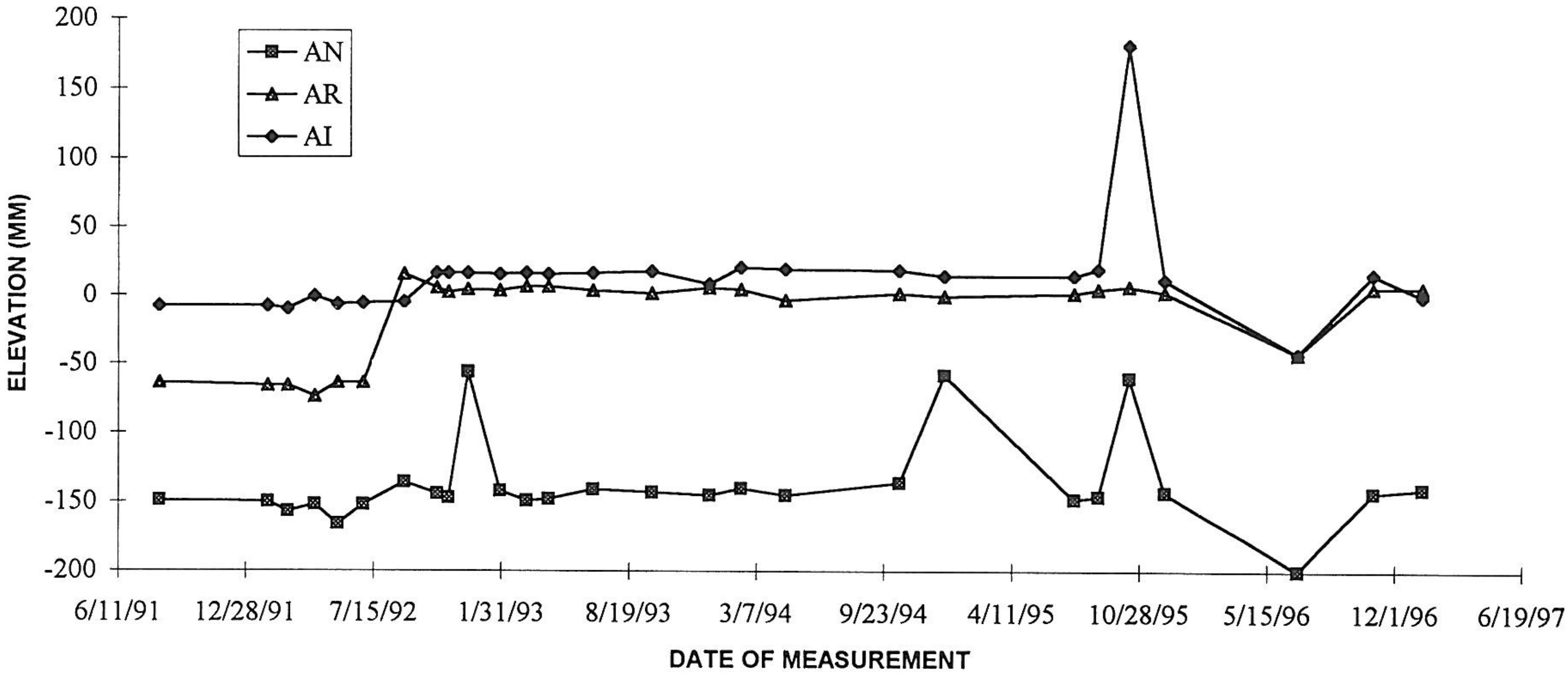
STANFORD CHART 6



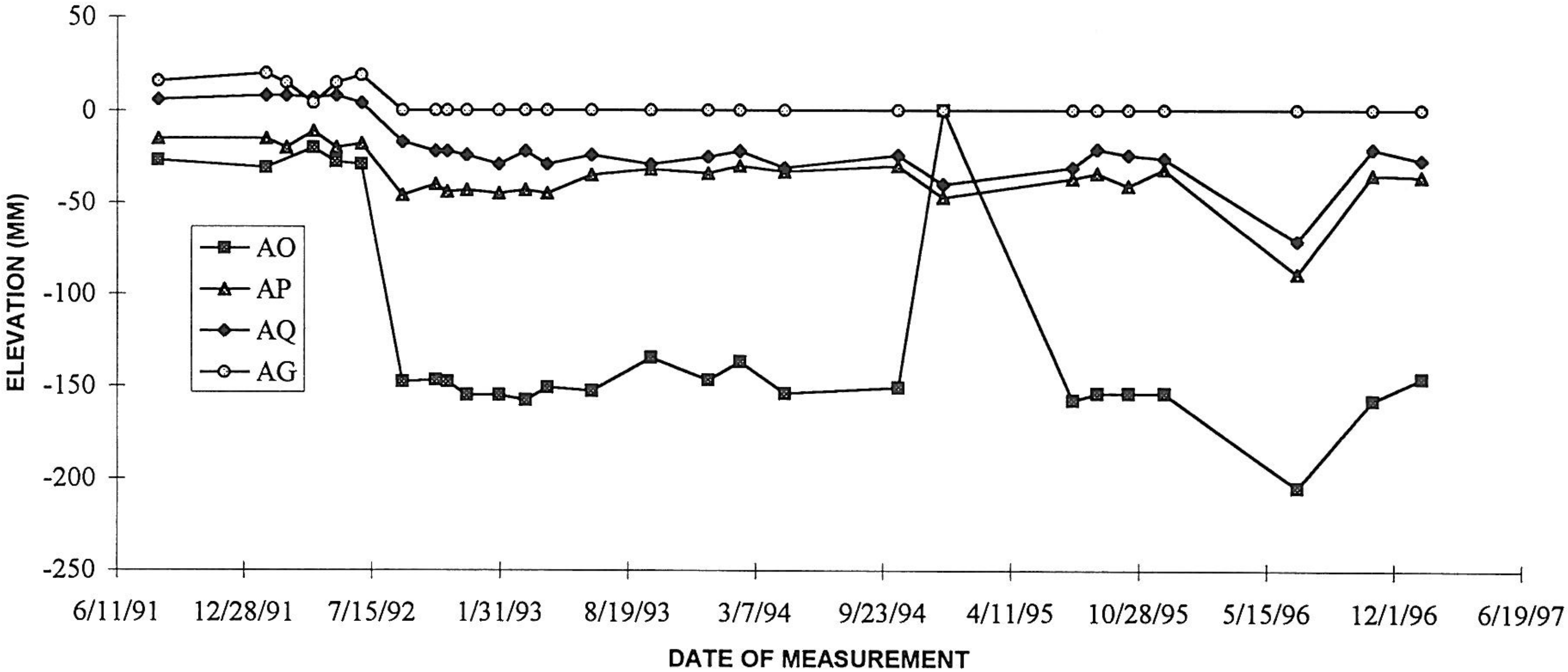
STANFORD CHART 7

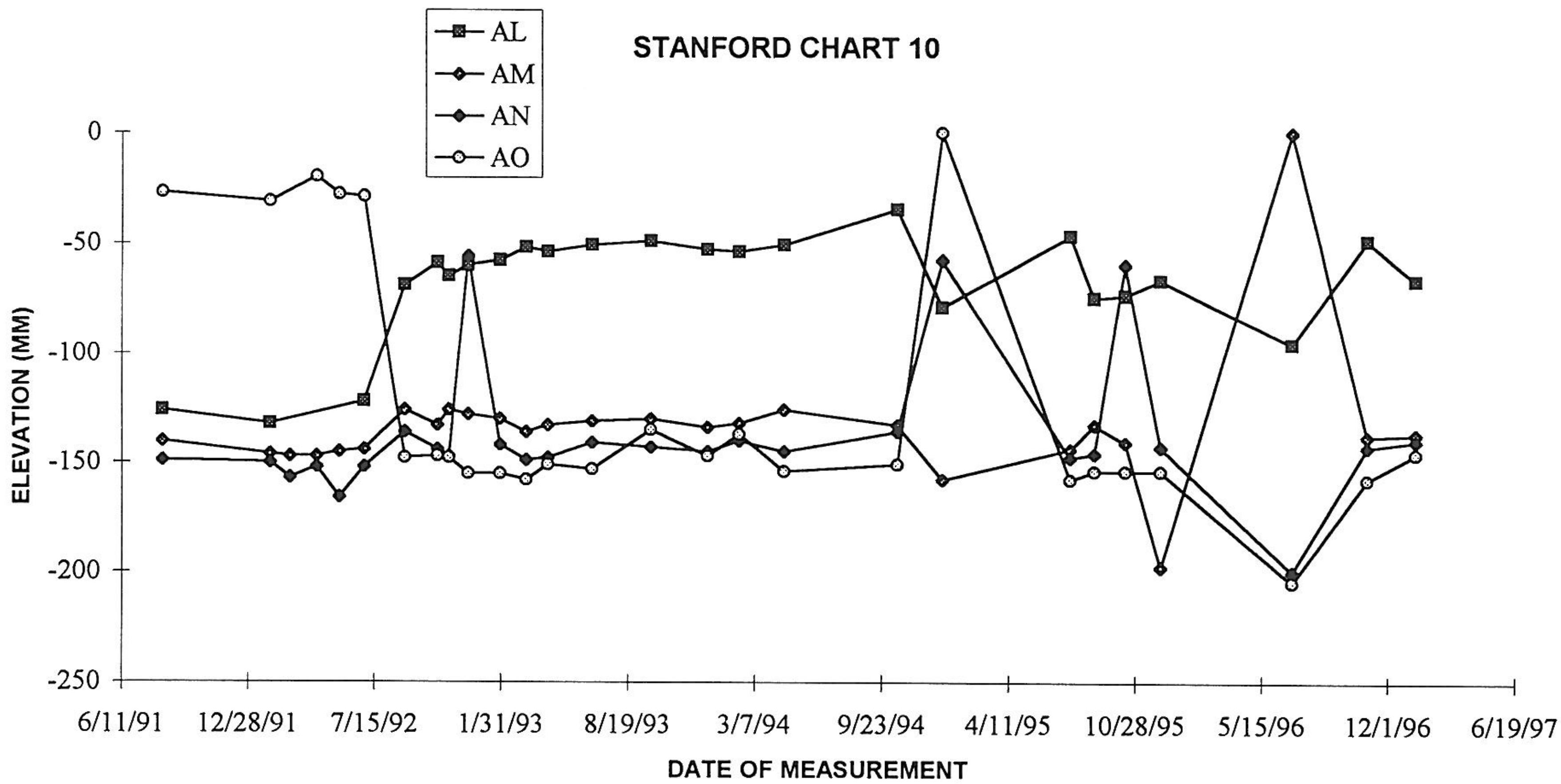


STANFORD CHART 8

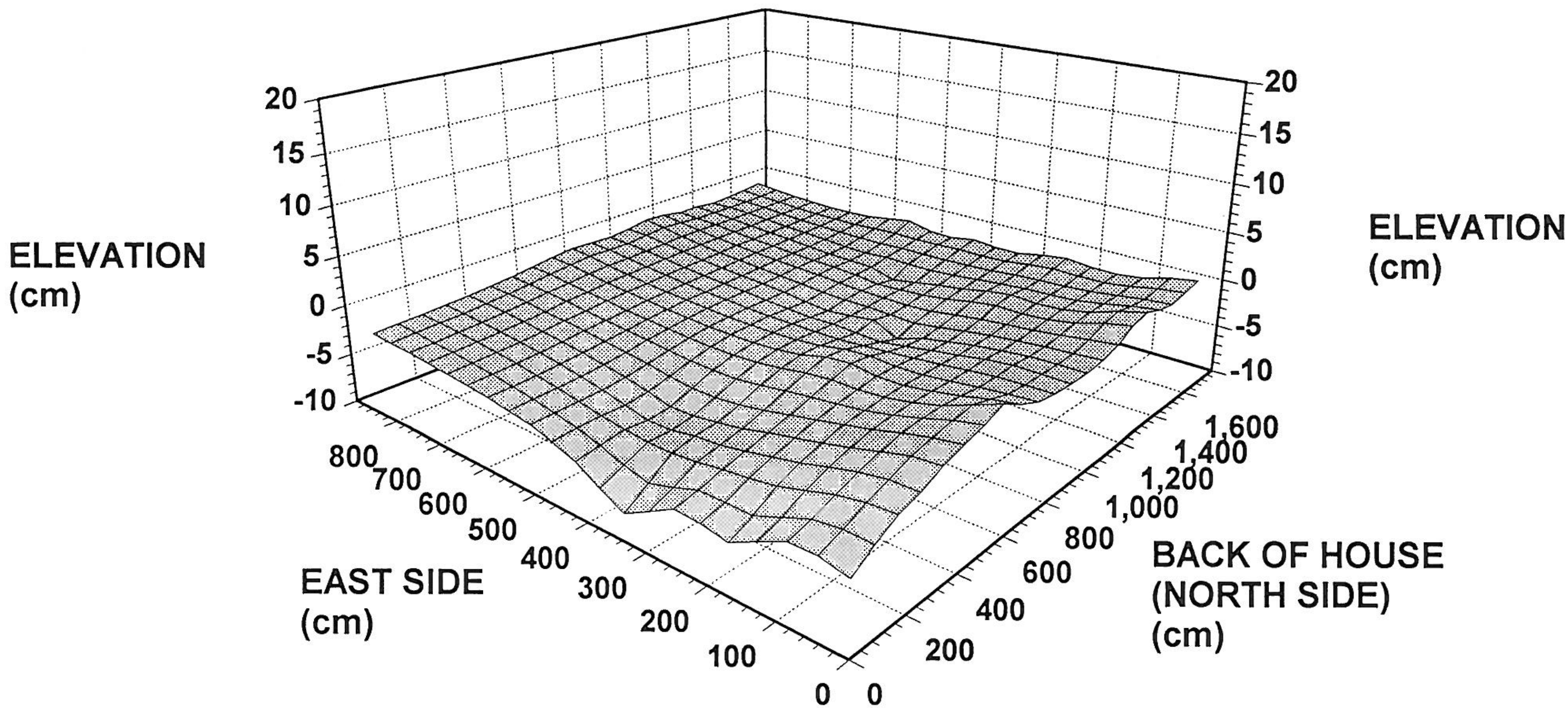


STANFORD CHART 9

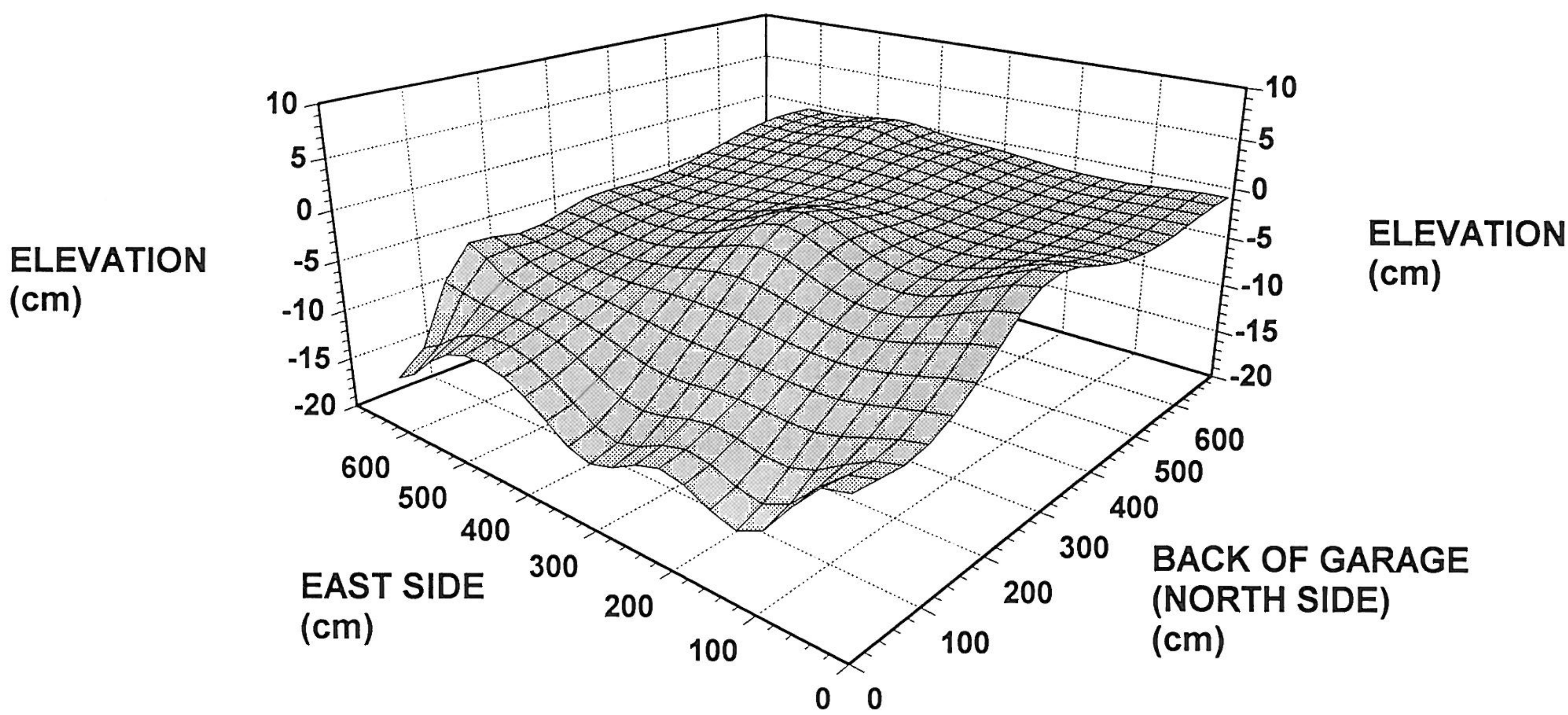



STANFORD CHART 10
AL
AM
AN
AO
0
-50
-100
-150
-200
-250
ELEVATION (MM)
6/11/91
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT

