PERMAFROST TECHNOLOGY FOUNDATION

FINAL REPORT

FOUNDATION STABILITY RESEARCH ON 19-21 GLACIER AVENUE FAIRBANKS, ALASKA

JUNE 1998

Final Report
on
Foundation Stability
Research Studies
on
19-21 Glacier Street
Fairbanks, Alaska

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Introduction

Severe floor and wall cracking in the garages of this structure was determined to be caused by settlement of very loose underlying soils. It was not clear at the time that Permafrost Technology Foundation acquired the property whether or not the house was underlain by permafrost. Loose soils are often found where permafrost has melted, however other causes for the condition are also frequently encountered. A solution to the settlement problem caused by loose underlying soils would benefit any structure that was experiencing this problem whether or not permafrost was involved. Therefore the house was deeded to the Permafrost Technology Foundation by Alaska Housing Finance Corporation for the purpose of research to develop economic techniques for stabilizing the foundations.

Permafrost underlying the foundation was initially suspected due to cracks found in the wallboard and in the concrete slab floors in the garages. A test hole was drilled by The Drilling Company and samples were taken at 5, 9, 10.5, 15 and 20 foot depths. The exploration revealed loose silt to a depth of 17 feet and loose sand to 24 feet with loose sandy gravel from 24 feet to the bottom of the hole at 39 feet. Seasonally frozen ground was found in the upper 4 feet, but no permafrost was found in the hole. An engineering report by Stutzmann Engineering Assoc. Inc. proposed that the loose soils be stabilized by injecting a gelling grout. They estimated the cost of this procedure at $65,000.

When PTF received the house, two additional borehole explorations were drilled, hole number 1 on the southwest corner 51.5 feet deep and hole number 2 on the northeast corner of the house 45 feet deep. Neither hole encountered any frozen ground, but both showed "heaving sands" at various depths. The driving resistance varied widely from very low at the 20 ft depth in hole 1 to high near the bottom of hole 2 (45 ft depth). Layers of loose sand as indicated by these drilling reports are subject to settlement, especially during dynamic events such as earthquakes, compaction during street repair etc. Based on this information, and the recommendations by Stutzmann Engineering, a search for a professional grouting service was initiated.

While the search for a grouting firm that was both affordable and reliable was ongoing, measurements of foundation stability using floor level surveys, crack width monitoring, and temperature-depth measurements were established and collected on a regular schedule.

During this time, Dr. Kinney attended an international conference on grouting and grout jacking in New Orleans, Louisiana. The conclusions were interesting and appropriate to this study. In general, grouting is an inexact science. There are places where it works well and places where it doesn't. Even under good conditions, success of a project is heavily dependent upon the skill of the operators.

The concept is that grout, usually a sand, cement and water slurry, is forced through holes in the floor. The pressure raises the floor and footings and the grout solidifies keeping the floor and footings in their new position. It is fairly easy to get good grout coverage and to get enough pressure to lift a residential structure. The problem comes in getting the right pressure to lift the light floor slabs and the heavy spread footings at the same time and by the same amount.

Cement grouts have several disadvantages particularly in permafrost environments. First, cement grout has a high coefficient of thermal conductivity and will accentuate the melting problem. Second, grouting does nothing to mitigate the root problem of thawing permafrost and may make any mitigation technique more difficult. Third, if there is future settlement, which should always be considered a possibility when dealing with permafrost, subsequent releveling will be much more difficult.

In view of the above considerations, and since the Permafrost Technology Foundation's purpose is to develop permafrost foundation solutions, it was decided not to try grouting at this site at this time. The technique was too expensive considering our research budget restrictions and alternative options for releveling houses on permafrost terrain. Cement grouts are not appropriate on permafrost terrain, and it is possible that after spending a lot of money on an inappropriate technology, the short-term result may not even be acceptable.

Structure Description

The building at this location is a two story four-plex with two 3-bedroom apartments in the upper story (see figure 1a), and two small 2-bedroom apartments, laundry, storage room and two 2-car garages on the first floor (figure 1b). The two first floor apartments are daylight basement apartments and are located at the rear of the structure, approximately 3 feet below the level of the garages. On the garage level, a central hallway leading from the front door provides access to the two 2-car garages and to all four apartments. Stairs leading up to the two 3-bedroom apartments and stairs leading

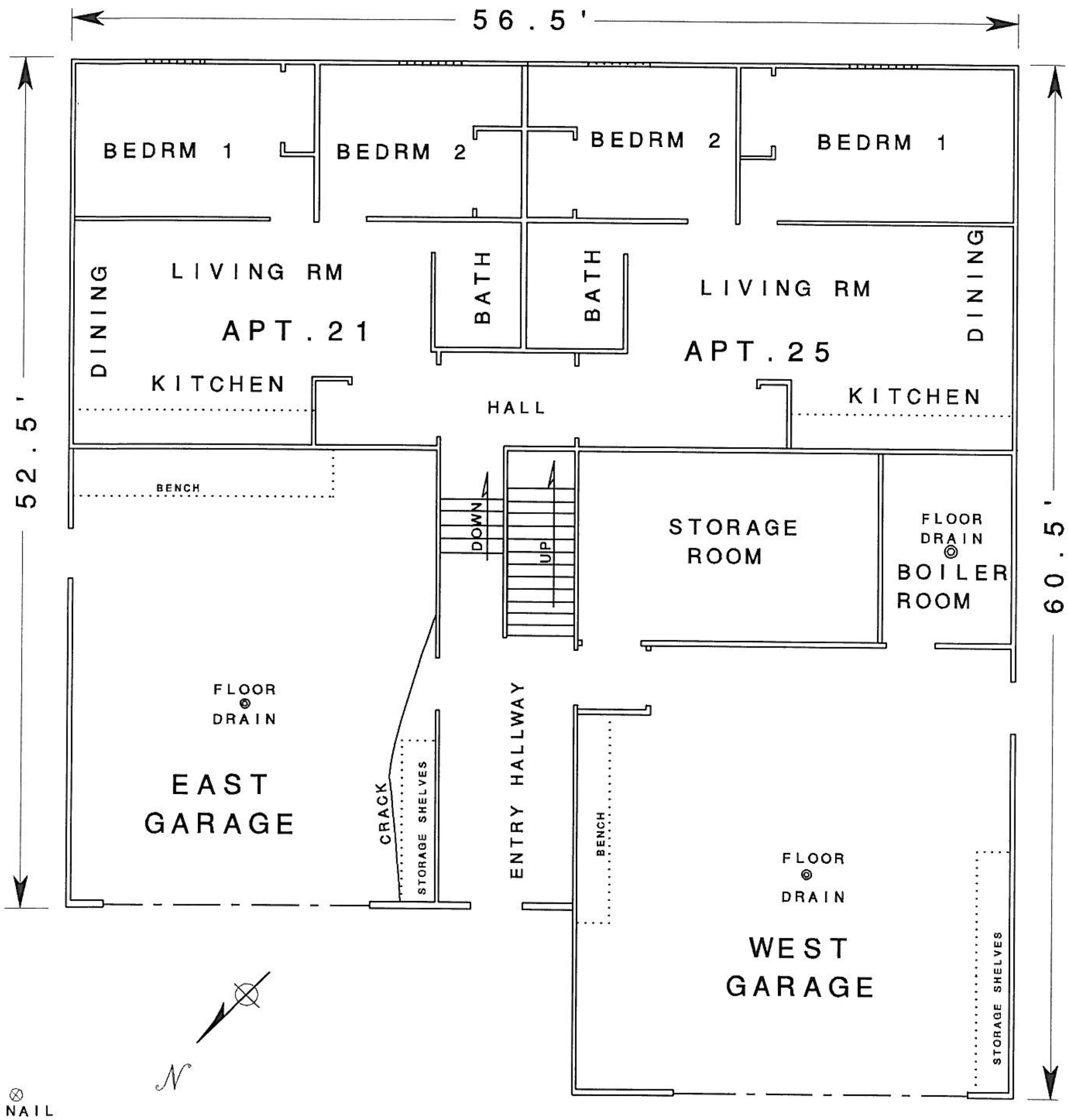

FIGURE 1a Floor plan of the lower levels - garage and basement apartments.