STANFORD
JANUARY 13, 1997

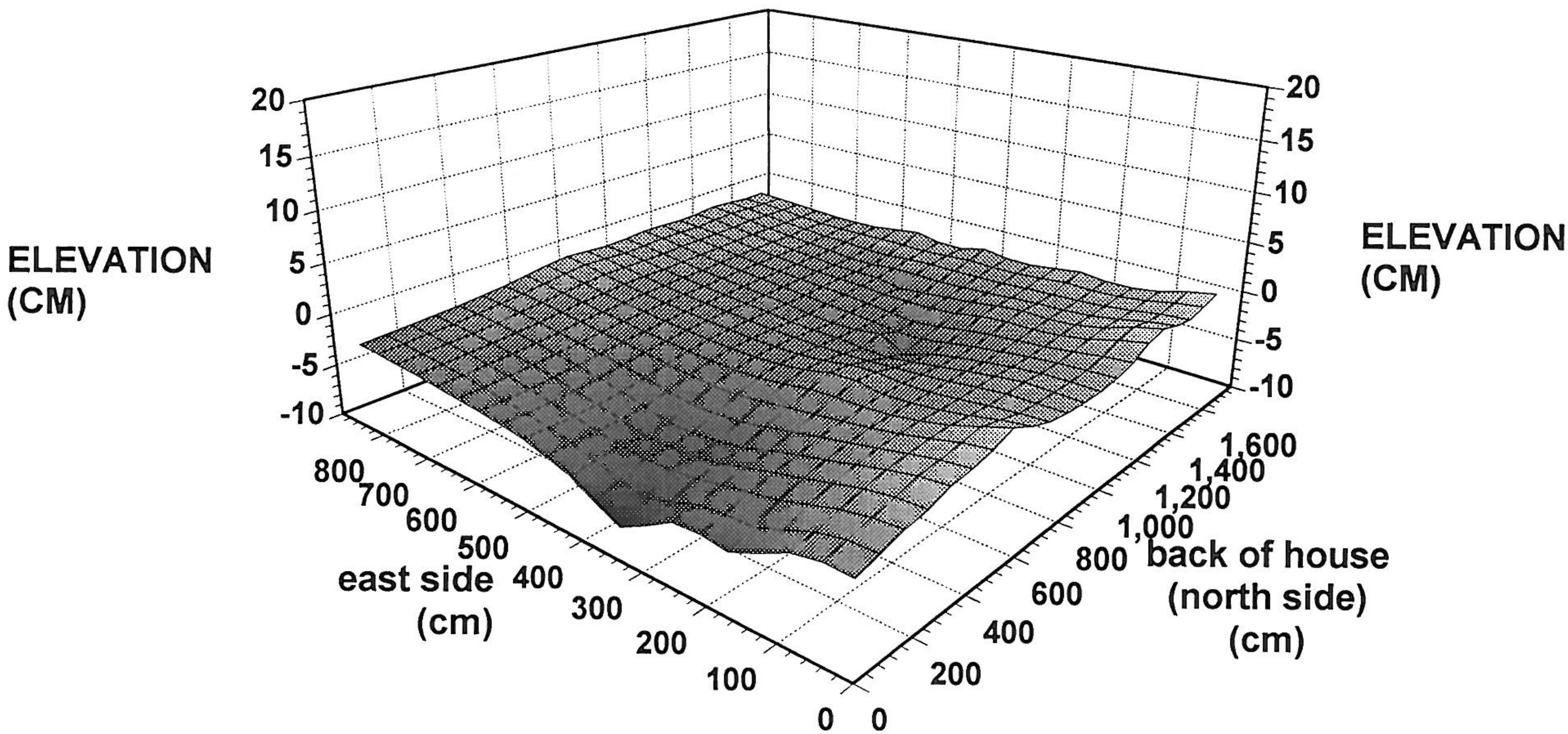


STANFORD GARAGE
JANUARY 13, 1997



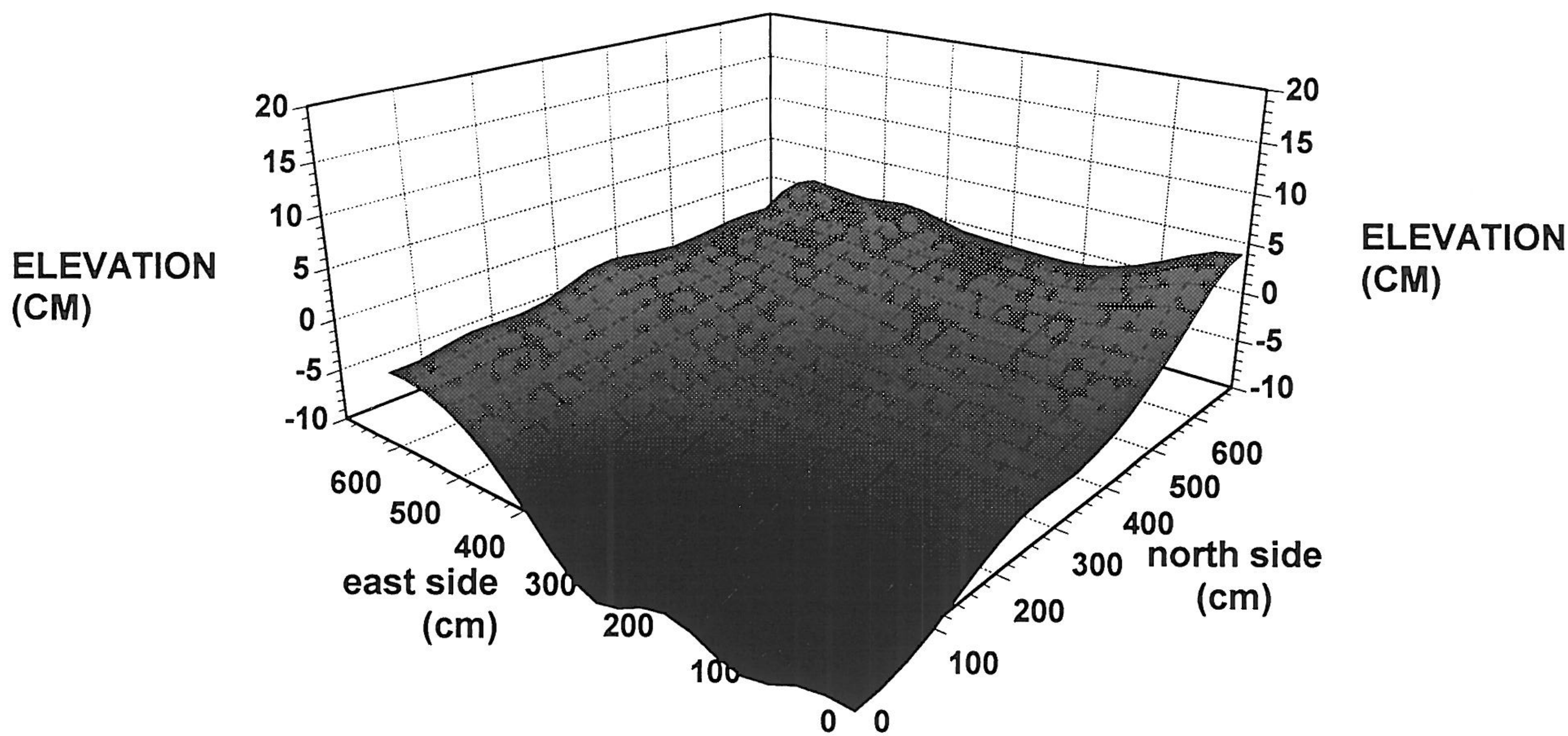
STANFORD

JUNE 29, 1992



STANFORD GARAGE

JUNE 29, 1992



Temperature Measurements

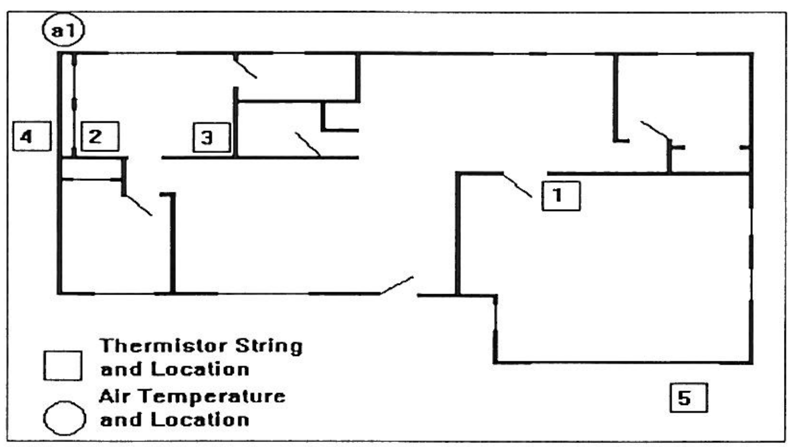
ST Thermistor Temperature Log

Operator : Sara/B-O
Date : 1/13/97

	String #1			String #2			String #3		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	9826	10.265	AIR	5797	21.662	AIR	5525	22.739
2	2	9269	11.488	plus 1 *	6206	20.145	plus 1 *	5719	21.965
3	3.5	8801	12.581	0	6990	17.531	0	5817	21.585
4	4.5	8770	12.656	1	8455	13.432	1	6000	20.894
5	5.5	8808	12.564	2	9267	11.492	2	6611	18.751
6	6.5	8872	12.411	3	9717	10.498	3	7279	16.649
7	7.5	9003	12.101	4	9987	9.926	4	7753	15.287
8	8.5	9235	11.565	5	10194	9.5	5	8078	14.405
9	9.5	9444	11.095	5.5	10277	9.331	5.5	8248	13.96
10	10.5	9694	10.548	6	10443	8.999	6	8453	13.437
11	11	9824	10.27	6.5	10432	9.021	6.5	8637	12.98
12	11.5	9933	10.039	\	\	\	\	\	\

	AIR			String #4			String #5		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	AO	#N/A	#N/A	0	18684	-2.622	0	#N/A	#N/A
2				5	20979	-4.839	2	27921	-10.18
3				10	12877	4.717	4	19745	-3.683
4				20	12109	5.962	6	15776	0.672
5				30	12716	4.971	8	14480	2.367
6				32	12854	4.753	14	13326	4.027
7				33	12962	4.584	20	13380	3.946
8				33.5	#N/A	#N/A	30	13808	3.315
9				34	13147	4.299	40	14362	2.53
10				35	13119	4.342	44	14414	2.458
11				40	13559	3.679	46	14511	2.325
12				54	14372	2.516	48	14553	2.267

* This thermistor is at the top of the pipe which is 1 foot above the ground surface.



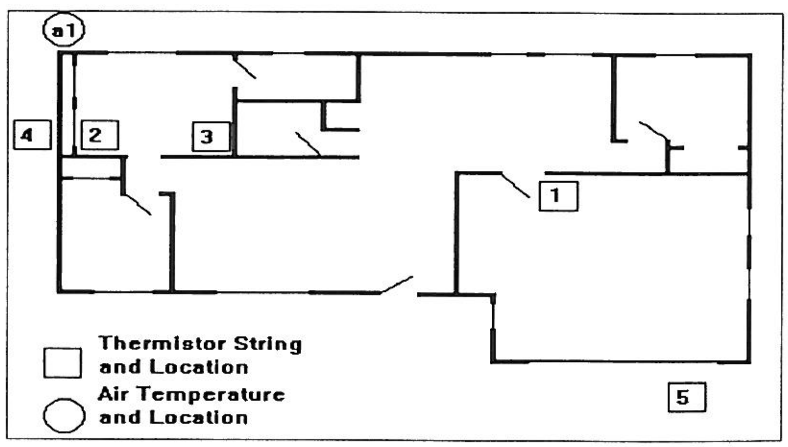
ST Thermistor Temperature Log

Operator : fu
Date : 7/17/95

		String #1			String #2			String #3	
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	#N/A	#N/A	AIR	#N/A	#N/A	AIR	#N/A	#N/A
2	2	6190	20.202	plus 1 *	6368	19.575	plus 1 *	6189	20.206
3	3.5	7018	17.443	0	6905	17.798	0	6309	19.781
4	4.5	7333	16.489	1	7944	14.764	1	6650	18.621
5	5.5	7572	15.796	2	8574	13.135	2	7245	16.751
6	6.5	30396	-11.732	3	8980	12.155	3	7805	15.143
7	7.5	8198	14.09	4	9292	11.436	4	8193	14.103
8	8.5	#N/A	#N/A	5	9606	10.739	5	8508	13.299
9	9.5	#N/A	#N/A	5.5	9756	10.415	5.5	8676	12.884
10	10.5	9477	11.022	6	9979	9.943	6	8893	12.361
11	11	9676	10.587	6.5	10063	9.769	6.5	9077	11.929
12	11.5	9844	10.227	\	\	\	\	\	\

		AIR			String #4			String #5	
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	AO	15053	1.597	0	#N/A	#N/A	0	14704	2.062
2				5	7514	15.962	2	#N/A	#N/A
3				10	#N/A	#N/A	4	#N/A	#N/A
4				20	12098	5.981	6	7268	16.682
5				30	12099	5.979	8	9095	11.887
6				32	12884	4.706	14	10806	8.293
7				33	13016	4.5	20	13361	3.974
8				33.5	13115	4.348	30	13.721	251.36
9				34	#N/A	#N/A	40	13937	3.129
10				35	13292	4.078	44	14527	2.303
11				40	13255	4.134	46	14796	1.939
12				54	13677	3.505	48	14982	1.691

* This thermistor is at the top of the pipe which is 1 foot above the ground surface.



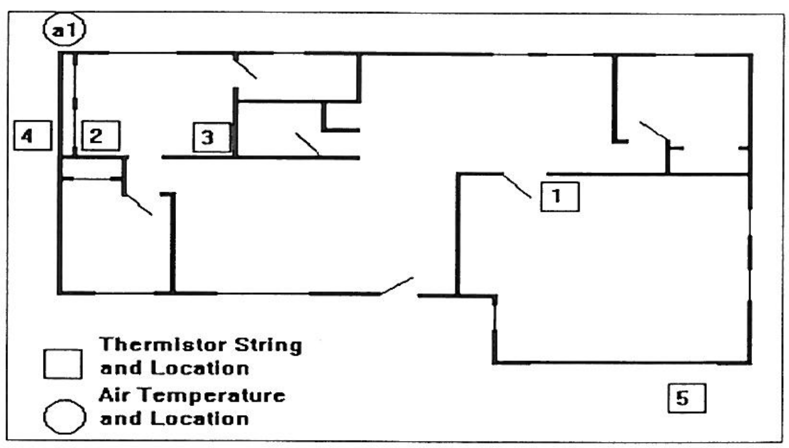
ST Thermistor Temperature Log

Operator : ma
Date : 6/24/94

	String #1			String #2			String #3		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	6130	20.418	AIR	6520	19.055	AIR	6440	19.327
2	2	6840	18.004	plus 1 *	6740	18.327	plus 1 *	6550	18.954
3	3.5	7600	15.716	0	7250	16.736	0	6630	18.688
4	4.5	7890	14.91	1	8230	14.007	1	6930	17.719
5	5.5	8130	14.268	2	8905	12.332	2	7560	15.83
6	6.5	8440	13.47	3	9360	11.283	3	8080	14.4
7	7.5	8790	12.607	4	9690	10.557	4	8485	13.357
8	8.5	9280	11.463	5	10040	9.816	5	8830	12.511
9	9.5	9690	10.557	5.5	10210	9.467	5.5	9020	12.061
10	10.5	10100	9.692	6	10420	9.045	6	9275	11.474
11	11	10300	9.285	6.5	10525	8.837	6.5	9420	11.148
12	11.5	10460	8.966	\	\	\	\	\	\

	AIR			String #4			String #5		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	AO	6790	18.165	0	7610	15.688	0	7040	17.375
2				5	8260	13.929	2	8090	14.374
3				10	10425	9.035	4	9090	11.898
4				20	12490	5.334	6	10720	8.458
5				30	13020	4.494	8	12260	5.71
6				32	13140	4.309	14	13950	3.11
7				33	13220	4.187	20	13980	3.067
8				33.5	#DIV/0!	#DIV/0!	30	14140	2.84
9				34	13395	3.923	40	14640	2.149
10				35	13345	3.998	44	14750	2
11				40	13720	3.443	46	14850	1.866
12				54	14530	2.299	48	14875	1.833

* This thermistor is at the top of the pipe which is 1 foot above the ground surface.



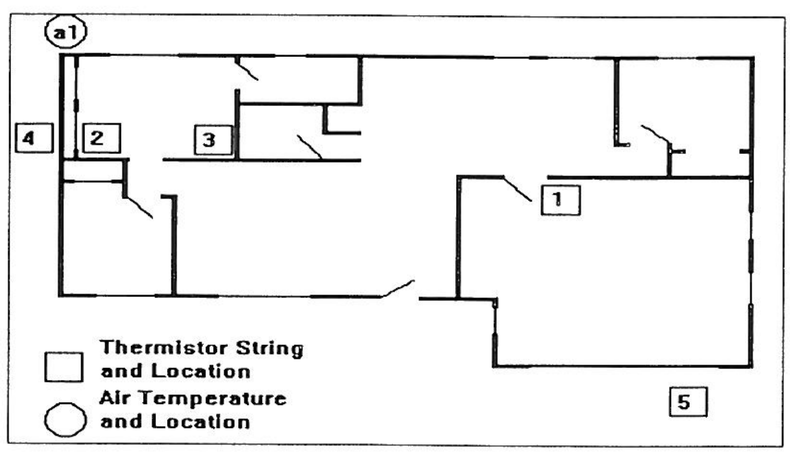
ST Thermistor Temperature Log

Operator : zhang
Date : 6/24/93

	String #1			String #2			String #3		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	5890	21.307	AIR	6980	17.562	AIR	6870	17.909
2	2	6840	18.004	plus 1 *	7135	17.083	plus 1 *	6990	17.531
3	3.5	7645	15.589	0	7385	16.336	0	7140	17.068
4	4.5	7940	14.775	1	7980	14.667	1	7630	15.631
5	5.5	8190	14.111	2	8715	12.789	2	8170	14.163
6	6.5	8500	13.319	3	9190	11.668	3	8540	13.219
7	7.5	8840	12.487	4	9515	10.938	4	8840	12.487
8	8.5	9315	11.384	5	9860	10.193	5	9070	11.945
9	9.5	9700	10.535	5.5	10025	9.847	5.5	9210	11.622
10	10.5	10120	9.651	6	10230	9.427	6	9390	11.215
11	11	10325	9.235	6.5	10370	9.145	6.5	9540	10.883
12	11.5	10480	8.926	\	\	\	\	\	\

	AIR			String #4			String #5		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	AO	4990	25.046	0	7585	15.759	0	5810	21.612
2				5	8210	14.059	2	6290	19.848
3				10	10180	9.528	4	8200	14.085
4				20	12580	5.188	6	10095	9.703
5				30	13200	4.218	8	11800	6.488
6				32	13310	4.051	14	14005	3.032
7				33	13405	3.908	20	14190	2.77
8				33.5	#N/A	#N/A	30	14380	2.505
9				34	13580	3.648	40	14850	1.866
10				35	13530	3.722	44	14920	1.773
11				40	13880	3.211	46	15020	1.641
12				54	14610	2.19	48	15040	1.614

* This thermistor is at the top of the pipe which is 1 foot above the ground surface.



ST Thermistor Temperature Log

Operator : zhang
Date : 10/9/92

	String #1			String #2			String #3		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	7680	15.49	AIR	6555	18.938	AIR	6250	19.989
2	2	7690	15.462	plus 1 *	6710	18.424	plus 1 *	6380	19.534
3	3.5	7980	14.667	0	6950	17.656	0	6510	19.089
4	4.5	8160	14.189	1	7580	15.773	1	6950	17.656
5	5.5	8330	13.749	2	8370	13.647	2	7520	15.944
6	6.5	8560	13.17	3	8845	12.475	3	7920	14.829
7	7.5	8795	12.595	4	9170	11.714	4	8260	13.929
8	8.5	9160	11.737	5	9490	10.993	5	8565	13.157
9	9.5	9465	11.048	5.5	9650	10.643	5.5	8740	12.728
10	10.5	9820	10.278	6	9805	10.31	6	8965	12.191
11	11	9990	9.92	6.5	9955	9.993	6.5	9140	11.783
12	11.5	10140	9.61	\	\	\	\	\	\

	AIR			String #4			String #5		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	AO	16585	-0.309	0	13310	4.051	0	14280	2.644
2				5	15655	0.823	2	13160	4.279
3				10	11110	7.722	4	12075	6.019
4				20	12040	6.078	6	11220	7.52
5				30	13080	4.402	8	10985	7.955
6				32	13240	4.157	14	12320	5.611
7				33	13350	3.991	20	13635	3.567
8				33.5	#N/A	#N/A	30	14620	2.176
9				34	13550	3.692	40	15070	1.575
10				35	13510	3.752	44	15105	1.529
11				40	13900	3.182	46	15200	1.405
12				54	14635	2.156	48	15210	1.392

* This thermistor is at the top of the pipe which is 1 foot above the ground surface.

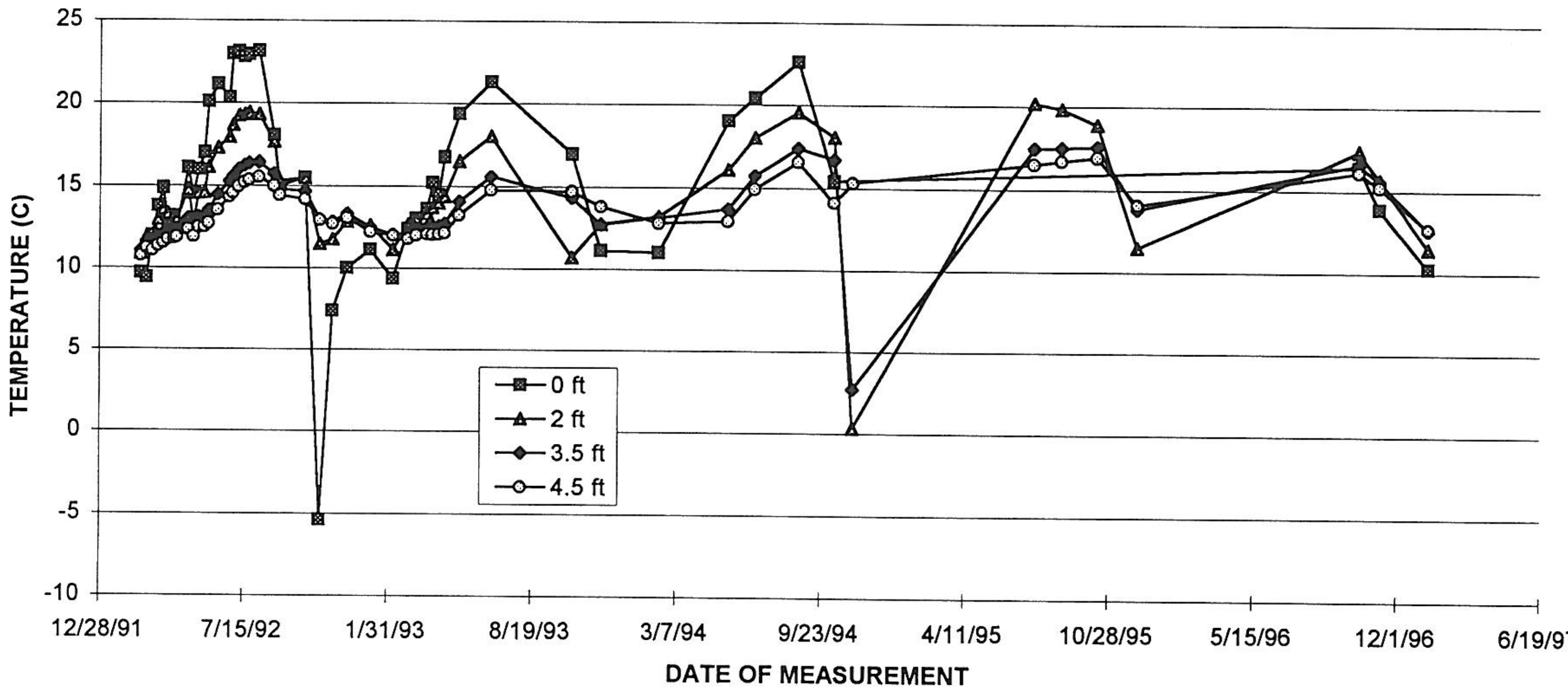
ST Thermistor Temperature Log

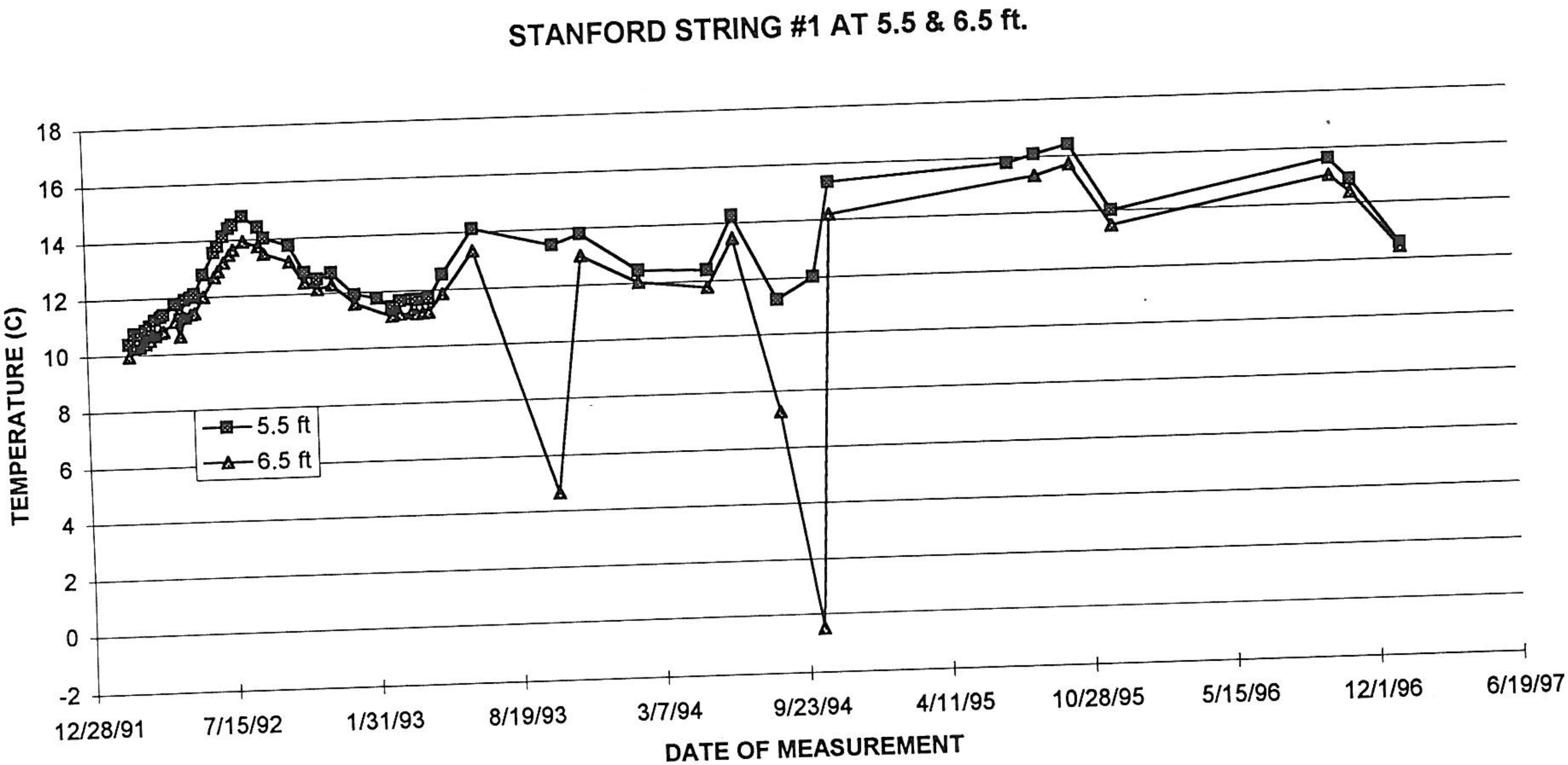
Operator : Yuan
Date : 2/24/92

	String #1			String #2			String #3		
Therm #	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)	Depth (ft)	R (avg)	Temp (C)
1	0	10110	9.672	AIR	6643	18.645	AIR	6160	20.31
2	2	9542	10.879	plus 1.5 *	6850.5	17.971	plus 1.5 *	6341.5	19.667
3	3.5	9470	11.037	0	7145	17.053	0	6525.5	19.037
4	4.5	9606	10.739	1	8016	14.57	1	7020	17.437
5	5.5	9772	10.38	2	9117	11.836	2	7748.5	15.299
6	6.5	9975	9.952	3	9745	10.438	3	8236	13.991
7	7.5	10192	9.504	4	10160	9.569	4	8621	13.019
8	8.5	10517	8.853	5	10522.5	8.842	5	8958.5	12.206
9	9.5	10734	8.431	5.5	10685.5	8.524	5.5	9146.5	11.768
10	10.5	10998	7.93	6	10827	8.253	6	9386	11.224
11	11	11118	7.707	6.5	10958	8.005	6.5	9556	10.848
12	11.5	11203	7.551	\	\	\	\	\	\

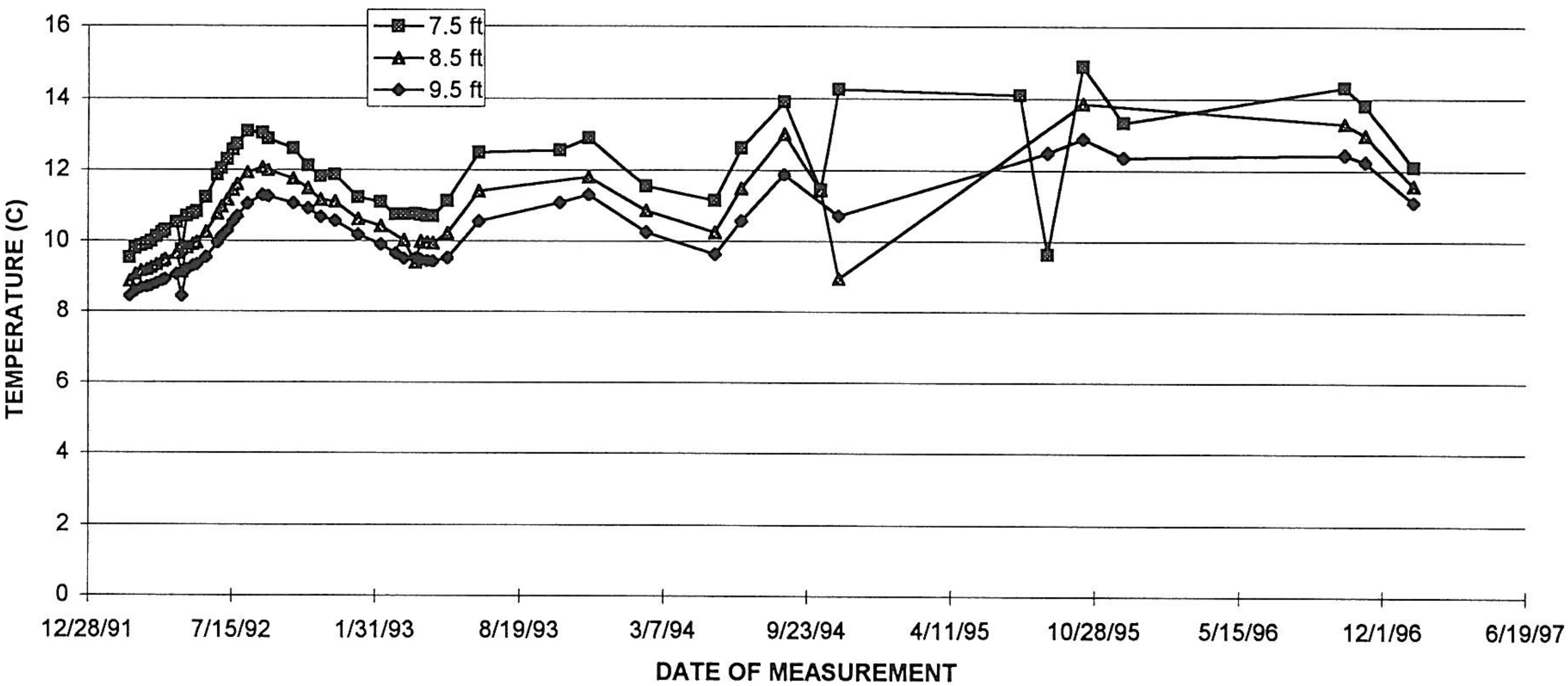
* This thermistor is at the top of the pipe which is 1 foot above the ground surface.

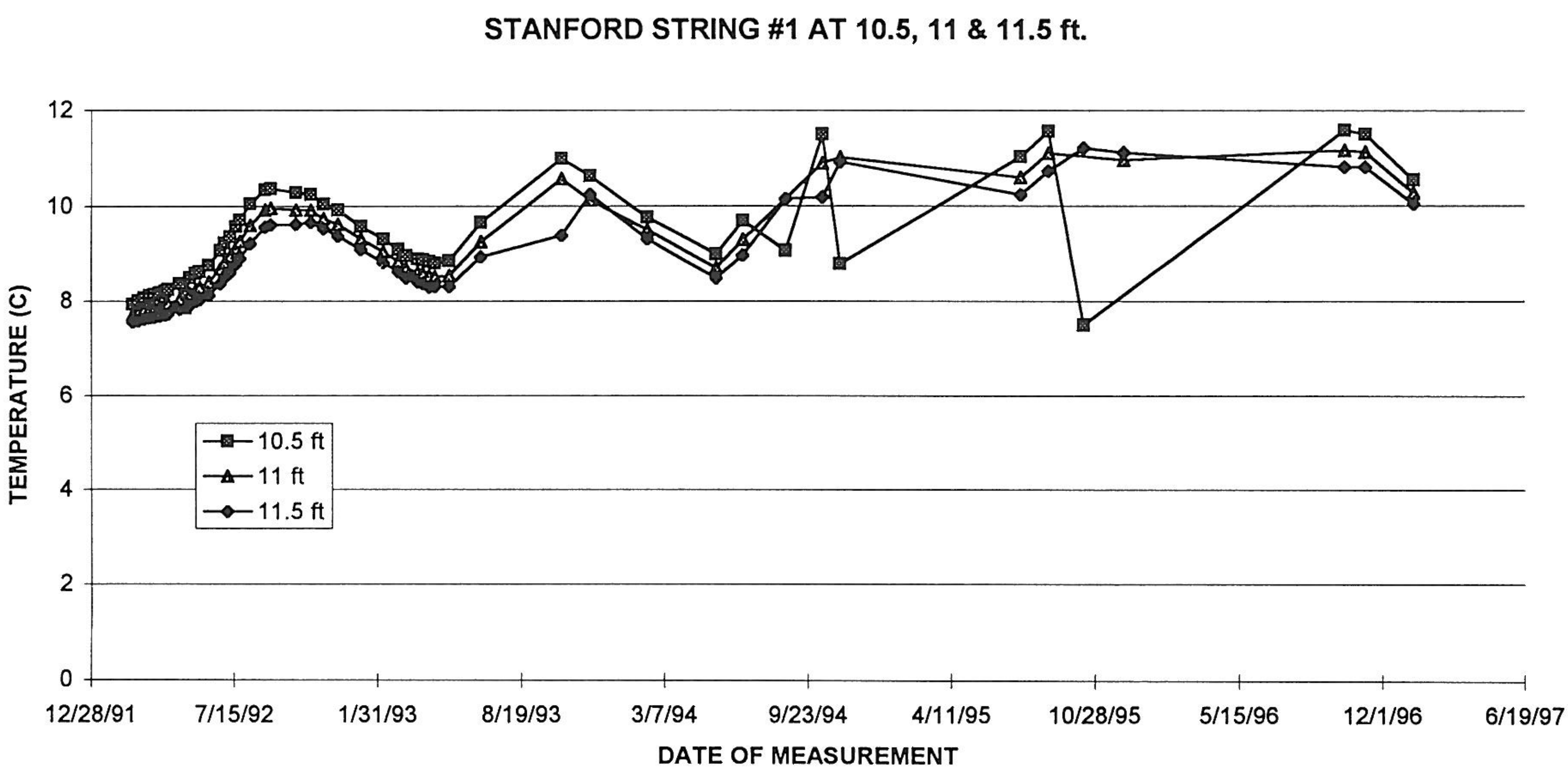
STANFORD STRING #1 AT 0, 2, 3.5 & 4.5 ft.