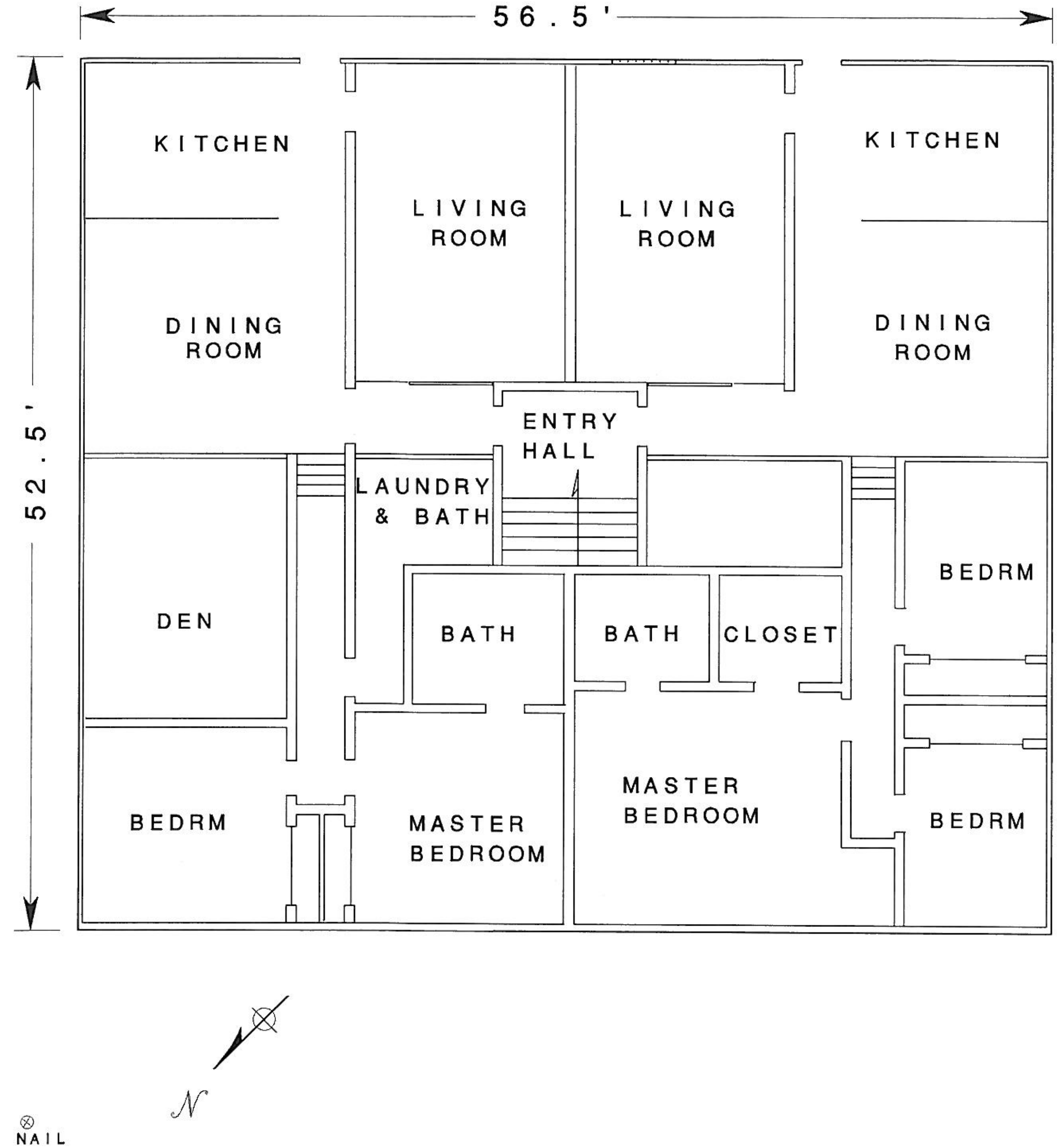

FIGURE 1b Floor plan of the upper levels - three bedroom apartments

down to the daylight basement apartments and a small laundry room are in the hall. A large storage room is also on the garage level. Both 3-bedroom upstairs apartments have their bedrooms above the garages, thus these apartments have two levels with a short stairway leading from the living room level up to the higher bedroom level. The boiler/utility room is located at the rear of the right hand garage. At the rear of the building the upstairs apartments each have a moderate size porch/deck with stairs leading down to the spacious back yard.

Level Measurements

Level measurement were taken to determine the relative elevation of the concrete floor in the garage and the daylight basement apartments. 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 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 both the garage and the lower level apartments were collected several times a year and accumulated for a period of six years. The level-data charts plotted as a function of time are shown in the appendix of this report. On the charts, each measurement location is designated on the floor plan by a letter (figure 2). In each chart a group of letters representing various locations were plotted together 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 easily be seen and tracked with time.

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. No such reliable benchmark or reference was available at this location, so 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.

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 in the general Fairbanks area. 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 it was also 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.

Temperature Measurement

When the permafrost test borings were drilled, thermistor strings, each with 12 thermistors were placed in the holes. Thermistor string 1 (in borehole #1) was positioned to measure temperatures at the surface of the ground and at depths of 10, 15, 20, 25, 30, 33, 36, 38, 40, 41 and 41.5 feet. Thermistor string 2 (in borehole #2) was positioned to measure temperatures at the surface of the ground and at depths of 4, 8, 12, 18, 23, 28, 34, 40, 42, 43 and 44 feet. Temperatures from these strings 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 all relevant purposes except, perhaps, the precise location of the actual freezing front (although this location is not really very important to our studies here). 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 standard 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 accuracy of the temperatures could, therefore, drift due to thermistor error by several one-thousands of a degree celsius and therefore, we cannot rely upon their accuracy to more than about a tenth of a degree. Nevertheless one tenth of a degree is adequate for the purposes of these studies and is better accuracy than would have been obtained using thermocouples.

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 there was no permafrost at this location, the temperature data is not as important as 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, and soil samples were taken at regular intervals of depth, as stated above. 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 to the bottom of each hole. 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 with boreholes on two opposite corners of the structure that are similar in nature, soils beneath the house can be inferred.

The water table was encountered at 12.8 and 12.7 feet respectively in the two holes. The earlier hole drilled by The Drilling Co. in March 1989 found the water table at 17 feet. The difference shows the variation in water table that occurs in the area from its traditional low in March to its high level in spring during breakup or late midsummer when rain and glacial melt sometimes create high water levels.

A small amount of seasonal frost was found at 5.9 ft in the hole on the northeast corner. This is consistent with conditions in this area in early July when this hole was drilled. The Drilling Co. hole which was drilled in March encountered frozen ground from the surface to a depth of 4 feet.