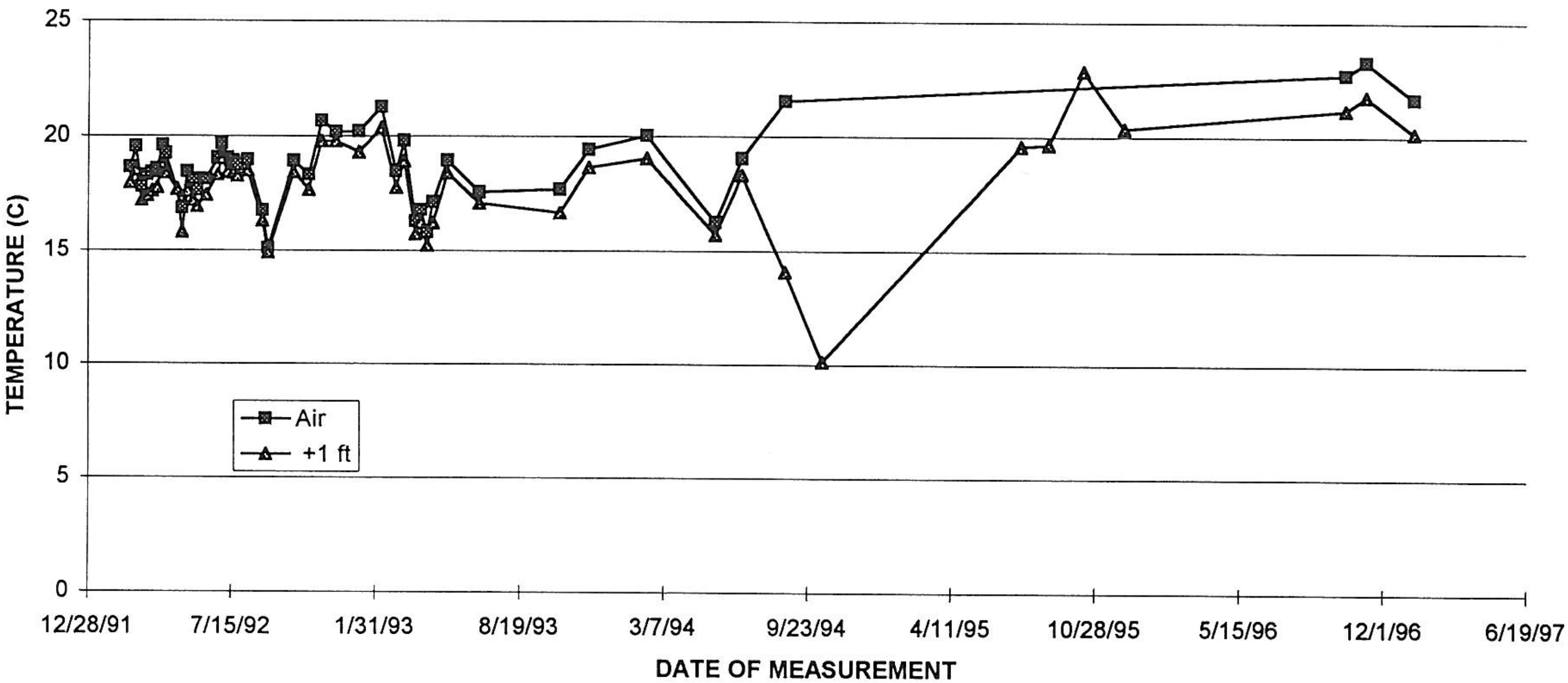

STANFORD STRING #1 AT 5.5 & 6.5 ft.
TEMPERATURE (C)
18
16
14
12
10
8
6
4
2
0
-2
5.5 ft
6.5 ft
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT

STANFORD STRING #1 AT 7.5, 8.5 & 9.5 ft.

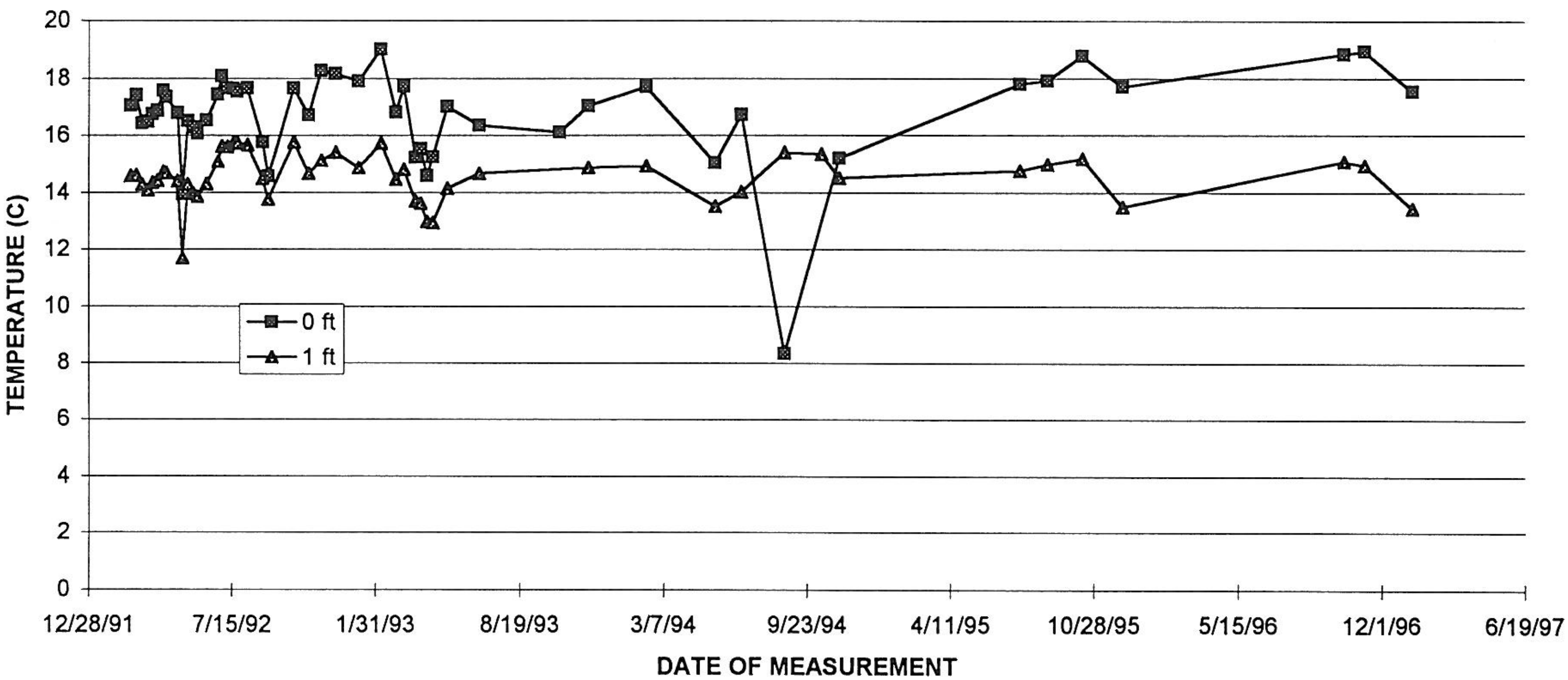



STANFORD STRING #1 AT 10.5, 11 & 11.5 ft.
TEMPERATURE (C)
12
10
8
6
4
2
0
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT
10.5 ft
11 ft
11.5 ft

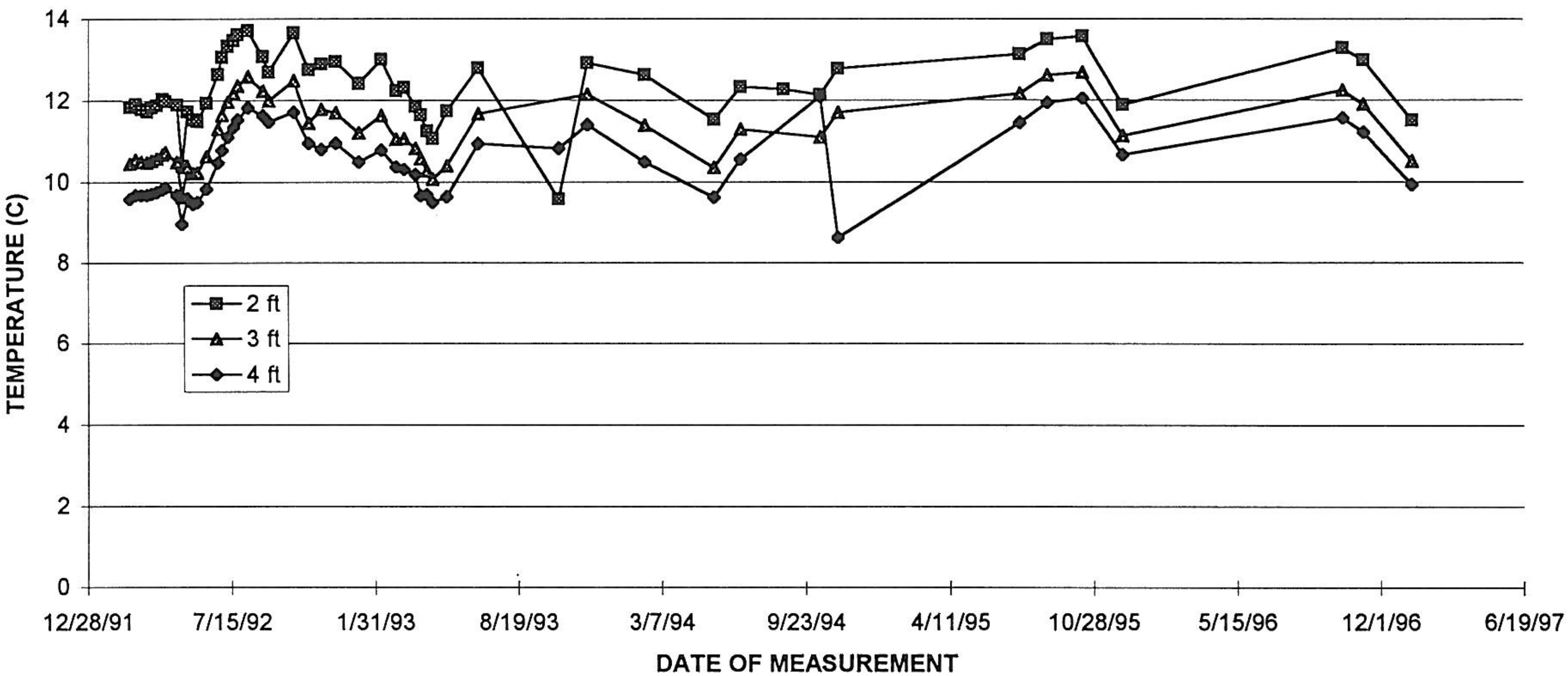
STANFORD STRING #2 : AIR & +1 ft.

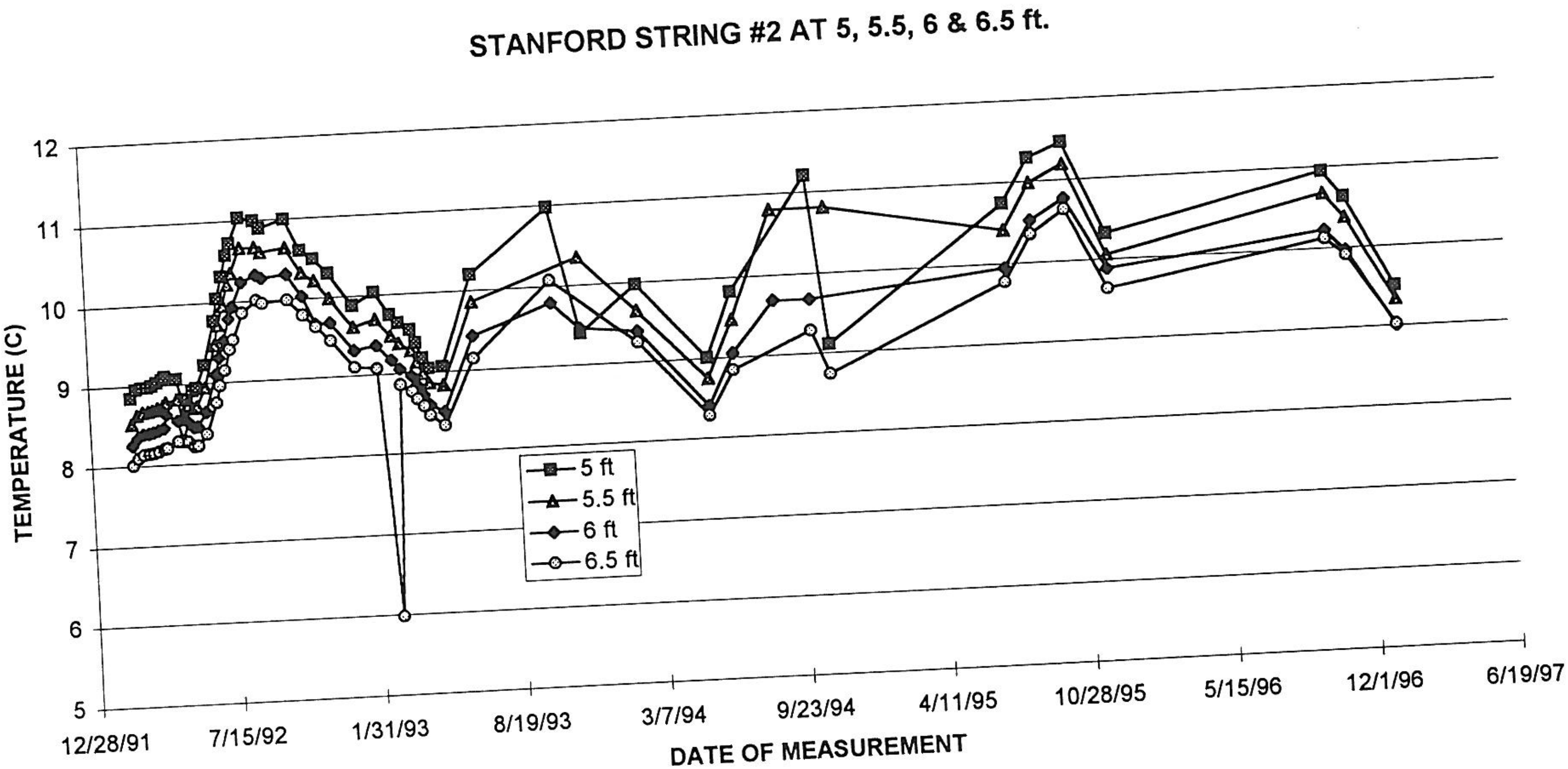


STANFORD STRING #2 AT 0 & 1 ft.



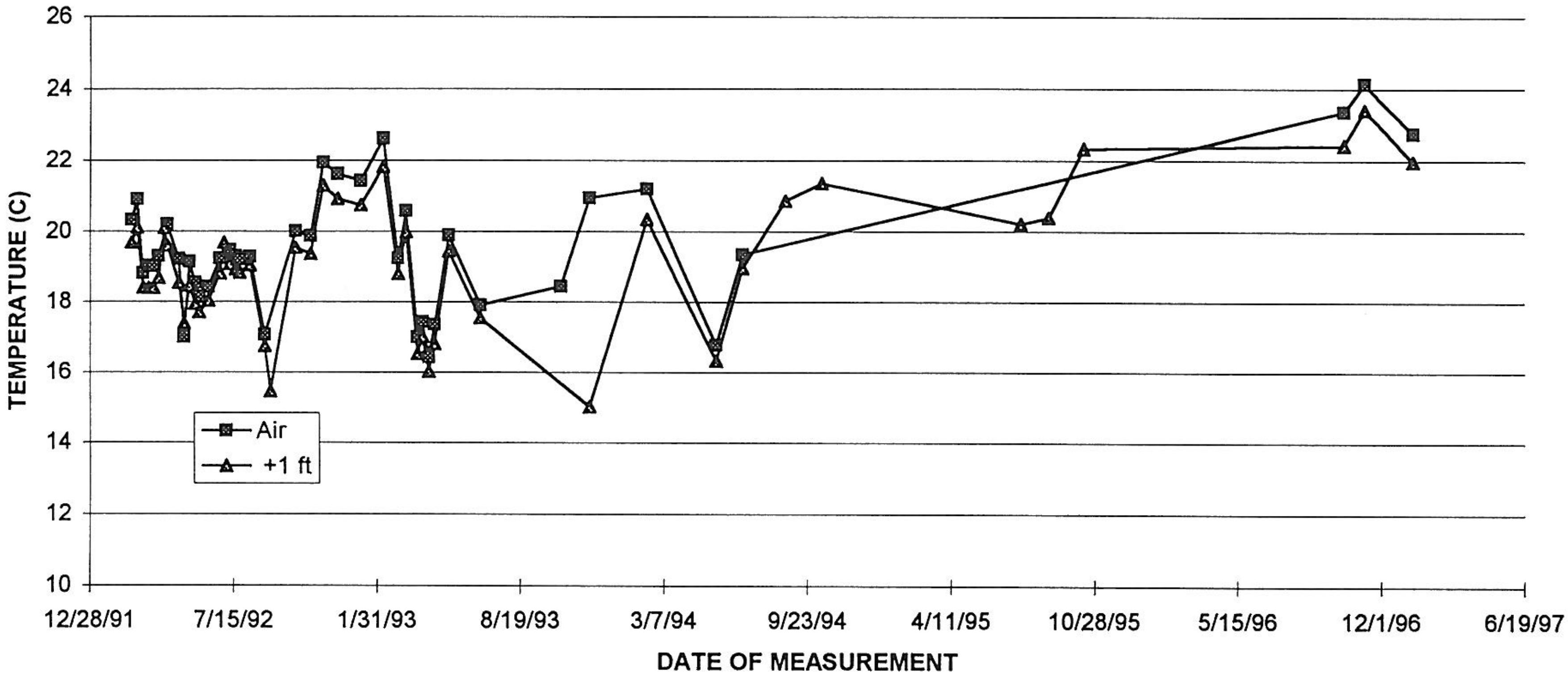
STANFORD STRING #2 AT 2, 3 & 4 ft.



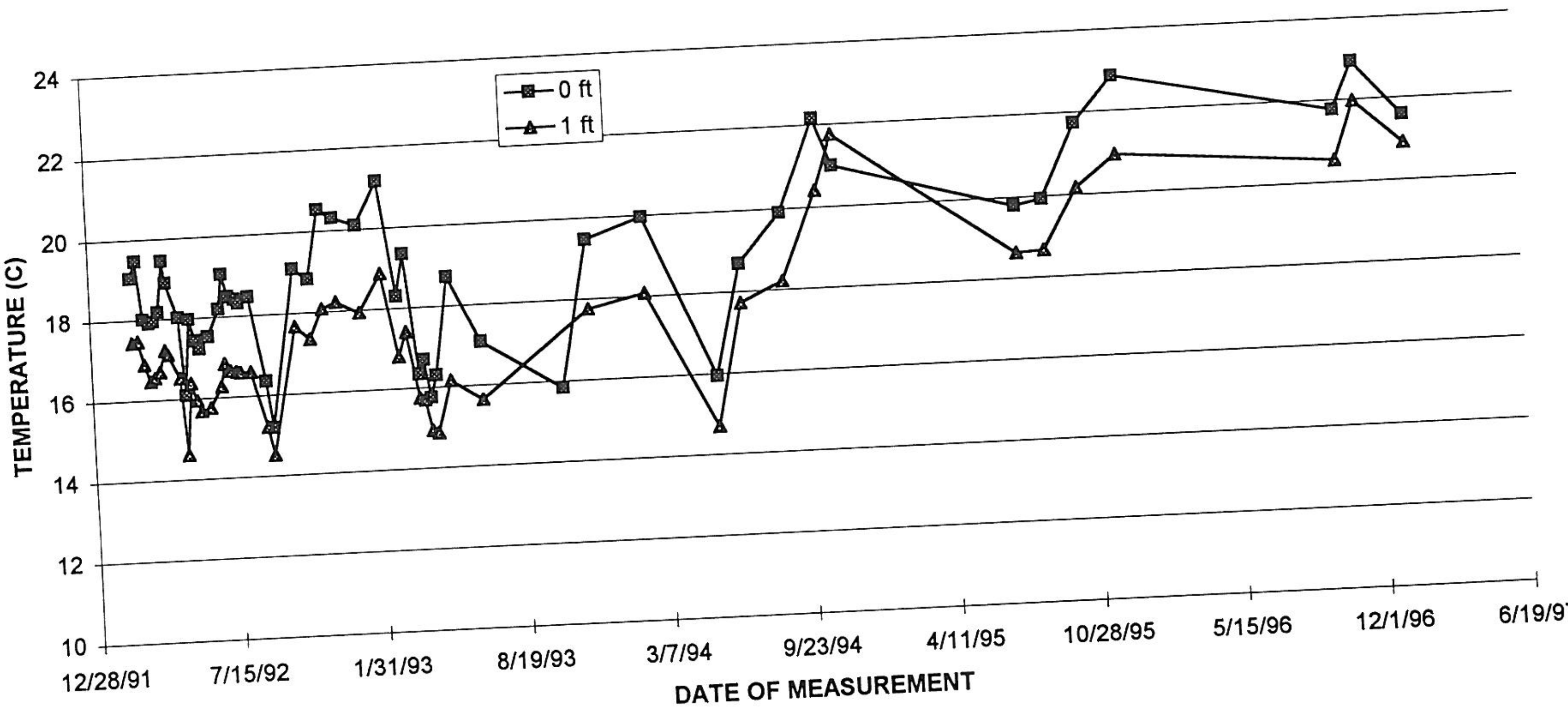


STANFORD STRING #2 AT 5, 5.5, 6 & 6.5 ft.
TEMPERATURE (C)
12
11
10
9
8
7
6
5
12/28/91
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT
5 ft
5.5 ft
6 ft
6.5 ft

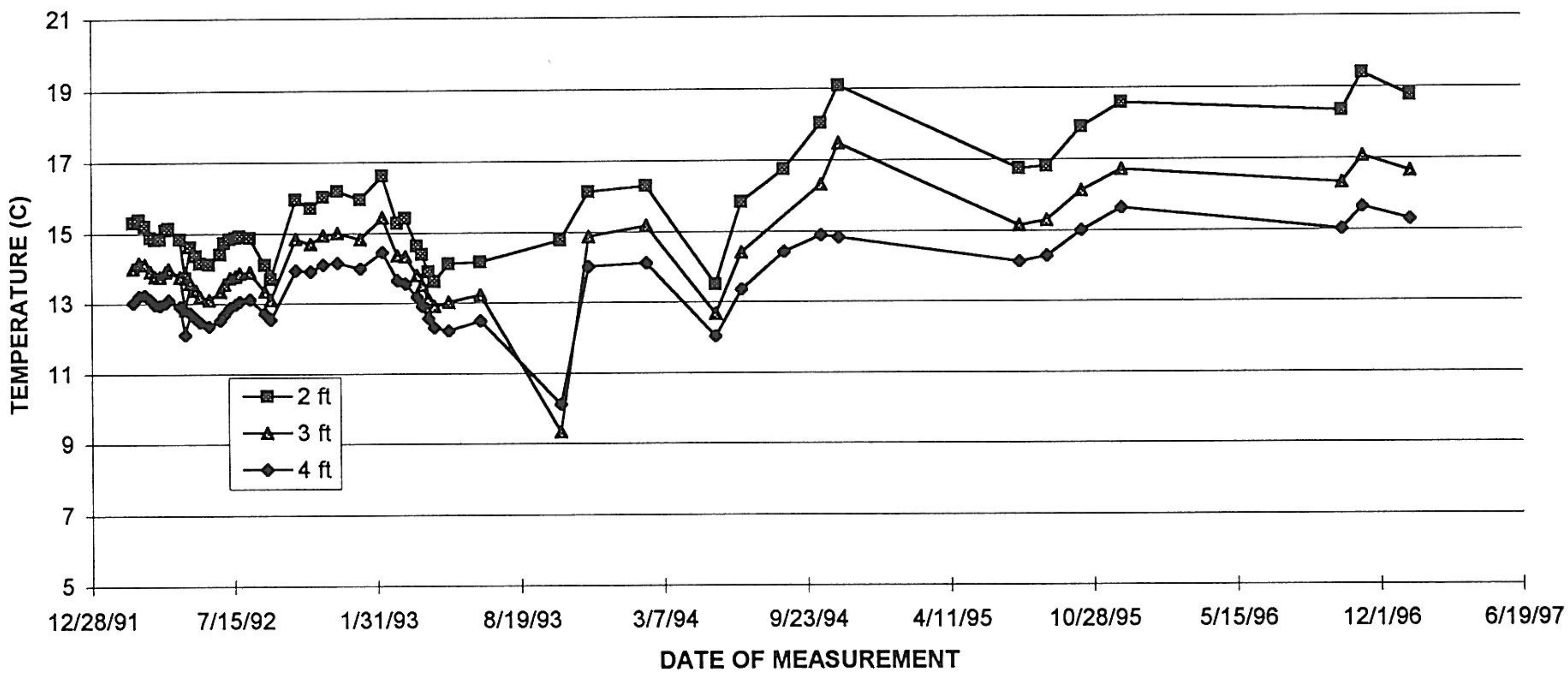
STANFORD STRING #3 : AIR & +1 ft.



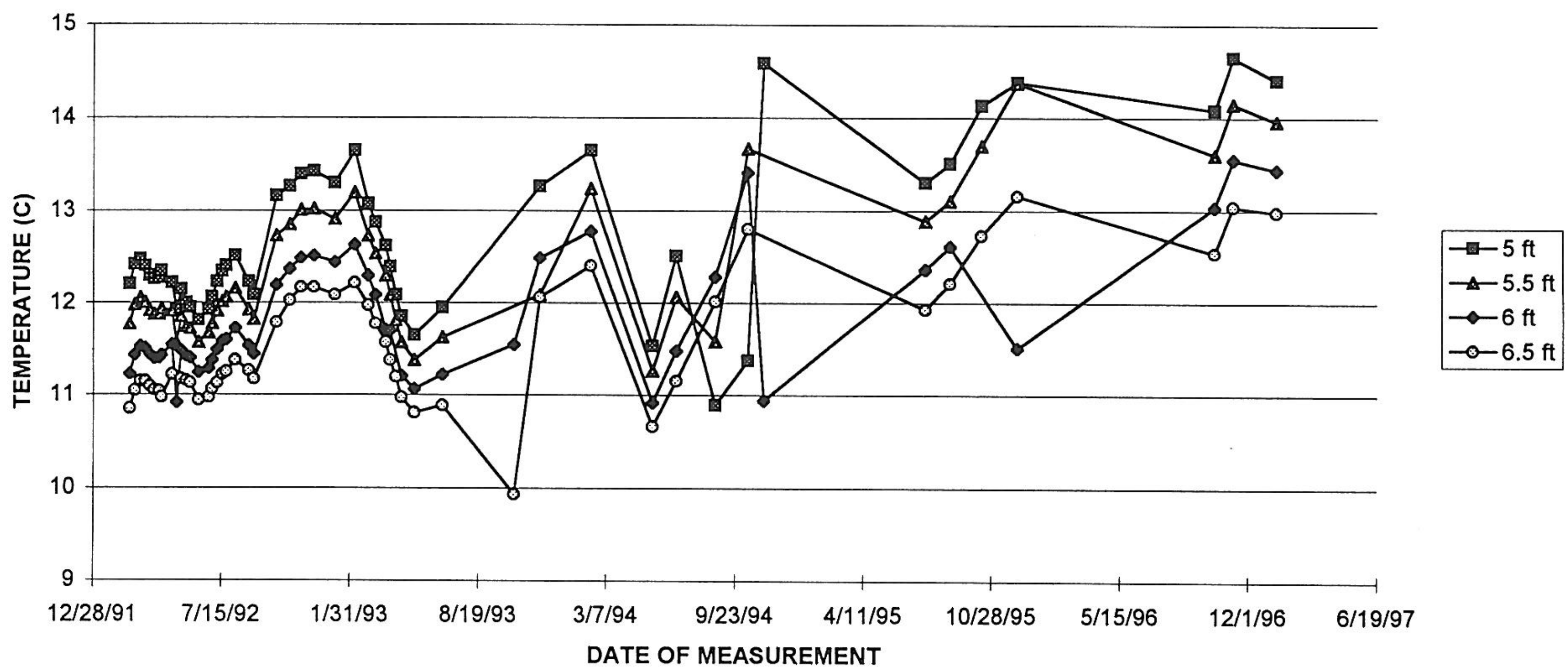
STANFORD STRING #3 AT 0 & 1 ft.



STANFORD STRING #3 AT 2, 3 & 4 ft.



STANFORD STRING #3 AT 5, 5.5, 6 & 6.5 ft.



Engineering Reports

STUTZMANN ENGINEERING ASSOC., INC.
P.O. BOX 71429
FAIRBANKS, ALASKA 99707
PHONE (907) 452-4094
FAX (907) 452-1034

January 29, 1998

Permafrost Technology Foundation
3875 Geist Road, Suite E-275
Fairbanks, AK 99709

Attn: Mr. Terry McFadden

Re: Engineering Report
4720 Stanford Drive
Fairbanks, Alaska

Dear Mr. McFadden:

As per your request we have conducted an onsite inspection of the above referenced property. This inspection was performed on January 16, 1998.

We have previously inspected this structure in December 1989 for the Alaska Housing Finance Corporation (A.H.F.C.). The purpose of our recent inspection was to allow for re-evaluation of our original report and findings.

It is our understanding, and appears to be so, that essentially no major maintenance or repairs have been performed on this building during the past eight years following our original inspection.

PERMAFROST TECHNOLOGY FOUNDATION DATA

We are in receipt of data, pertinent to this structure, recorded by the Permafrost Technology Foundation (P.T.F.) during the period between August 1991 and January 13, 1997. This data consists of two categories of information and is included with this report.

1.) Temperature data of underlying soils.
2.) Relative elevations of the first floor within the building.

The soil temperature data indicates no presence of frozen soils down to a depth of 54 feet at the bedroom end of the structure and 48 feet at the front door of the garage.

The elevation data indicates approximately 3½ inches of elevation differential on the first floor. The high point being at the master bedroom area and the low point at the exterior wall of the bedroom behind the garage. Approximately 5½ inches of elevation differential were found to existing on the garage floor surface across the width of the garage.

CURRENT INVESTIGATION

No additional soil borings were drilled during our January 16, 1998 inspection of this structure.

This investigation did include elevation readings on the first floor and garage floor surfaces and also elevation readings on top of the foundation concrete footing within the crawlspace area.

Our elevation readings on the first floor and garage floor surfaces are in agreement with those elevation differentials recorded during the P.T.F. monitoring of this structure.

Minor differences do exist but these are attributed to the carpet floor surfacing. Our recent measurements indicate an elevation differential of approximately 3.4 inches from one end of the house to the other within the living area of the structure. These measurements also indicate an elevation differential of approximately 5 3/4 inches on the concrete garage floor surface across the width of the garage. As mentioned these elevation differentials are quite consistent with those recorded by the P.T.F. between the dates of August 1991 and January 1997.

Our recent elevation measurements taken on the footings within the crawlspace do indicate differences from those readings taken previously by our office in December 1989. A plan sketch of the foundation with relative elevations and noted differences is included with this report. These readings indicate an elevation differential of 6 3/4 inches in December 1989 and 5 3/4 inches on January 16, 1998, a 1 inch differential settlement during that time period. This settlement may have occurred during that time period between December 1989 and August 1991, the date the P.T.F. began gathering data on this structure. As previously noted, the P.T.F. data indicates little if any change in elevation readings on the first floor surface. The P.T.F. did not record elevations on the concrete foundation footings.

Additional discrepancies were also noted during our recent inspection within the crawlspace area.

Water damage has occurred to the floor area below the bathroom locations. Only water staining of the wood members was noted but minor rotting may be present.

The entire interior surface of the concrete masonry block perimeter foundation walls is sprayed with approximately 1 inch thick layer of urethane foam insulation. As per the Uniform Building Code (U.B.C.), foam insulation within a crawlspace area should be protected with a fireproofing barrier. This structure is not located within the Fairbanks City limits, an area in which the U.B.C. is enforced. It is therefore at the option of the buyer or lender as to whether this foam is required to be protected with a fireproof material.

CONCLUSION

The elevation readings taken on top of the foundation footings indicate that approximately 1 inch of differential settlement occurred during the time between our two inspections. No apparent differential settlement was noted during the time of monitoring by the P.T.F. The 1 inch settlement therefore possibly occurred during that period prior to the commencement of the P.T.F. monitoring and following our first inspection.

The existing elevation differential found on the first floor of this house (3.4") is in excess of that normally found in a structure of this type. This differential is not readily noticeable by the naked eye and does not appear to be affecting the livability of the structure.

While little no differential settlement of this structure appears to have occurred during the time between August 1991 and January 1997 we are not convinced that additional differential settlement will not occur in the future. In our opinion, any additional settlement which may occur will not be catastrophic to the structure.

We recommend that this structure continue to be monitored by the P.T.F. or by the future owner if sold. Once stabile, this structure should be releveled as per "Drawing 3" of our January 26, 1990 report, a copy of which is enclosed with this report.

Replacement of the garage slab is recommended at this time. The installation of a floor drain with underlying dry well to handle miscellaneous snow melt is also recommended. The replacement of the slab at this time will help minimize problems which may result from water draining to the foundation wall.

All repair items, other than releveling, which are recommended in our January 26, 1990 report should be accomplished and monitored in lieu of possible settlement.

Our recommendations are based on problems which were readily apparent during the inspection. This report is meant to address only those concerns specifically mentioned herein and does not address the adequacy of the structure as a whole. Construction methods identified in one particular area have been assumed to be representative of like portions of the building. Hidden structural defects or deficiencies which may exist, but have not manifested themselves through some movement or failure, were likely to not have been identified with the inspection.

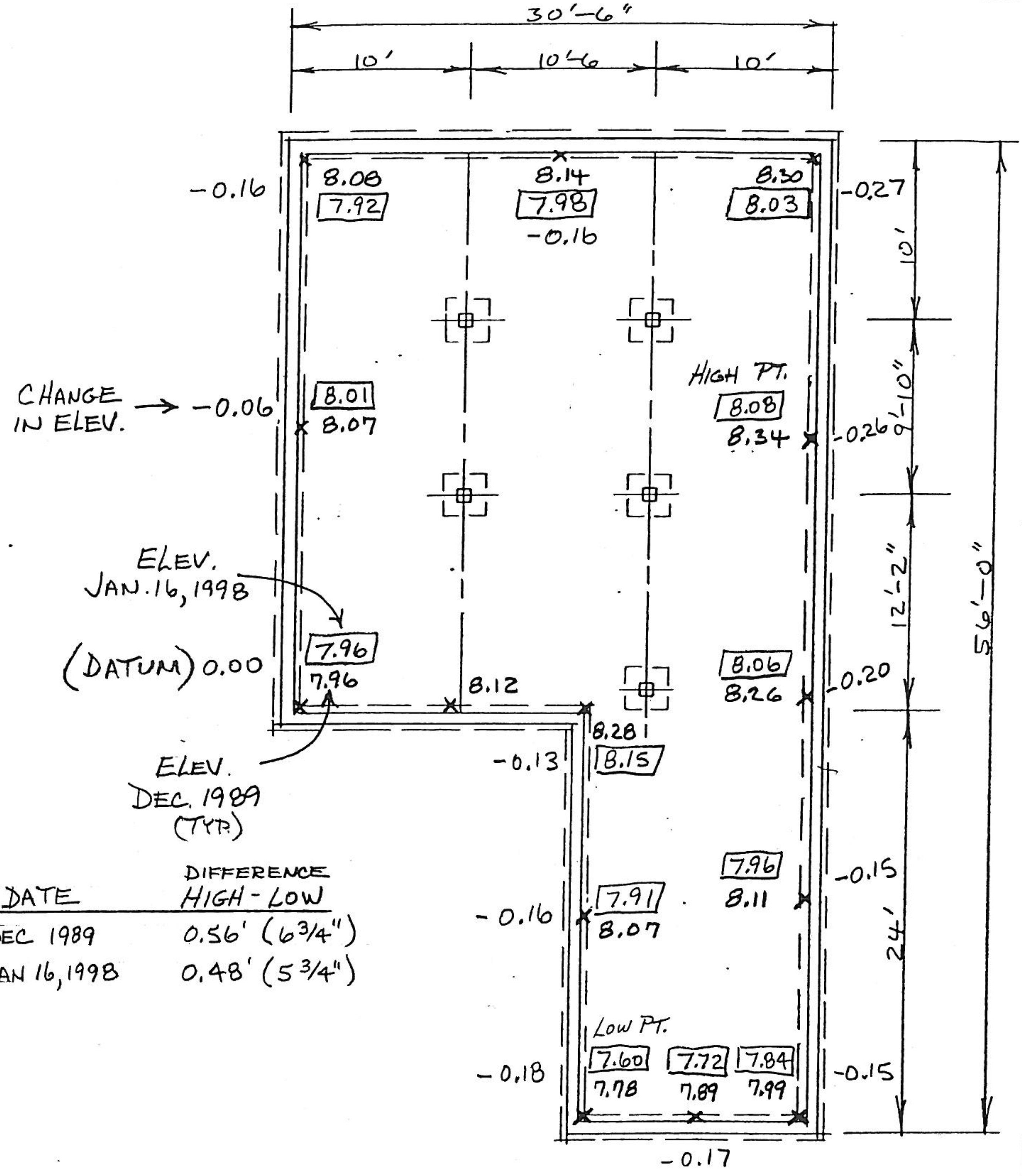
If you have any questions regarding this report, please contact our office.

Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

STATE OF ALASKA
49TH
JAMES H. ALTHERR
NO. 8039
CE
REGISTERED PROFESSIONAL ENGINEER

James H. Altherr, C.E.
97-228b



DATE	DIFFERENCE HIGH - LOW
DEC 1989	0.56' (6 3/4")
JAN 16, 1998	0.48' (5 3/4")

CRAWLSPACE -
ELEVATIONS ON TOP OF CONCRETE FOOTING

STUTZMANN ENGINEERING ASSOCIATES, INC.
ENGINEERS SURVEYORS PLANNERS
P. O. BOX 1428, FAIRBANKS, ALASKA 99707 (907) 452-4094

A.H.F.C. # 13252 (GRIBBLE)
4720 STANFORD DRIVE
FOR: COLDWELL - BANKER

DRAWN BY: NKE
DATE: 1/19/98
SCALE: 1/8" = 1 FT.
REVISED:

DRAWING NUMBER

ORIGINAL REPORTS

BY
STUTZMANN ENGINEERING ASSOC., INC.

STUTZMANN ENGINEERING ASSOC., INC.
P.O. BOX 1429
FAIRBANKS, ALASKA 99707
(907) 452-4094

January 26, 1990

Coldwell Banker
105 Adak Avenue
Fairbanks, AK 99701

Attn: Tom Hovenden

Re: AHFC #13252 (Gribble)
MBS - No Pool; WA #51942
4720 Stanford Drive

Gentlemen:

We have been asked to investigate the sagging garage ceiling beam, severly cracked garage floor, and failing floor support beams and posts in the above referenced house. Following is a report of our findings.

EXISTING CONDITIONS

Our inspection of the one story, ranch style house revealed that all of the above problems do exist. The house is "L" shaped with a low sloped hip roof. The sagging beam is supporting one end of the manufactured trusses which run full length of the main axis of the house. The roof over the garage is partially supported by these trusses and this beam. The beams consist of 2 - 4 X 12's, side by side, and are spanning 23½ ft. Assuming they are Hem Fir No. 2, since no grade stamps could be seen, each beam should be limited to design loads of between 50 lbs and 100 lbs per lineal foot. This is not sufficient for this location.

The garage floor is cracked and has settled approximately 4 inches near the center, compared to the front and back edges. Further investigation proved that some floors in the main part of the house are also not level. We shot elevations at random points on the concrete footing in the crawlspace and discovered that the Southerly corners of the house are as much as one-half foot lower than the highest point on the back wall.

The 2 X 10 floor joists at 16 inches on center are supported by 2 - 4 X 12 beams. These beams are in turn supported by intermediate posts on concrete pads. The posts and beams are not well connected and have twisted out of position while insufficient bearing area has resulted in crushing of the beams at some locations.

FOUNDATION SETTLEMENT

The differential settlement, first noted in the garage slab failure and subsequently in the main footings, has resulted in relatively minor structural damage up to the present. The elevations which were taken on the perimeter footing in the crawlspace indicate that the building has tilted fairly regularly toward the South. This relatively uniform tilt has resulted in much less structural deformation and superficial damage than might be expected in a case where there is a one-half foot differential settlement in a house. Three soil test borings were made in an attempt to determine the cause of settlement and the prognosis for future stability.

By breaking through the cracked concrete garage floor, we were able to drill a soil test hole using a small, gasoline powered, portable drill near the lowest part of the slab. We discovered a 2 inch void under the floor indicating additional settlement of the underslab backfill. The small drill, a "Mobile Drill" rig utilized 2 inch diameter, continuous flight auger in 3 ft. sections.

The first 5 to 6 feet of material appeared to be fill brought into the site prior to construction. It is probable that this house, which lies in the

Chena/Tanana River flood plain, was required by Borough regulations to be constructed several feet above the original elevation of the site. This would explain the deeper than average fill under this and the neighboring house, which appears to have been built by the same contractor. The hole was continued down through sand, gravel, and silts encountering the water table in the 15 ft. to 18 ft. vicinity. No frozen ground was apparent down to the bottom of hole at 30 ft.; however, the sampling method was limited to raising material by high speed rotation of the drill due to the restricted height of the garage ceiling and the limited vertical travel of the machinery. Because this sampling method results in considerable contamination of the material as it is drawn up the hole, it is possible to miss lesser occurrences of frozen soils.

In the search for more conclusive evidence, we undertook two additional soil borings with larger machines outside the structure. The logs of these holes, TH1 and TH2, did provide more information and are attached to this report. Although no permafrost was encountered, the larger machine allowed us to take standard penetration tests which yielded some relatively low values in the upper stratum.

Taking the available evidence as a whole, it is our opinion that one or more of the three following conditions were responsible for the settlement of this house.

1. The house was built off level through faulty instruments at the time of construction.

2. Permafrost under the building has receded, resulting in consolidation of the soils.

3. The deep fill upon which the house is constructed was not property compacted.

There are any number of arguments for and against each case, some of which are as follows.

The general tilt in one direction supports the first proposal, but the uneven floors and the failed garage slab argue against it. The lack of any evidence of frozen material in the drill samples argue against the second proposal, but the tilt toward the South, where solar affect is greater, at least partially supports that theory. The low blow counts in the shallow soils argues for the third proposal, but even these soil bearing strengths should be sufficient to support the relatively light loads imposed by conventional spread footings of a single story residence.

A search of the Borough Assessors records indicate that this house was constructed during the winter of 1974-75. If the fill material was placed just prior to construction in the late fall of 1974, it may have contained frozen material, including lumps and voids, which has subsequently melted, leaving an unconsolidated fill. We would have expected settlement from this source to have occurred much sooner, but of course we do not know when the damage was actually apparent.

We did contact a family who owned the house about 10 years ago. They indicated that the only problem they noticed was settlement of the floor which allowed separation of the center partition and the ceiling. This they repaired by jacking up the center beams and increasing the height of the supporting posts in the crawlspace.

It is our opinion that some combination of melting permafrost and poor compaction of the original fill are responsible for the present situation. We suspect that the problems encountered by the previous owners were the first indications of the settlement which may well have run its course by this time. Of course the most crucial question at this point concerns the present and future stability of the structure. We cannot guarantee that this house is stabilized, but it is our opinion that, based on the available evidence, there is a good chance that future settlement will be relatively minor. We, therefore, recommend that the house be releveled at this time.

RELEVEL HOUSE AND GARAGE

This work should be undertaken following the garage slab replacement so that any additional settlement caused by the compacting operation can be accommodated in the repair.

Existing anchor bolts will have to be released and extended through the use of sleeve nuts and threaded rod. The garage and house will have to be raised simultaneously since they are structurally interdependent. The frame shall be raised and leveled so that differential elevations are 1/16 inch per ft. or less for short spans and 1½ inch or less in the entire structure.

Once leveled, non-shrink grout shall be injected into the gap between the top of the concrete block wall and the sill plate. The concrete block foundation wall at the front of the house has been corbeled out as if to support a rock or brick face veneer which was never constructed. The block cores which are open and exposed at the top shall be filled with vermiculite insulation and sealed off with the grout material which shall be beveled or sloped away from the building so as to promote good drainage. When the grout has hardened, the house may be lowered and the anchor bolts extended and tightened as necessary. The house sewer, water supply line, and heating boiler lines may require minor modifications to accommodate the releveling procedure.

REPAIR GARAGE SLAB

The existing garage slab has cracked along a construction joint parallel with the front wall and about mid-span. Both the front and back halves of the slab tilt toward this crack and toward the Southeast wall of the garage. Since we know there are additional voids under the slab and further settlement and damage can be expected, we suggest that the entire garage slab be removed. This area should then be compacted to 95% of dry weight density using a heavy, vibratory compactor, and a new, 4 inch thick, garage slab containing 6 X 6 - 10/10 wire mesh shall be constructed of concrete capable of attaining a compressive strength of 2500 p.s.i. in 28 days. The slab surface should be nearly level with a slight depression in the center to pond drainage. Since the building is not level, the contractor should use a spirit level instead of the existing walls as a guide for the slab surface elevations. A 1/2 inch thick expansion joint filled with asphalt impregnated fiberboard or similar material shall separate all walls, column pads, and the existing apron from the new floor slab. Stairs and landings at existing entryways may be replaced as at present.

REPAIR OF FLOOR BEAMS AND POSTS

The 2 - 4 X 12 beams supporting the floor joists exhibit localized warping and buckling due to a lack of proper restraint. Narrow wedge shims have been driven between posts and beams evidently in an effort to relevel the floor. The wood fiber of the beam is being crushed at some of these locations due to excessive bearing pressure.

We recommend replacing the existing posts with 4 X 8, treated wood posts at the same location so that the existing concrete pads may be utilized. The post to beam connection should be fitted with preformed metal anchors such as "Simpson PC 48", or equal, to provide proper seating and lateral restraint of the beam, especially at the butt joint locations.

The 12 ft. beam span, (farthest from the crawlspace access hatch), is longer than normal design criteria would allow. We recommend installation of supplemental supports at the center of that span only. They may consist of treated, 4 X 4, columns resting on precast 15" X 15" X 6", concrete pads containing 2 rebars each way. All "leveling" and straightening of floor support members must take into consideration the tilt of the building. It would be desirable to "string line" the column elevations in two directions to average out the minor irregularities of the foundation wall.

REPAIR GARAGE CEILING BEAM

The existing, doubled, 4 X 12, sawn wood beam in the garage ceiling is inadequate to carry the roof loads transferred to it through the trusses. There is water staining on the living room ceiling above the front door and on the exterior Southeast wall of the garage. Both of these locations are at the lower end of the two roof valleys and may be a result of poor roof surfacing or cracks due to excessive flexing of the roof due to the weak beams. The situation is complicated by the lack of available space for a deeper beam due to interference with the overhead door and operator.

We suggest sandwiching the existing beam with two 1-3/4" by 11-7/8" Micro=Lam beams on each side. First, all sheetrock encasing the existing beam and the ceiling a few inches each side of the beam should be removed. If there is more than 3 inches of snow on the roof, the area over the garage and up to the main axis peak shall be cleared. The existing beams may be straightened with jacks and temporary supports, a half to one inch of mid span camber would be desirable if possible. The Micro=Lam beams shall be fastened to the existing beams, one at a time, with 2 rows of 16d nails, staggered at 12 inch centers. The ends of the beams should be let into reconstructed beam seats in the exterior walls. Also, an additional column should be installed 4 ft. from the exterior garage wall, near the boiler, to shorten the beam span. A 6 X 6, sawn column of Hem-Fir No. 2, or better, may be used. A specially fabricated column cap, similar to the "Simpson CC" series, should be used at the beam connection. The base should be supported on a 30" X 30" X 10" poured, concrete pad containing three No. 5 deformed bars each way and a "Simpson AB66" adjustable post base. The pad should be poured so that the top surface is flush with the proposed new garage floor.

EXTERIOR DRAINAGE

Since excessive soil moisture may have contributed to settlement of the building, we suggest that steps be taken to divert surface water away from the building as much as possible. Eaves troughs should be installed along the front of the building with special attention to the roof valley area on both sides of the garage. These should be fitted with downspouts, tailpipes, and splash blocks, if needed, to divert the water away from the foundation area.

Additional fill should be placed and well compacted along the Southeast side of the garage in the settled area. This material shall be graded away from the building and seeded to match the existing lawn.

SUMMARY OF WORK ITEMS

1. Relevel superstructure and construct concrete pad for new beam support column.

2. Replace garage slab, add floor drain and column pad.

3. Replace beam support posts in crawlspace and add two additional posts and pads.

4. Add Micro-Lam beams and supporting column to existing beam in garage ceiling.

5. Install rain gutters on front side and fill, compact, grade, and seed along Southeast side of garage.

The roof valleys should be inspected this summer by a competent roofer to determine the cause of the water staining problems. Inspection of the brittle roof surfacing at this time would probably be inconclusive and result in surface damage.

All of the above construction shall conform to standard practice and the Uniform Building Code.

Our recommendations are based on problems which were readily apparent during the inspection. This report is meant to address only those concerns specifically mentioned herein and does not address the adequacy of the structure as a whole. Construction methods identified in one particular area have been assumed to be representative of like portions of the building. Hidden structural defects or deficiencies which may exist, but have not manifested themselves through some movement or failure, were likely to not have been identified with the inspection.

If the contractor encounters more structural problems during construction, he should contact us for our recommendations. It is assumed the contractor will be knowledgeable enough to perform his duties in a proper manner and be capable of identifying other possible deficiencies if they are revealed during construction.

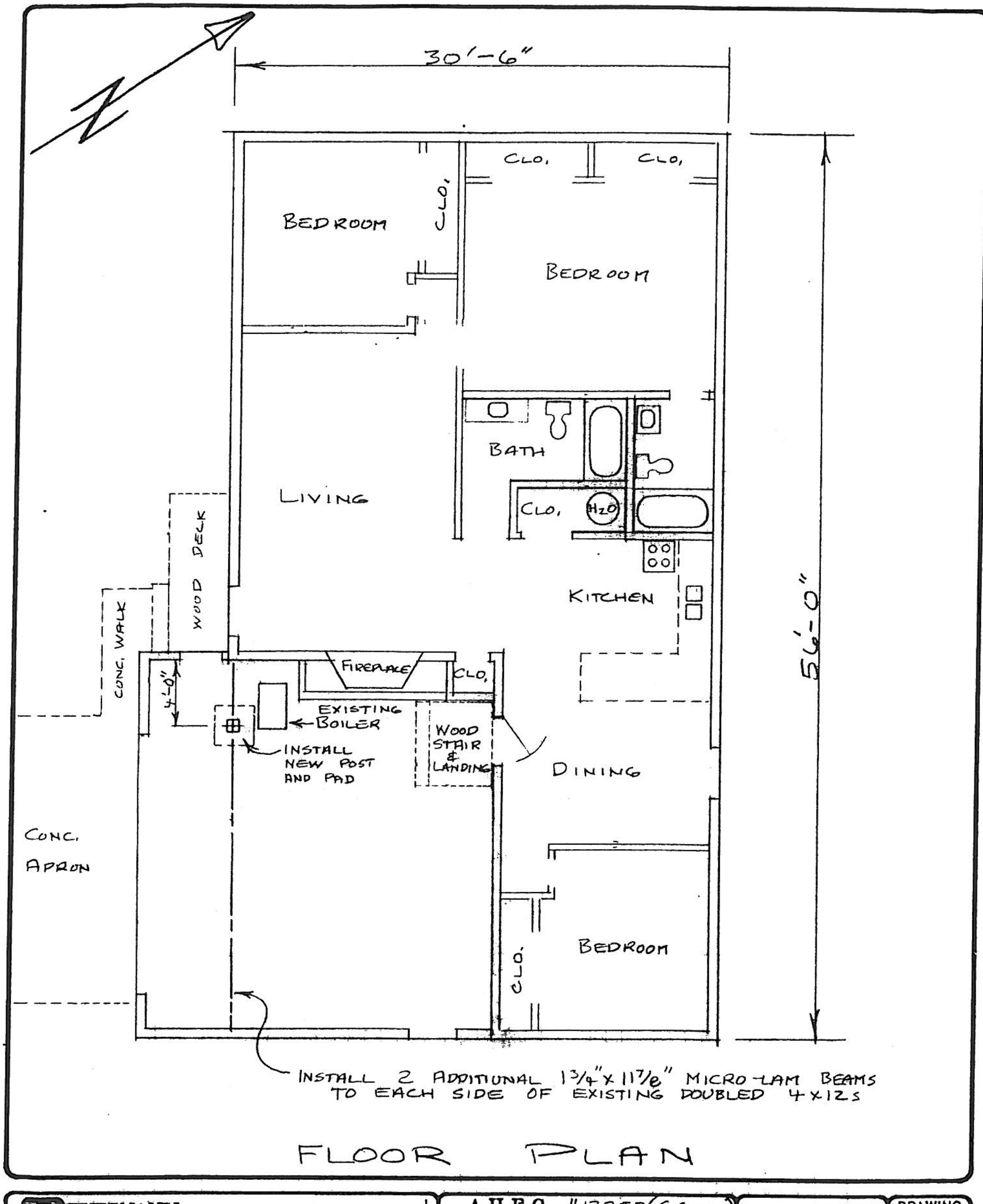
Prior to commencing work, the contractor should contact us to set up an inspection schedule. It is the responsibility of the contractor to contact us as work progresses, so that we can inspect items being repaired. Repairs should not be covered before inspection.

If you have any questions regarding this report, please contact our office.