Results and Conclusions

Several potential grouting contractors and experts in the grouting field were interviewed over the duration of the project, but none were found that were confident of success. Grouting was to be an expensive experiment that the experts in the field flatly stated had little likelihood of succeeding in stabilizing the structure. Due to budget constraints and other projects that appeared more promising, the decision was made not to grout the structure until either new technology or expertise was forthcoming that gave a better promise of success.

The data on the levels and the crack width monitoring, however, did provide a good deal of information on the stability of the structure as it now stands. Figure 3 shows the increase of differential settlement in millimeters at each measuring point on the lower level of the structure for the period over which measurements were made. In the six years of record, the differential settlement of the concrete floor in the lower level (i.e. the daylight basement apartments and the garages) increased at nearly every point of measurement. The increase was not great. The maximum increase was 27 mm (1-1/8 in.), which indicates that the building is still moving since all but two points (J and AM) showed a change in the differential. The elevation vs. time plots (see appendix) indicate that this is a uniform gradual increase rather than an abrupt increase as might be brought on by a one-time dynamic event such as an earthquake.

Since the differential increase is generally positive, with respect to point A, it suggests that either point A is settling more rapidly that all other points, or that the other points are actually rising (heaving) with respect to point A. Since the structure has been heated for the entire period, it seems unlikely that frost heaving has taken place beneath the house to progressively raise the structure. Individual points in the structure such as the corners of the garage may have frost develop beneath them, but points well inside the structure are very unlikely to be experiencing frost heaving. It is obvious in Figure 3 that the maximum rise with respect to A occurs along a ridge through the center of the structure from the front entrance to the back wall of the basement apartments. This is not indicative of frost heaving.

This leaves us with the implication that point A has subsided more than the other measurement points. If this is the case, then the settlement has been predominantly along the northwest and north wall of the west garage. With similar settlement along the north and east sides of the east garage. The settlement is small and gradual, amounting to approximately an average of 18 mm (3/4 in.) over a six year period. If this rate continues, some compensation in the foundation will probably have to be made sometime in the next 10 to 12 years. This could be as minor as jacking and filling under the footings along the north one half of the structure to as major as a complete releveling of the entire structure and repairing of the cracked floor slab, footings, and foundation wall.

The question that is left unresolved is whether the present rate will continue. If the problem were one of progressive melting of permafrost beneath the structure, then it would be reasonable to expect continued settlement at an ever decreasing rate as the thaw beneath the structure became deeper. However, permafrost does not seem to be a factor in this case. Settlement appears to be due to gradual recompaction of the loose sands under the foundation probably caused by the weight of the structure. In this case, it is difficult to determine the maximum amount of settlement without further sampling and testing of the soils, but it could be expected that the settlement would stop at some point when the loose sands became compacted enough to support the weight of the structure.

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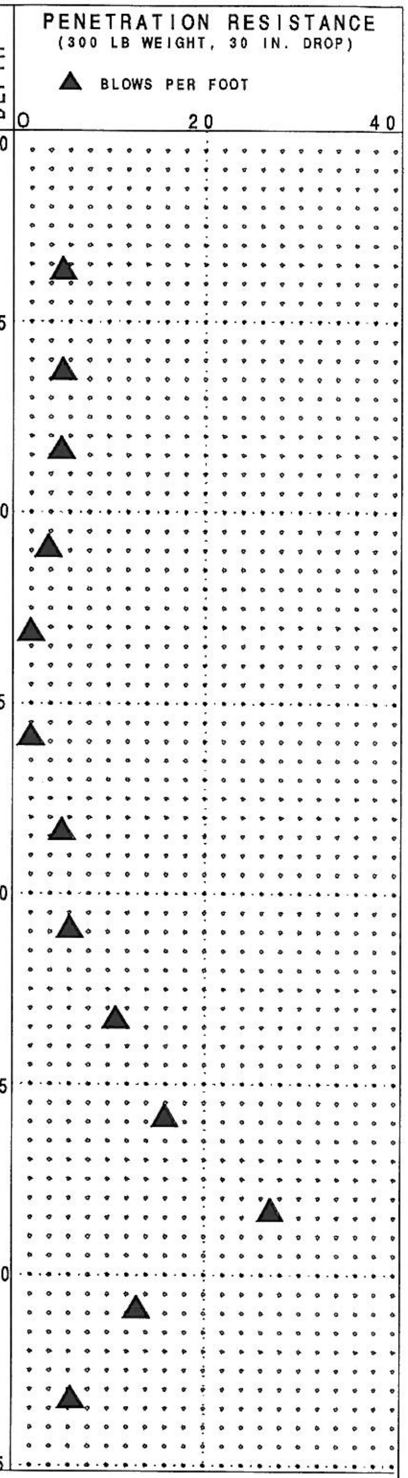
Appendix

Bore Hole Logs

SOIL DESCRIPTION SURFACE ELEVATION:	GRAPHIC LOG	DEPTH	SAMPLE	GROUND WATER	DEPTH
BROWN GRAVELLY SILTY SAND TO SANDY SILT, SOME ORGANICS MOIST GREY SANDY GRAVEL			1		0
BROWN TO GREY SILTY SAND W/BROWN BTOWN SILT INCLUSIONS, ORGANICS			2		5
BROWN W/ REDDISH BROWN AND BLACK NODULES, SANDY SILT, MOIST, SOME ORGANICS (1-2%), TO SILTY SAND			3		
BROWN TO GREY SANDY SILT TO SILT TOSILT TO SILTY SAND.			4		10
GREY SLIGHTLY SANDY SILT W/ TRACE ORGANICS, VERY MOIST TO WET			5	▽	
GREY SLIGHTLY SAND SILT, WET, OVER ONE FT GREY SITLY DAND, WET			6		15
GREY SAND, WET, MEDIUM GRAINED			7		
1 FT GREY MED GR.SAND, WET 0.5 FT GREY SANDY GRAVEL,WET, ALUVIUM			8		20
GREY SANDY GRAVEL, WET (ALUVIUM) GRAVEL COARSE TO FINE, SAND MEDIUM			9		
GREY SANDY GRAVEL BENEATH 0.5 FT OF MEDIUM GREY SAND BELIEVED TO BE HEAVING			10		25
GREY SANDY GRAVEL, WET GRAVEL COARSE TO FINE, SAND FINE TO COARSE (ALLUVIUM)			11		
GREY MEDIUM TO COARSE GRANED SAND, WET (MAY BE HEAVING) 0.5 FT OF GREY SANDY GRAVEL, WET. GRAVEL FINE TO COARSE (ALLUVIUM)			12 13		30 35



LEGEND

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

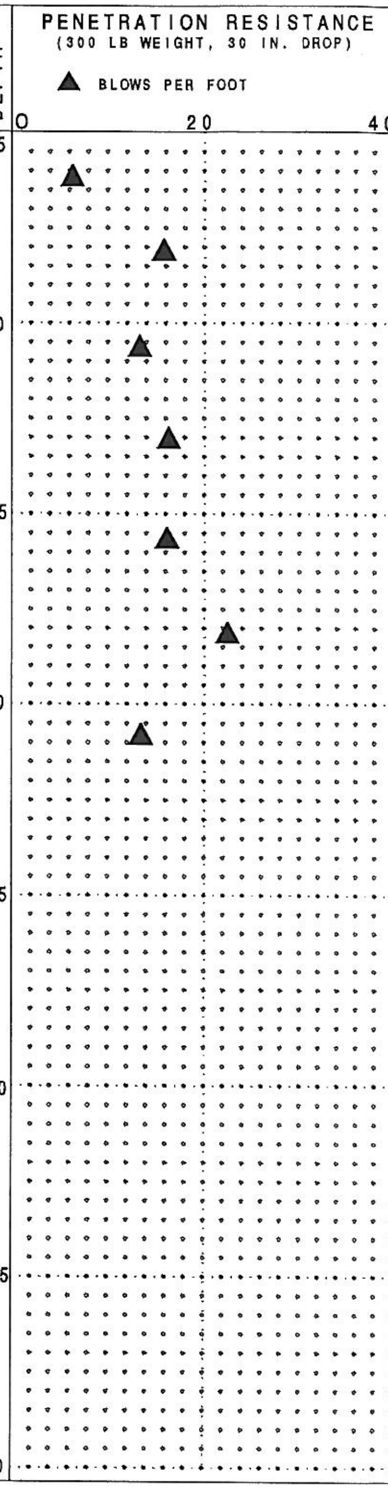
BORING LOG

19-21 GLACIER ST.

BH1 SOUTHWEST CORNER

JULY 1.1992

SOIL DESCRIPTION SURFACE ELEVATION:	GRAPHIC LOG	DEPTH	SAMPLE	GROUND WATER	DEPTH
GREY MEDIUM GRAINED SLIGHTLY SILTY SAND, WET.		35	14		35
GREY SLIGHTLY SILTY SANDY GRAVEL WET, SAND-FINE TO COARSE, GRAVEL FINE TO COARSE.ZP		40	15 16 17		40
		45	18 19		45
BOH		50	20		50
		55			55
		60			60
		65			65
		70			70



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: 19-21 Glacier St.

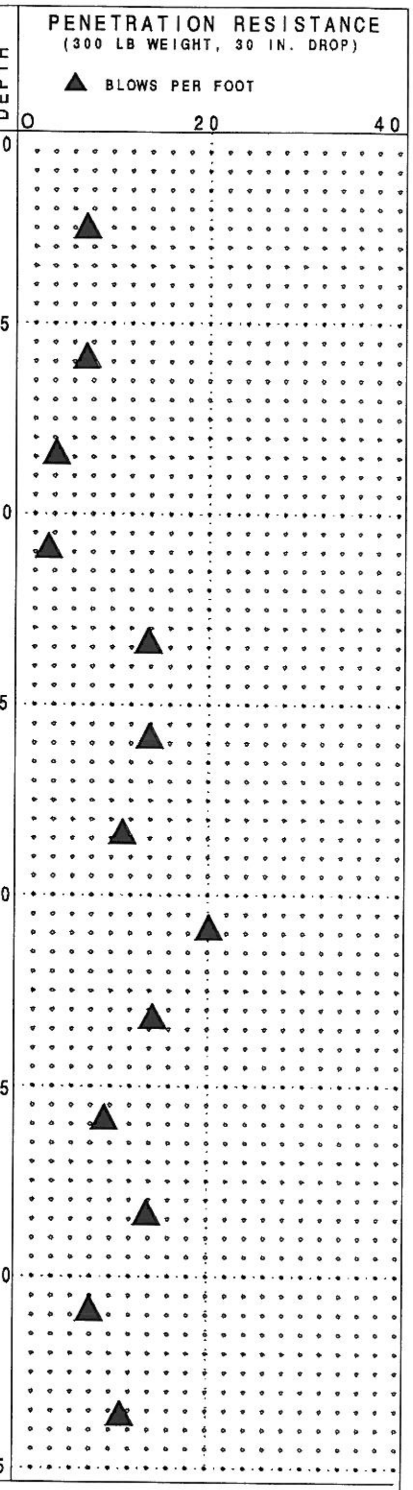
LOCATION: BH1 SOUTHWEST CORNER

PAGE: TWO OF TWO

DATE: JULY 1, 1992

PERMAFROST TECHNOLOGY FOUNDATION

SOIL DESCRIPTION	GRAPHIC LOG	DEPTH	SAMPLE	GROUND WATER
SURFACE ELEVATION:				
LARGE ROCK IN SPOON, NO OTHER SAMPLE. SEASONAL FROST TO 5.9 FT.		0		
GREY SANDY GRAVEL 0.3 FT.		5	I	
WOODY ORGANIC LAYER 0.2 FT.				
BROWN SLIGHTLY SANDY SILT TO SANDY SILT WITH SLIGHT ORGANIC CONTENT. MOIST.			I	
SANDY SILT BELOW 10 FT, MOIST.		10	I	
GREY SANDY GRAVEL, WET. GRAVEL-FINE TO MEDIUM, SAND- FINE TO COARSE.			I	▽
GREY MEDIUM GRAINED SLIGHTLY SILTY SILTY SAND, WET.		15	I	
			I	
		20	I	
BROWN TO GREY SANDY GRAVEL, WET.				
GREY SANDY GRAVEL.			I	
		25	I	
			I	
		30	I	
			I	
		35		



LEGEND

FROZEN GROUND

GRAVEL

SAND

CLAY

PEAT

ORGANIC CONTENT

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

▲ BLOWS PER FOOT

● % WATER CONTENT

BORING LOG

NAME 19-21 GLACIER

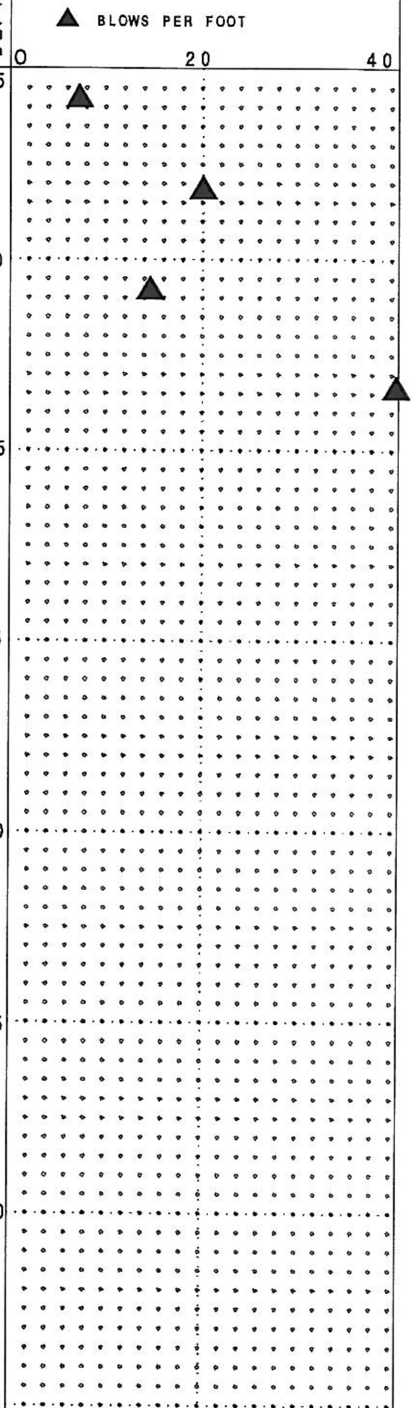
LOCATION BH2 N.E.CORNER

DATE JULY 1, 1992

PERMAFROST TECHNOLOGY FOUNDATION

SOIL DESCRIPTION SURFACE ELEVATION:	GRAPHIC LOG	DEPTH	SAMPLE	GROUND WATER	DEPTH
GREY SANDY GRAVEL, WET. GRAVE-FINE TO MEDIUM, SAND-FINE TO COARSE.		35 – 40			35 – 40
VERY DENSLY PACKED GREY MEDIUM GRAINED SAND. BELEIVED TO BE HEAVE. BOH		45			45
		50			15
		20			20
		25			25
		30			30
		35			35