Sincerely,

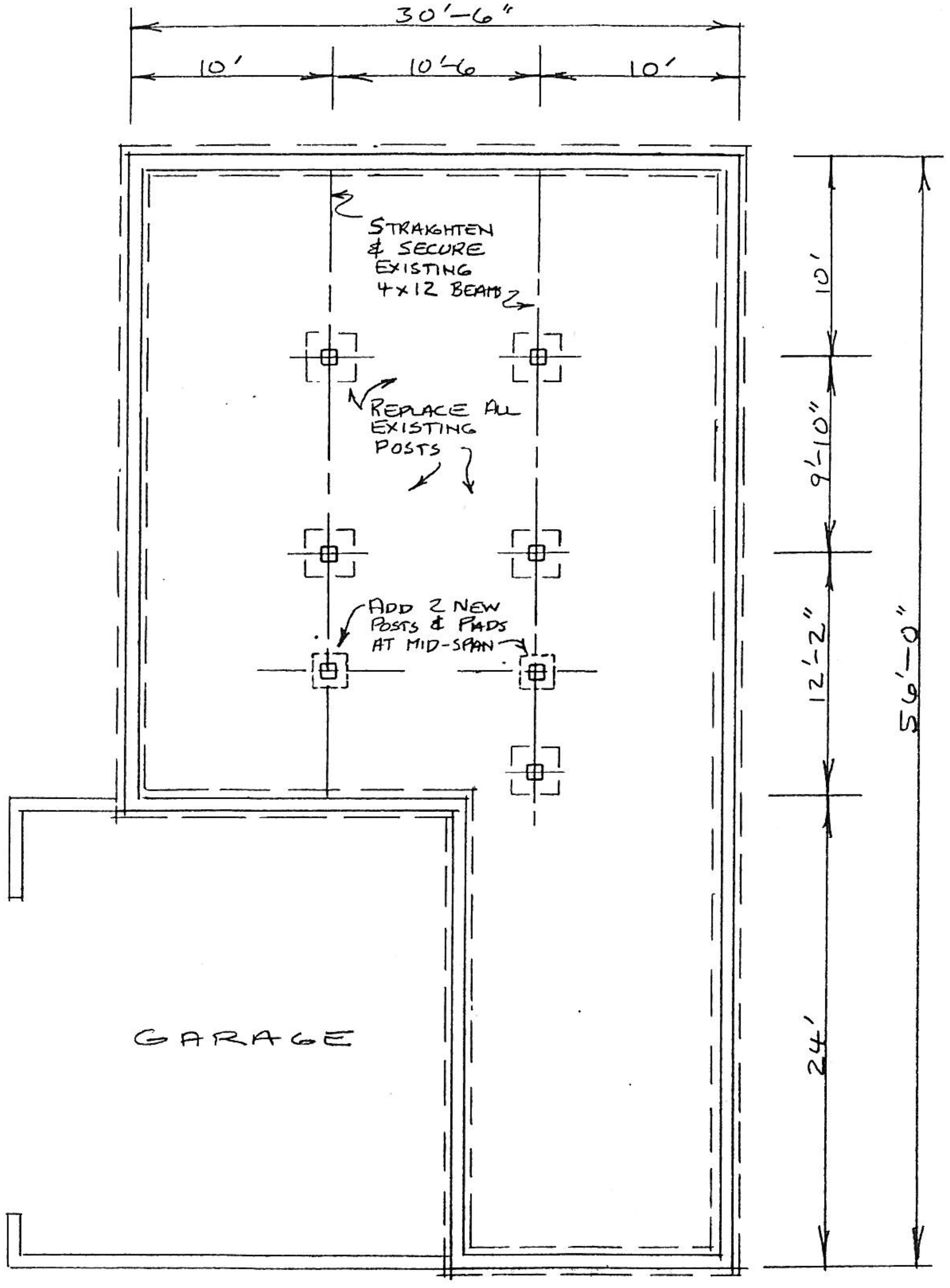
STUTZMANN ENGINEERING ASSOC, INC.

Paul E. Stutzmann, P.E.
57/GG



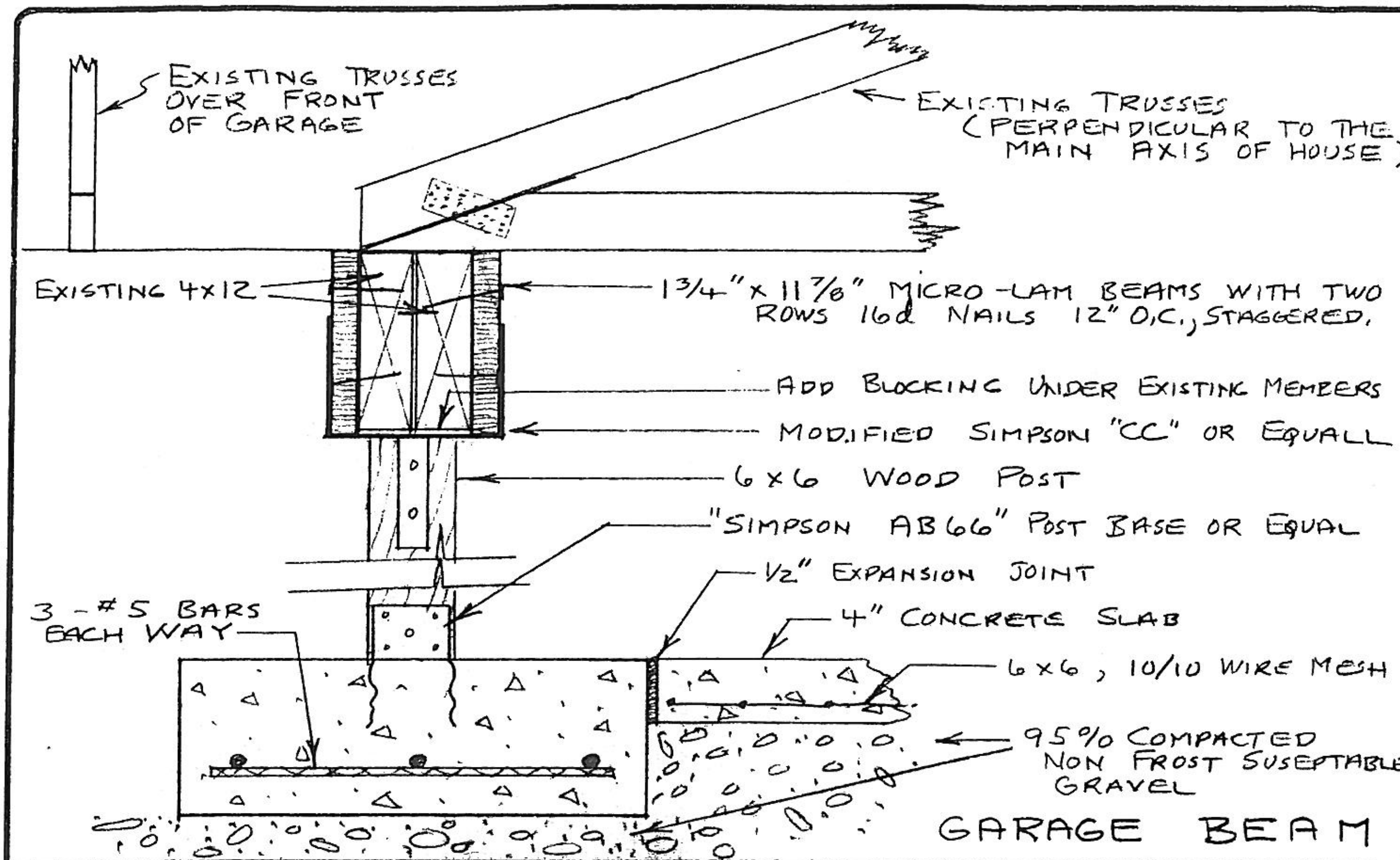
FLOOR PLAN

STUTZMANN ENGINEERING ASSOCIATES, INC. — ENGINEERS, SURVEYORS, PLANNERS — P. O. BOX 1428, FAIRBANKS, ALASKA 99707 — (907) 452-4094	A.H.F.C. #13252 (GRIBBLE) 4720 STANFORD DRIVE	DRAWN BY: NKE DATE: 12/1/09 SCALE: 1/8" = 1 FT.	DRAWING NUMBER 1
	FOR: COLDWELL-BANKER	REVISED:	

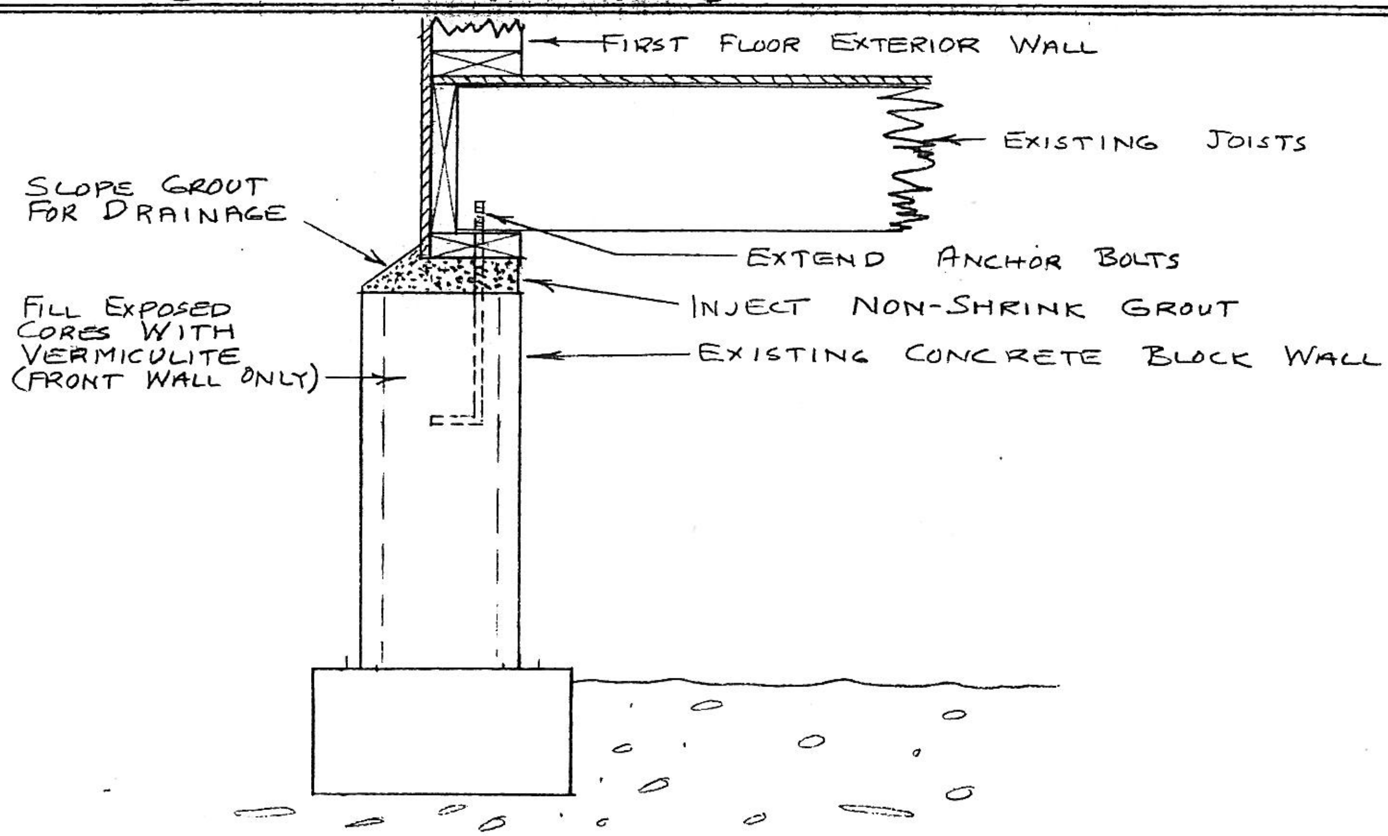


FOUNDATION PLAN

STUTZMANN ENGINEERING ASSOCIATES, INC. ENGINEERS SURVEYORS PLANNERS P. O. BOX 1429, FAIRBANKS, ALASKA 99707 (907) 452-4094	A.H.F.C. # 13252 (GRIBBLE) 4720 STANFORD DRIVE FOR: COLDWELL - BANKER	DRAWN BY: NKE DATE: 12/1/09 SCALE: 1/8" = 1 FT. REVISED:	DRAWING NUMBER 2



GARAGE BEAM



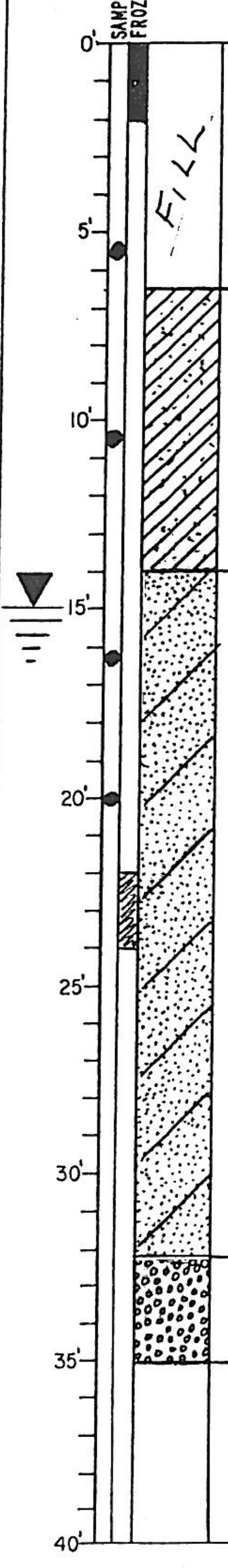
RELEVELING GROUT AT SILL

STUTZMANN ENGINEERING ASSOCIATES, INC. — ENGINEERS SURVEYORS PLANNERS — P. O. BOX 1429, FAIRBANKS, ALASKA 99707 (907) 453-4094	A.H.F.C. # 13252 (GRIBBLE) 4720 STANFORD DRIVE FOR: COLDWELL-BANKER	DRAWN BY: NKE DATE: 1/26/90 SCALE: 1" = 1 FT REVISED:	DRAWING NUMBER 3

STUTZMANN ENGINEERING ASSOC., INC.

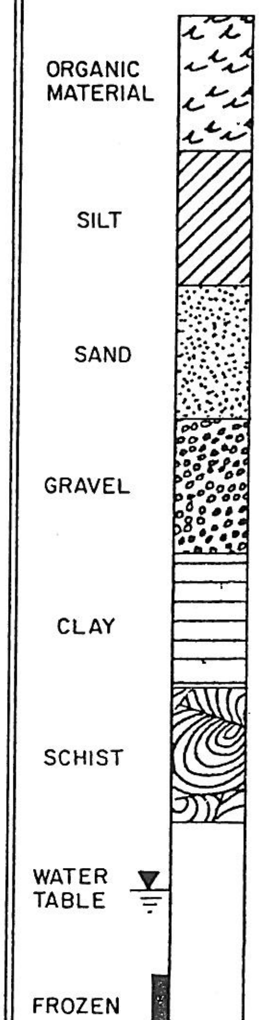
P.O. BOX 1429, FAIRBANKS, ALASKA 99707 — (907) 452-4094

CLIENT: COLDWELL BANKER / A.H.F.C.	JOB No. AHFC #13252 (GRIBBLE)
HOLE No.: TH 1	DATE 12/5/89
LOCATION: 5 FT. S. OF S.E. CORNER OF GARAGE	DRILLER: E. CLARK
	LOGGED BY: J. ALTHEER
DRILLED WITH SKID MOUNTED RIG	SHEET No. 1 OF 1



SOIL DESCRIPTION	SAMPLE DATA
INTERMIXED LAYERS OF SAND, SILT AND GRAVEL. APPERS TO BE FILL PLACED DURING THE CONSTRUCTION PHASE OF THE DWELLING.	N = 4
FINE, BROWN, SANDY SILT DAMP	N = 6
WATER TABLE @ 15' ± FINE, GREY, SILTY SAND	N = 7
	N = 16
(FROZEN ?)	
TRACE GRAVEL @ 25'	
GRAVEL	
END OF BORING @ 35'	

LEGEND



N = SPT blows/ft.
2" O.D. spoon
140#, 30" drop

W = % Moisture

GSS = % Gravel / Sand / Silt

STUTZMANN ENGINEERING ASSOC., INC.
P.O. BOX 1429, FAIRBANKS, ALASKA 99707 — (907) 452-4094

CLIENT: COLDWELL BANKER / A.H.F.C JOB No. AHFC # 13252 (GRIBBLE)

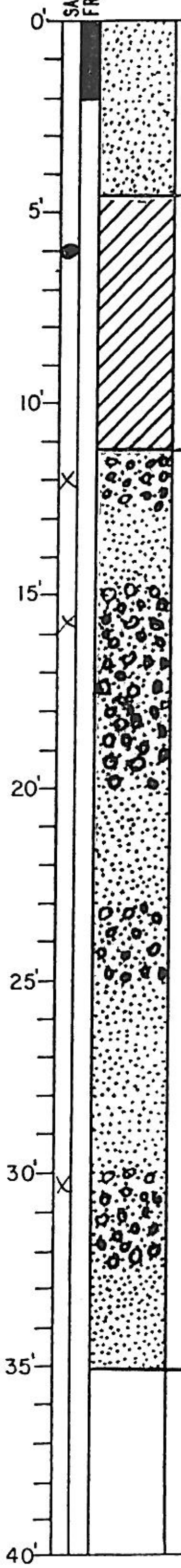
HOLE No.: TH 2 DATE 12/6/89

LOCATION: 5 FT. FROM ℄ OF N.W. SIDE OF HOUSE. DRILLER: E. CLARK

LOGGED BY: J. ALTHERR

DRILLED WITH PAYNE 2000
4" HOLLOW STEM & 2" S.S. SAMPLER

SHEET No. 1 OF 1



SOIL DESCRIPTION	SAMPLE DATA
FINE SAND FAIRLY DRY	
FINE, BROWN, SILT DAMP	N = 4
INTERMIXED LAYERS OF SAND AND GRAVEL	N ≈ 20
	N ≈ 24
NOTE: SOME OF THE SAND LAYERS DRILLED SLIGHTLY HARDER. MARGINALLY FROZEN? COULD NOT OBTAIN SOIL SAMPLE FROM SAND LAYERS. NO FROZEN DRILL CUTTINGS CAME TO SURFACE.	N = 14
END OF BORING @ 35'	

LEGEND

ORGANIC MATERIAL

SILT

SAND

GRAVEL

CLAY

SCHIST

WATER TABLE

FROZEN

N = SPT blows/ft.
2" O.D. spoon
140#, 30" drop

W = % Moisture

GSS = % Gravel / Sand / Silt

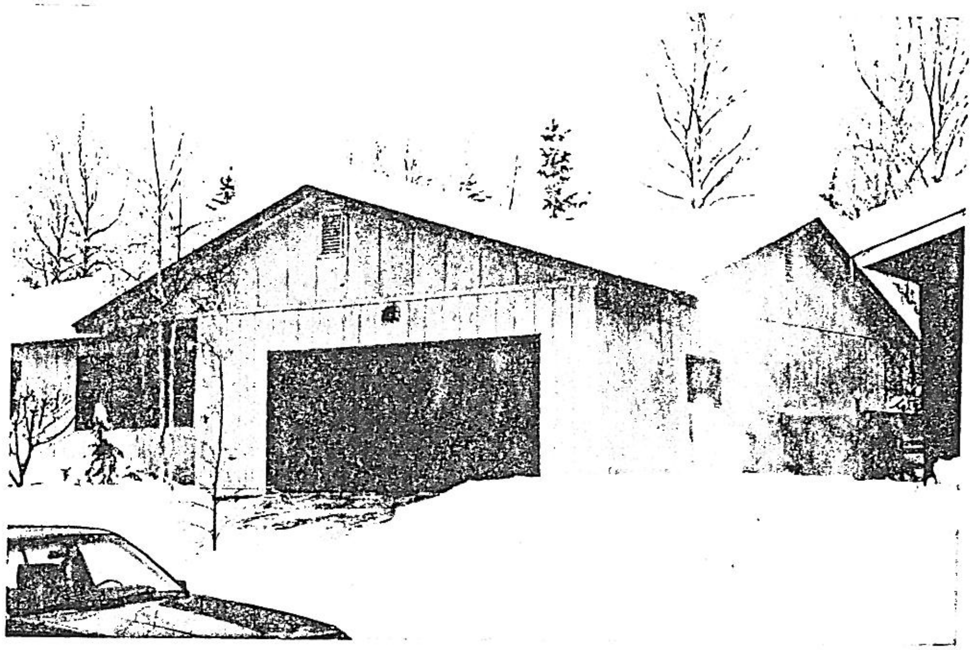


PHOTO #1: FRONT OF GARAGE AND SOUTHEAST END OF HOUSE. NOTE ELEVATION ABOVE STREET.