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



LEGEND

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 19-21 GLACIER

LOCATION BH2 N.E.CORNER(CONTINUED)

DATE JULY 1, 1992

PERMAFROST TECHNOLOGY FOUNDATION

45X@PJL EOJ NAME = "MSJOB 1"

Level Measurements

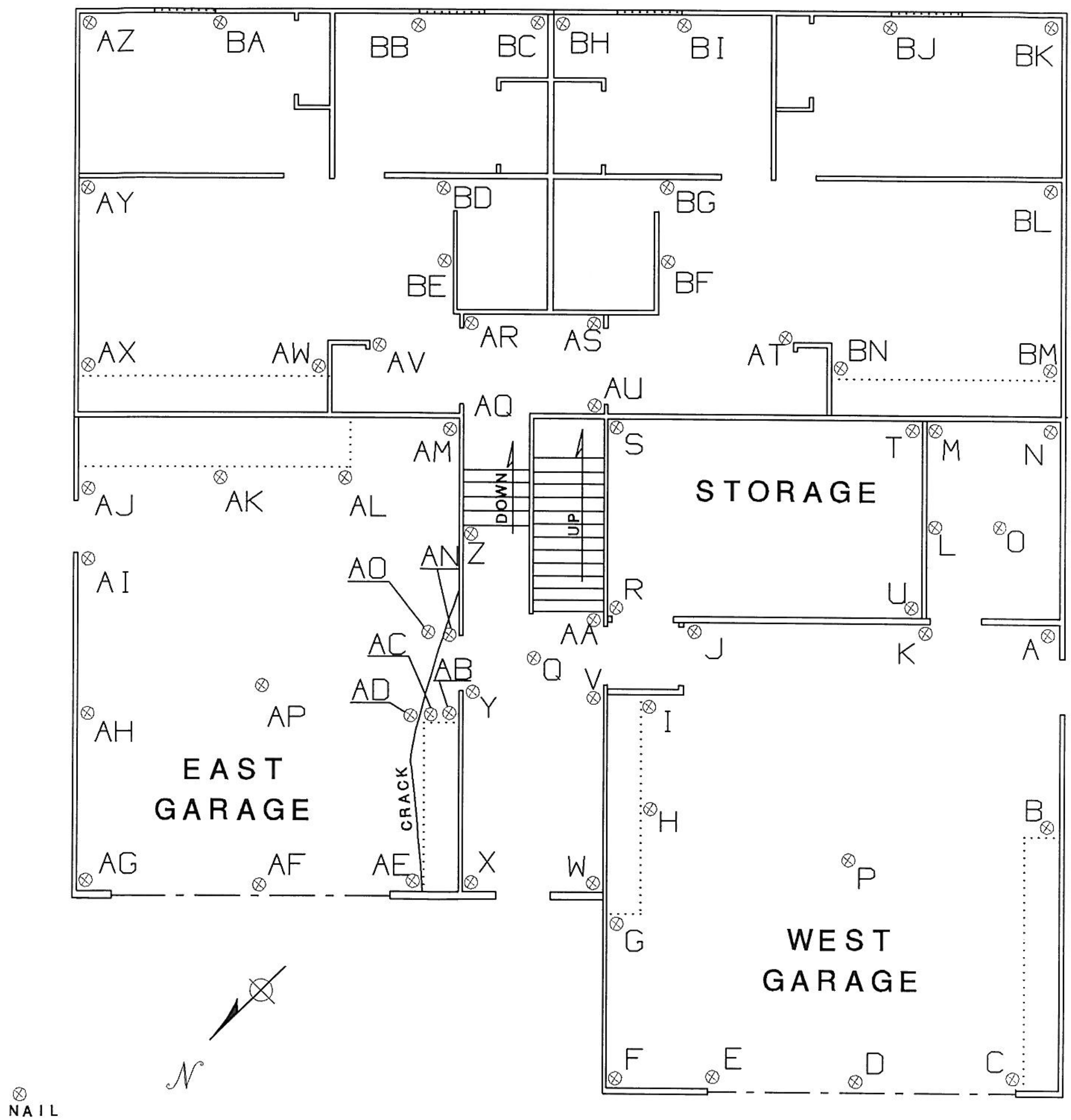


FIGURE 2 level measurement locations on the garage and basement apartment floors.

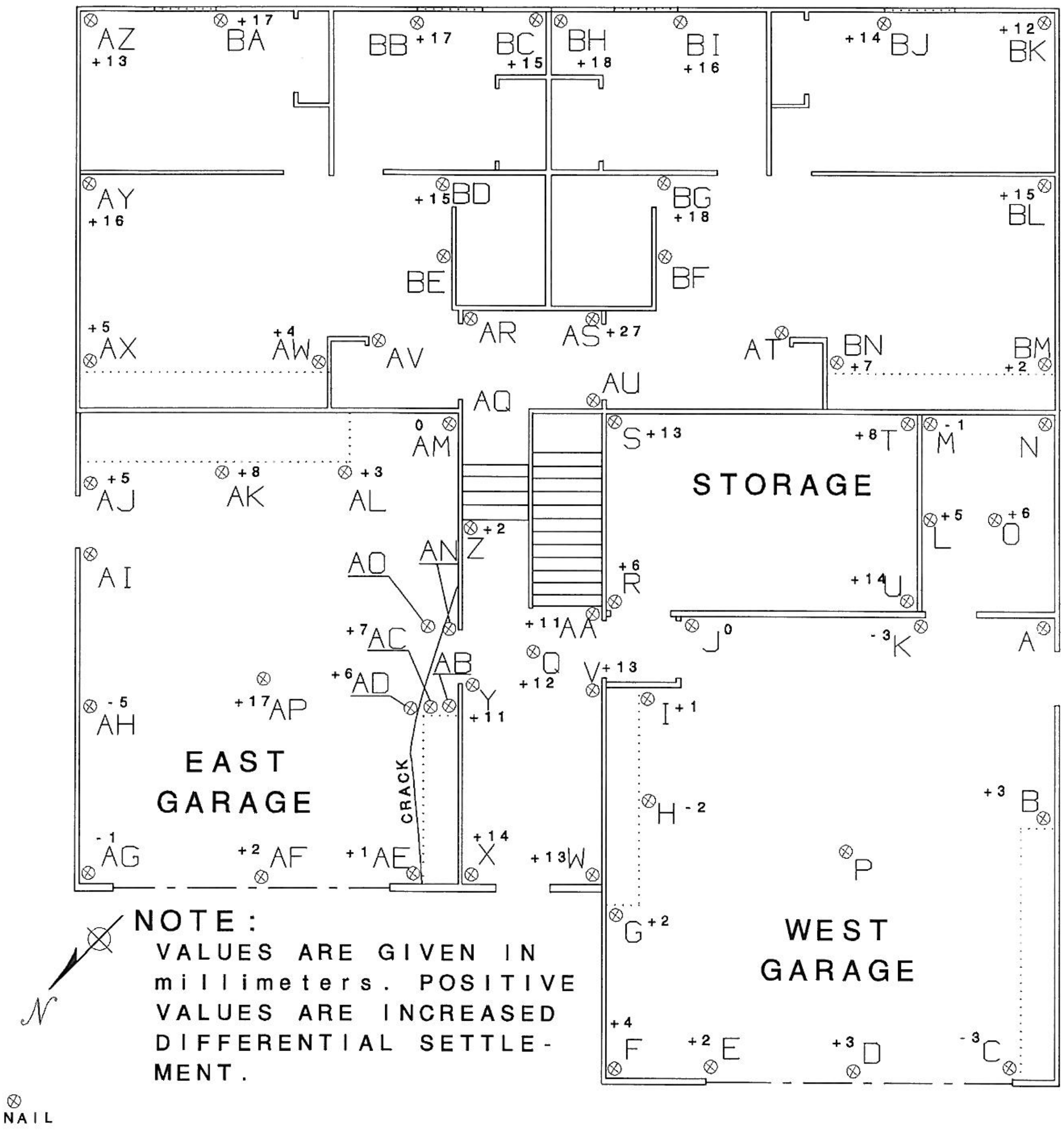


FIGURE 3 Differential settlement changes at each measurement point during the six years of record.

Glacier Level Data
Operator : sara/bo

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	12/12/96	2/4/97	2/4/97	(mm)
A (1)*	0	320	0	0
B (1)	5	327	7	2
C (1)	24	340	20	-4
D (1)	55	374	54	-1
E (1)	81	404	84	3
F (1)	95	418	98	3
G (1)	102	421	101	-1
H (1)	101	420	100	-1
I (1)	110	430	110	0
J (1)	114	434	114	0
K (1)	53	378	58	5
L (1)	43	368	48	5
M (1)	80	402	82	2
N (1)	23	347	27	4
O (1)	5	322	2	-3
P (1)	22	342	22	0
Q (1)	140	460	140	0
Q (2)**	\	365	\	\
R (2)	127	351	126	-1
S (2)	136	358	133	-3
T (2)	91	313	88	-3
U (2)	76	298	73	-3
Q (3)**	\	362	\	\
V (3)	138	361	139	1
W (3)	126	346	124	-2
X (3)	129	349	127	-2
Y (3)	151	375	153	2
Z (3)	139	358	136	-3
AA (3)	138	357	135	-3
Q (4)**	\	437	\	\
AB (4)	134	434	137	3
AC (4)	133	431	134	1
AD (4)	125	423	126	1
AE (4)	103	403	106	3
AF (4)	104	402	105	1
AG (4)	110	409	112	2
AH (4)	124	422	125	1
AI (4)	141	440	143	2

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (4)	143	441	144	1
AK (4)	146	444	147	1
AL (4)	124	424	127	3
AM (4)	126	427	130	4
AN (4)	136	435	138	2
AO (4)	124	425	128	4
AP (4)	79	381	84	5
Q (5)**	\	1244	\	\
AQ (5)	-752	355	-749	3
AR (5)	-745	364	-740	5
AS (5)	-748	361	-743	5
AU (5)	-755	350	-754	1
AQ (6)**	\	346	\	\
AV (6)	-748	354	-741	7
AW (6)	-767	334	-761	6
AX (6)	-755	347	-748	7
AY (6)	-746	356	-739	7
AZ (6)	-738	357	-738	0
BA (6)	-748	353	-742	6
BB (6)	-756	348	-747	9
BC (6)	-755	345	-750	5
BD (6)	-742	357	-738	4
BE (6)	-738	361	-734	4
AU (7)**	\	358	\	\
AT (7)	-761	353	-759	2
BF (7)	-740	370	-742	-2
BG (7)	-745	368	-744	1
BH (7)	-752	362	-750	2
BI (7)	-752	356	-756	-4
BJ (7)	-762	347	-765	-3
BK (7)	-779	326	-786	-7
BL (7)	-798	316	-796	2
BM (7)	-843	269	-843	0
BN (7)	-795	318	-794	1

Elevation of Apartments Separate from Garage with respect to point "AQ"

Points	Difference
AQ	0
AR	9
AS	6
AT	-10
AU	-5
AV	8
AW	-12
AX	1
AY	10
AZ	11
BA	7
BB	2
BC	-1
BD	11
BE	15
BF	7
BG	5
BH	-1
BI	-7
BJ	-16
BK	-37
BL	-47
BM	-94
BN	-45

Q (8)	\	696	\	\
NAIL (8)	159	720	164	5

Q(1) - Q(2)= 95
Q(1) - Q(3)= 98
Q(1) - Q(4)= 23
Q(1) - Q(5)= -784
AQ(5) - AQ(6)= 9
AU(5) - AU(7)= -8
Q(1) - Q(5)+ AQ(5) - AQ(6)= -775
Q(1) - Q(5)+ AU(5) - AU(7)= -792

Glacier Level Data
Operator : fu/michael'

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	10/16/94	5/20/95	5/20/95	(mm)
A (1)*	0	500	0	0
B (1)	11	512	12	1
C (1)	16	519	19	3
D (1)	41	554	54	13
E (1)	73	580	80	7
F (1)	91	n/a	#VALUE!	#VALUE!
G (1)	91	606	106	15
H (1)	95	602	102	7
I (1)	100	610	110	10
J (1)	101	612	112	11
K (1)	51	565	65	14
L (1)	38	547	47	9
M (1)	61	581	81	20
N (1)	11	528	28	17
O (1)	10	511	11	1
P (1)	14	526	26	12
Q (1)	131	627	127	-4
Q (2)**	\	547	\	\
R (2)	121	537	117	-4
S (2)	115	537	117	2
T (2)	73	597	177	104
U (2)	63	574	154	91
Q (3)**	\	552	\	\
V (3)	129	550	125	-4
W (3)	119	535	110	-9
X (3)	118	537	112	-6
Y (3)	139	563	138	-1
Z (3)	124	549	124	0
AA (3)	127	548	123	-4
Q (4)**	\	606	\	\
AB (4)	127	598	119	-8
AC (4)	125	599	120	-5
AD (4)	124	589	110	-14
AE (4)	98	572	93	-5
AF (4)	93	571	92	-1
AG (4)	98	580	101	3
AH (4)	121	594	115	-6
AI (4)	128	609	130	2

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (4)	136	612	133	-3
AK (4)	134	613	134	0
AL (4)	128	598	119	-9
AM (4)	113	598	119	6
AN (4)	128	603	124	-4
AO (4)	123	594	115	-8
AP (4)	81	551	72	-9
Q (5)**	\	1423	\	\
AQ (5)	237	532	-764	-1001
AR (5)	241	540	-756	-997
AS (5)	240	589	-707	-947
AU (5)	231	525	-771	-1002
AQ (6)**	\	535	\	\
AV (6)	242	541	-758	-1000
AW (6)	222	519	-780	-1002
AX (6)	235	533	-766	-1001
AY (6)	240	543	-756	-996
AZ (6)	235	544	-755	-990
BA (6)	237	538	-761	-998
BB (6)	234	534	-765	-999
BC (6)	235	532	-767	-1002
BD (6)	247	547	-752	-999
BE (6)	247	546	-753	-1000
AU (7)**	\	524	\	\
AT (7)	231	519	-776	-1007
BF (7)	231	534	-761	-992
BG (7)	231	530	-765	-996
BH (7)	231	527	-768	-999
BI (7)	231	523	-772	-1003
BJ (7)	231	515	-780	-1011
BK (7)	231	495	-800	-1031
BL (7)	231	482	-813	-1044
BM (7)	231	436	-859	-1090
BN (7)	231	485	-810	-1041

Elevation of Apartments Separate from Garage with respect to point "AQ"

Points	Difference
AQ	0
AR	8
AS	57
AT	-12
AU	-7
AV	6
AW	-16
AX	-2
AY	8
AZ	9
BA	3
BB	-1
BC	-3
BD	12
BE	11
BF	3
BG	-1
BH	-4
BI	-8
BJ	-16
BK	-36
BL	-49
BM	-95
BN	-46