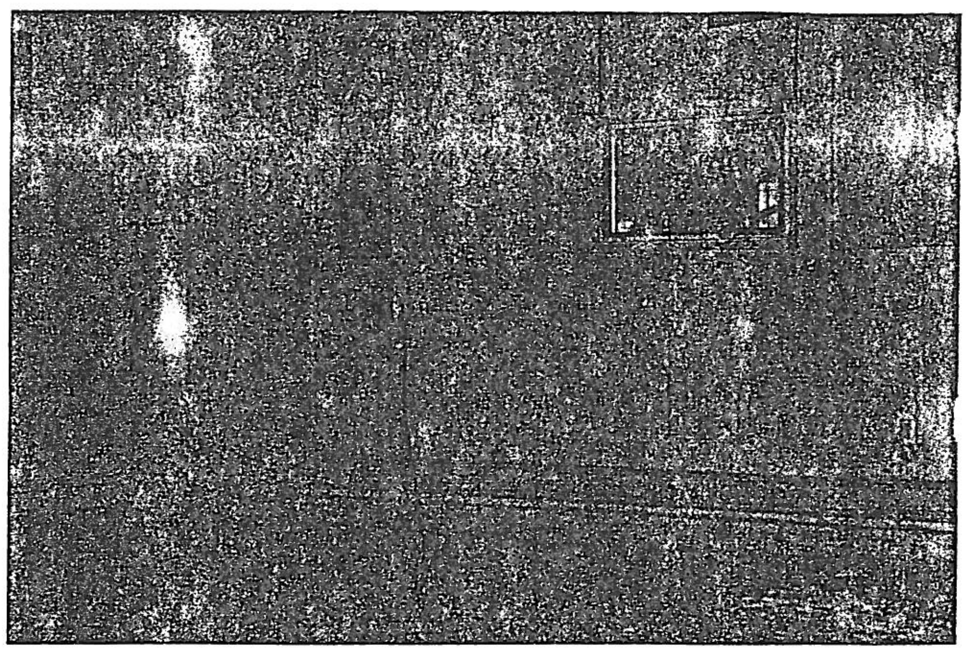


PHOTO #2: LOOKING AT SOUTHEAST END OF GARAGE. NOTE CRACK AND SETTLEMENT OF GARAGE SLAB IN CENTER FOREGROUND, JUST BELOW WINDOW.

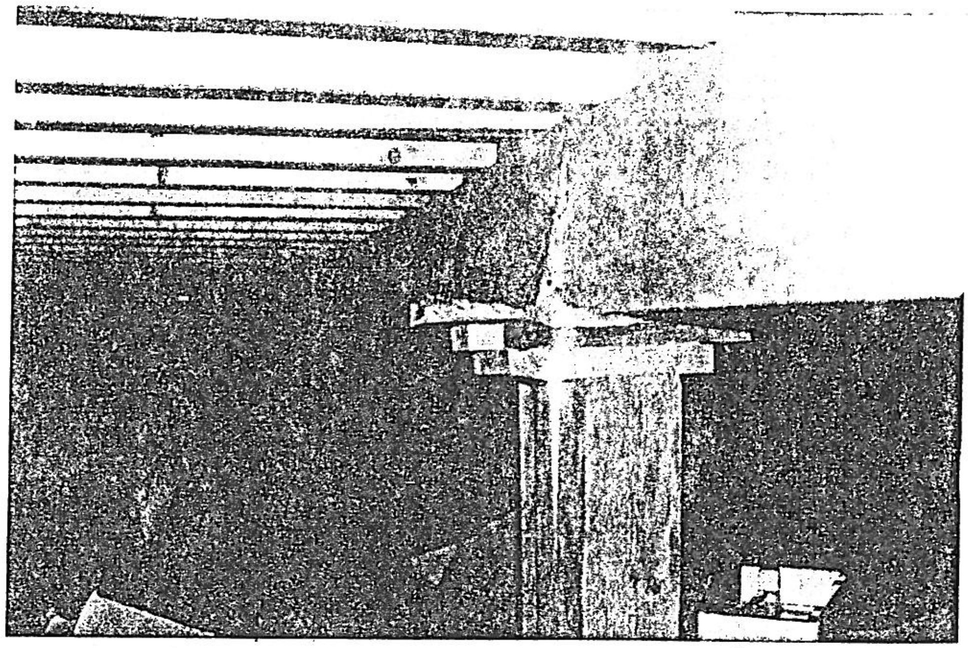


PHOTO #3: MAIN BEAM SUPPORTING FLOOR JOISTS. NOTE TWISTING DUE TO SHIMMING AND LACK OF LATERAL RESTRAINT.

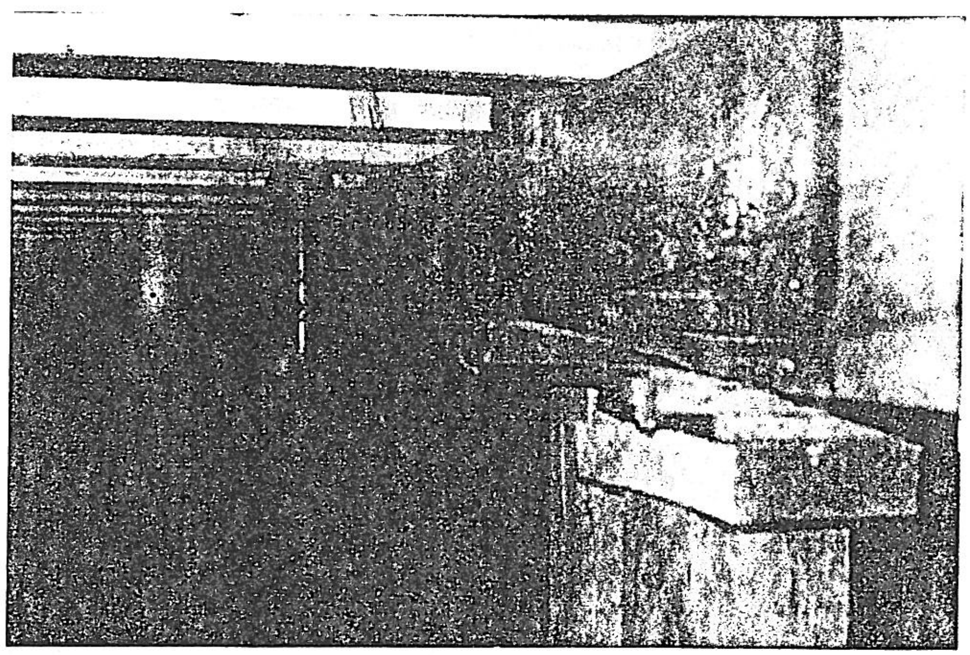


PHOTO #4: CRUSHING AND FAILURE OF MAIN BEAM DUE TO INSUFFICIENT BEARINGS ON SHIMS.

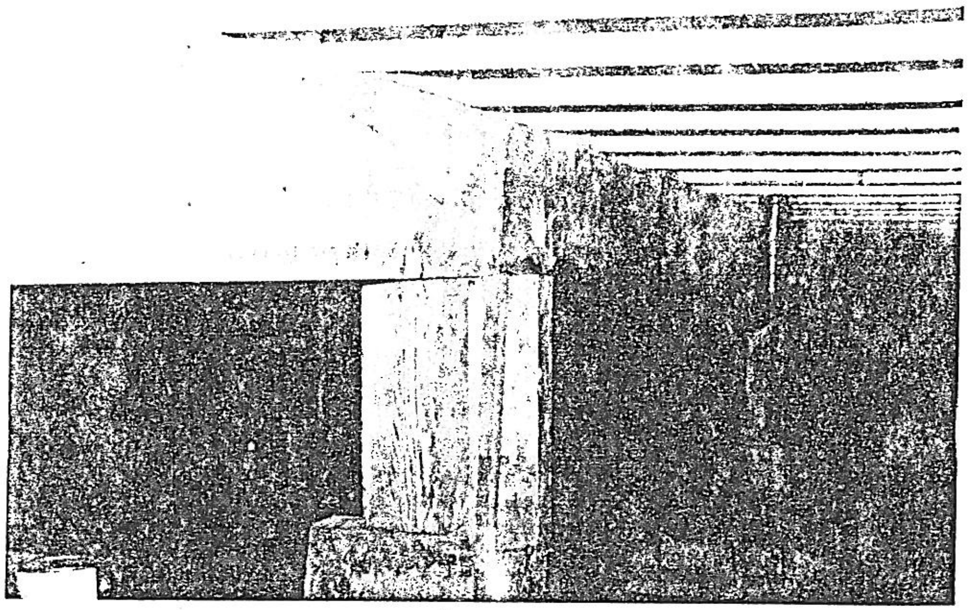


PHOTO #5: VERTICAL MISALIGNMENT OF MAIN BEAM AT BUTT JOINT DUE TO POOR SUPPORT SYSTEM.

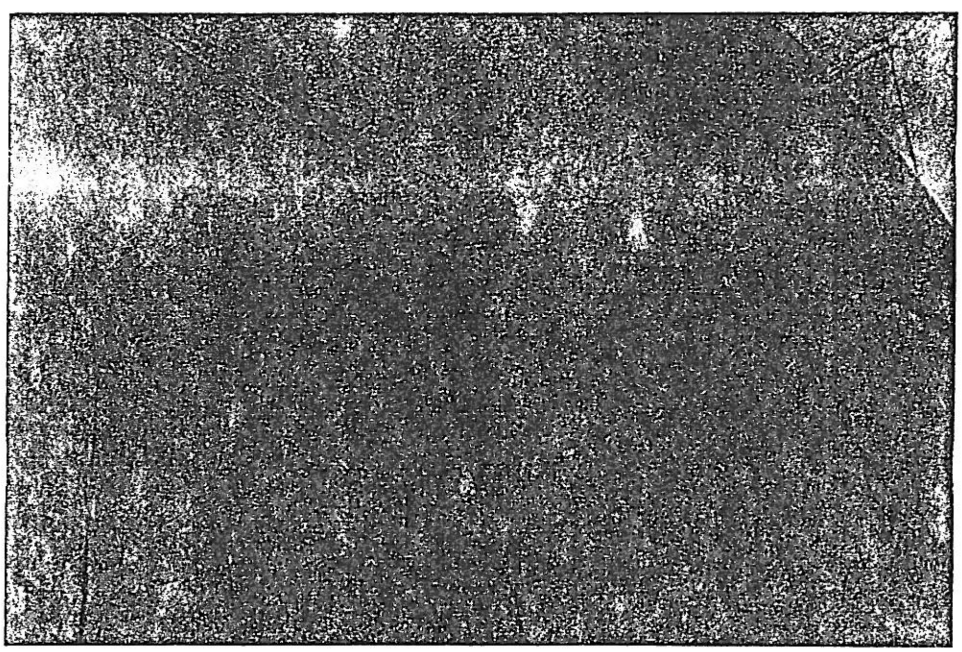


PHOTO #6: MINOR CRACKING OF SHEETROCK IN GARAGE AT WALL-CEILING JOINT, DUE TO WEAK GARAGE CEILING BEAM AND/OR BUILDING SETTLEMENT.

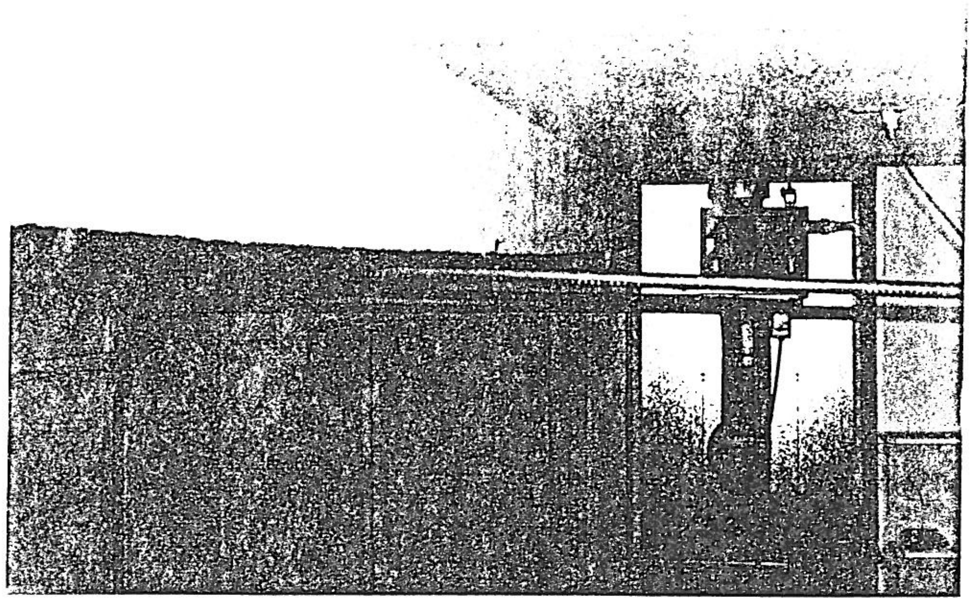
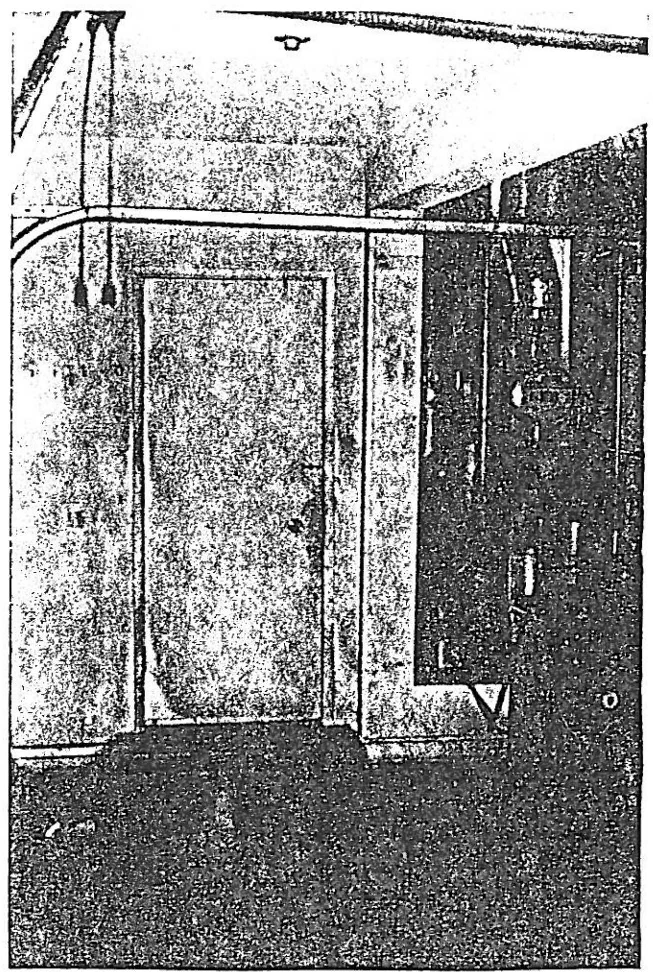


PHOTO #7: SHEETROCK ENCASED WOOD BEAM SUPPORTING FRONT END OF MAIN ROOF TRUSSES IN GARAGE SHOWS EXCESSIVE SAG.

PHOTO #8: NORTHWEST END OF GARAGE CEILING BEAM. NEW COLUMN SHOULD BE LOCATED JUST BEYOND OVERHEAD DOOR TRACK AND NEXT TO BOILER.



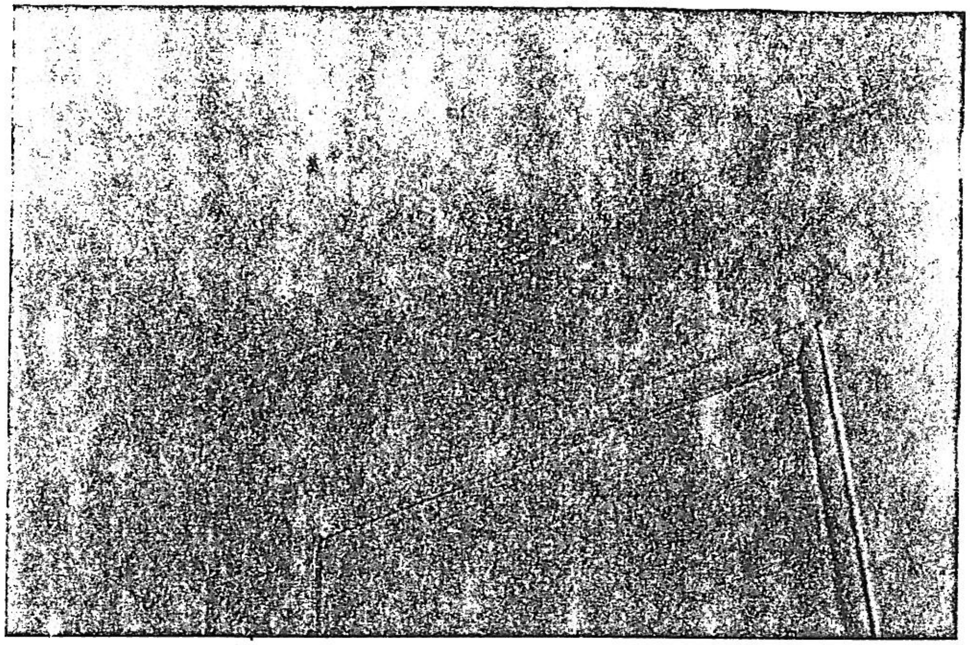


PHOTO #9: WATER STAINING OF LIVING ROOM CEILING OVER MAIN ENTRY DOOR. THIS IS LOCATED AT LOW END OF VALLEY IN HIP ROOF.

PHOTO #10: WATER DAMAGE TO EXTERIOR FINISH ON SOUTHEAST END OF GARAGE, JUST BELOW VALLEY IN HIP ROOF.