Q (8)	\		\	\
NAIL (8)	140		127	-13

Q(1) - Q(2)= 80
Q(1) - Q(3)= 75
Q(1) - Q(4)= 21
Q(1) - Q(5)= -796
AQ(5) - AQ(6)= -3
AU(5) - AU(7)= 1
Q(1) - Q(5)+ AQ(5) - AQ(6)= -799
Q(1) - Q(5)+ AU(5) - AU(7)= -795

Glacier Level Data
Operator : Zhang/Ma

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date	2/20/93	3/27/93	3/27/93	(mm)
A (1)*	0	325	0	0
B (1)	3	336	11	8
C (1)	22	347	22	0
D (1)	54	378	53	-1
E (1)	78	406	81	3
F (1)	88	423	98	10
G (1)	96	419	94	-2
H (1)	98	426	101	3
I (1)	106	435	110	4
J (1)	111	437	112	1
K (1)	54	380	55	1
L (1)	60	386	61	1
M (1)	77	405	80	3
N (1)	15	342	17	2
O (1)	-5	327	2	7
P (1)	21	350	25	4
Q (1)	137	463	138	1
Q (2)**	\	411	\	\
R (2)	123	396	123	0
S (2)	129	404	131	2
T (2)	84	356	83	-1
U (2)	61	334	61	0
Q (3)**	\	401	\	\
V (3)	135	400	137	2
W (3)	118	383	120	2
X (3)	122	387	124	2
Y (3)	144	409	146	2
Z (3)	133	399	136	3
AA (3)	133	399	136	3
Q (4)**	\	471	\	\
AB (4)	126	460	127	1
AC (4)	126	460	127	1
AD (4)	119	453	120	1
AE (4)	103	437	104	1
AF (4)	#N/A	437	104	#N/A
AG (4)	#N/A	443	110	#N/A
AH (4)	#N/A	457	124	#N/A
AI (4)	134	464	131	-3

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (4)	137	472	139	2
AK (4)	138	473	140	2
AL (4)	119	453	120	1
AM (4)	129	463	130	1
AN (4)	130	463	130	0
AO (4)	124	457	124	0
AP (4)	#N/A	410	77	#N/A
Q (5)**	\	1252	\	\
AQ (5)	-755	360	-754	1
AR (5)	-749	367	-747	2
AS (5)	-751	366	-748	3
AU (5)	-761	356	-758	3
AQ (6)**	\	372	\	\
AV (6)	-750	378	-748	2
AW (6)	-770	357	-769	1
AX (6)	-758	369	-757	1
AY (6)	-749	379	-747	2
AZ (6)	-748	381	-745	3
BA (6)	-751	376	-750	1
BB (6)	-756	370	-756	0
BC (6)	-756	376	-750	6
BD (6)	-745	380	-746	-1
BE (6)	-744	383	-743	1
AU (7)**	\	380	\	\
AT (7)	-770	373	-765	5
BF (7)	-753	388	-750	3
BG (7)	-754	387	-751	3
BH (7)	-763	382	-756	7
BI (7)	-745	375	-763	-18
BJ (7)	-773	364	-774	-1
BK (7)	-785	356	-782	3
BL (7)	-806	335	-803	3
BM (7)	-850	289	-849	1
BN (7)	-800	340	-798	2

Elevation of Apartments Separate from Garage with respect to point "AQ"

Points	Difference
AQ	0
AR	7
AS	6
AT	-11
AU	-4
AV	6
AW	-15
AX	-3
AY	7
AZ	9
BA	4
BB	-2
BC	4
BD	8
BE	11
BF	4
BG	3
BH	-2
BI	-9
BJ	-20
BK	-28
BL	-49
BM	-95
BN	-44

Q (8)	\	1208	\	\
NAIL (8)	167	1240	170	3

Q(1) - Q(2)= 52
Q(1) - Q(3)= 62
Q(1) - Q(4)= -8
Q(1) - Q(5)= -789
AQ(5) - AQ(6)= -12
AU(5) - AU(7)= -24
Q(1) - Q(5)+ AQ(5) - AQ(6)= -801
Q(1) - Q(5)+ AU(5) - AU(7)= -813

Glacier Level Data
Operator : TM, TK

	Previous Elevation	New Reading	New Elevation	Elevation Difference
Date			12/19/90	
A (1)*			0	0
B (1)			2	2
C (1)			21	21
D (1)			51	51
E (1)			77	77
F (1)			91	91
G (1)			99	99
H (1)			98	98
I (1)			106	106
J (1)			108	108
K (1)			55	55
L (1)			47	47
M (1)			76	76
N (1)			17	17
O (1)			-8	-8
P (1)			14	14
Q (1)			122	122
Q (2)**	\			\
R (2)			114	114
S (2)			114	114
T (2)			74	74
U (2)			53	53
Q (3)**	\		\	\
V (3)			120	120
W (3)			105	105
X (3)			107	107
Y (3)			128	128
Z (3)			128	128
AA (3)			118	118
Q (4)**	\		\	\
AB (4)			123	123
AC (4)			123	123
AD (4)			117	117
AE (4)			102	102
AF (4)			101	101
AG (4)			102	102
AH (4)			124	124
AI (4)			N/A	N/A

	Previous Elevation	New Reading	New Elevation	Elevation Difference
AJ (4)			133	133
AK (4)			134	134
AL (4)			118	118
AM (4)			127	127
AN (4)			129	129
AO (4)			120	120
AP (4)			66	66
Q (5)**	\		\	\
AQ (5)			-774	-774
AR (5)			N/A	N/A
AS (5)			-776	-776
AU (5)			N/A	N/A
AQ (6)**	\		\	\
AV (6)			N/A	N/A
AW (6)			-771	-771
AX (6)			-759	-759
AY (6)			-761	-761
AZ (6)			-757	-757
BA (6)			-765	-765
BB (6)			-770	-770
BC (6)			-771	-771
BD (6)			-759	-759
BE (6)			N/A	N/A
AU (7)**	\		\	\
AT (7)			-782	-782
BF (7)			-768	-768
BG (7)			-768	-768
BH (7)			-774	-774
BI (7)			-774	-774
BJ (7)			-790	-790
BK (7)			-805	-805
BL (7)			-818	-818
BM (7)			-849	-849
BN (7)			-807	-807

Elevation of Apartments Separate from Garage with respect to point "AQ"

Points	Difference
AQ	0
AR	N/A
AS	-2
AT	-8
AU	N/A
AV	N/A
AW	3
AX	15
AY	13
AZ	17
BA	9
BB	4
BC	3
BD	15
BE	N/A
BF	6
BG	6
BH	0
BI	0
BJ	-16
BK	-31
BL	-44
BM	-75
BN	-33

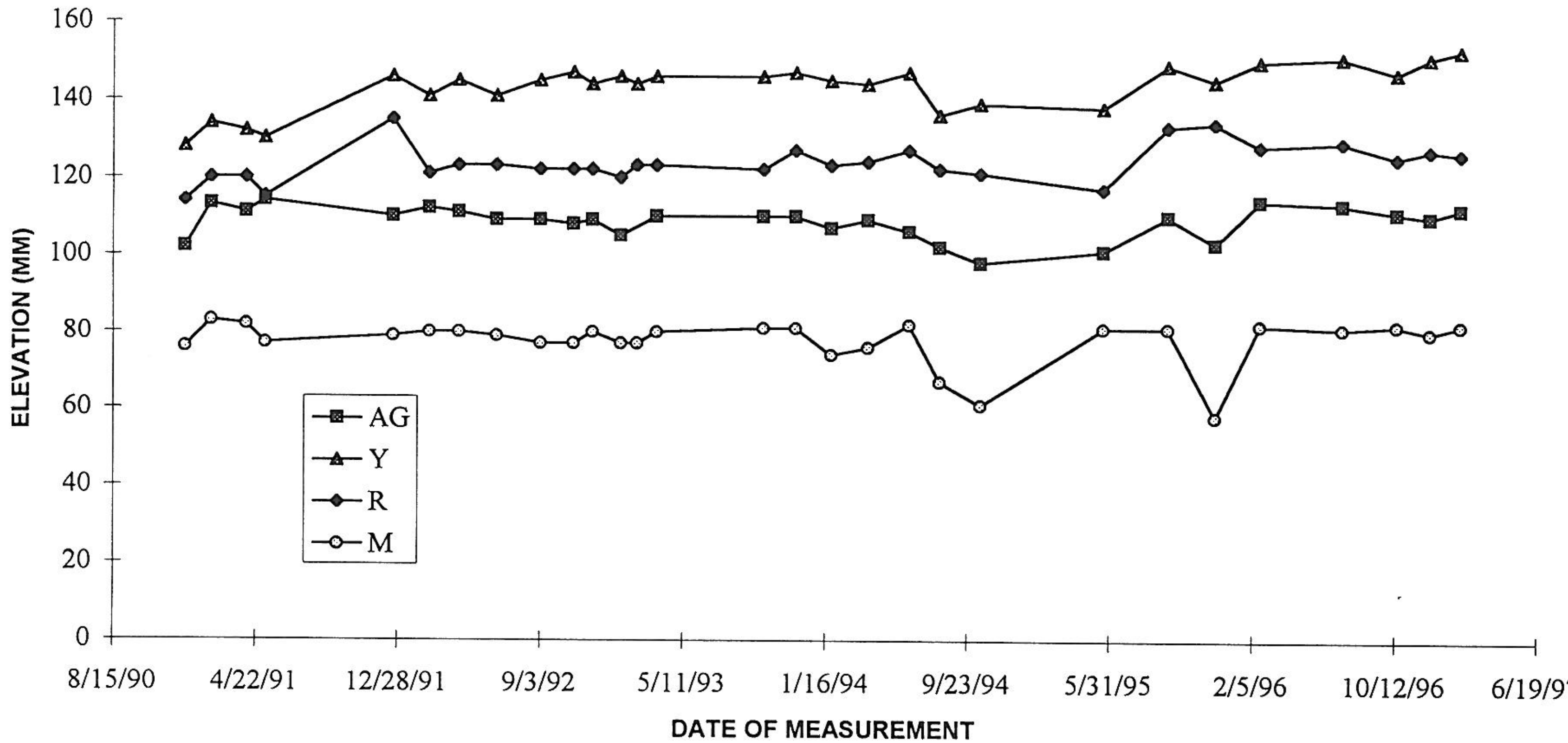
	Q(1) - Q(2)= 0
	Q(1) - Q(3)= 0
	Q(1) - Q(4)= 0
	Q(1) - Q(5)= 0
	AQ(5) - AQ(6)= 0
	AU(5) - AU(7)= 0
Q(1) - Q(5)+	AQ(5) - AQ(6)= 0
Q(1) - Q(5)+	AU(5) - AU(7)= 0

* 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.

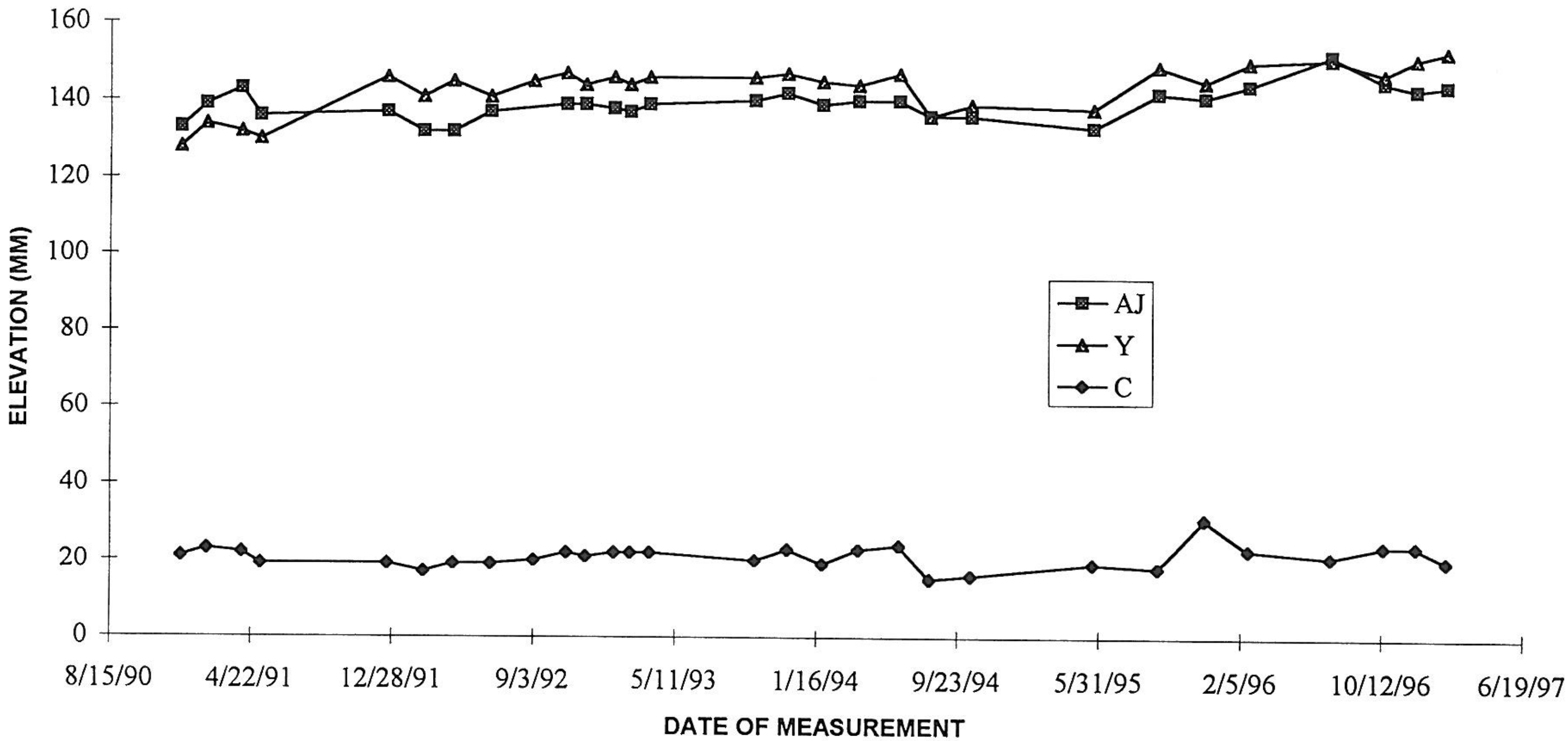
** Points "Q", "AQ" & "AT" are the common points used to correlate data from all points to point "A (1)".

*** When taking the elevation reading of point "Q" from location 5, the scale on the rod may be repositioned as needed.

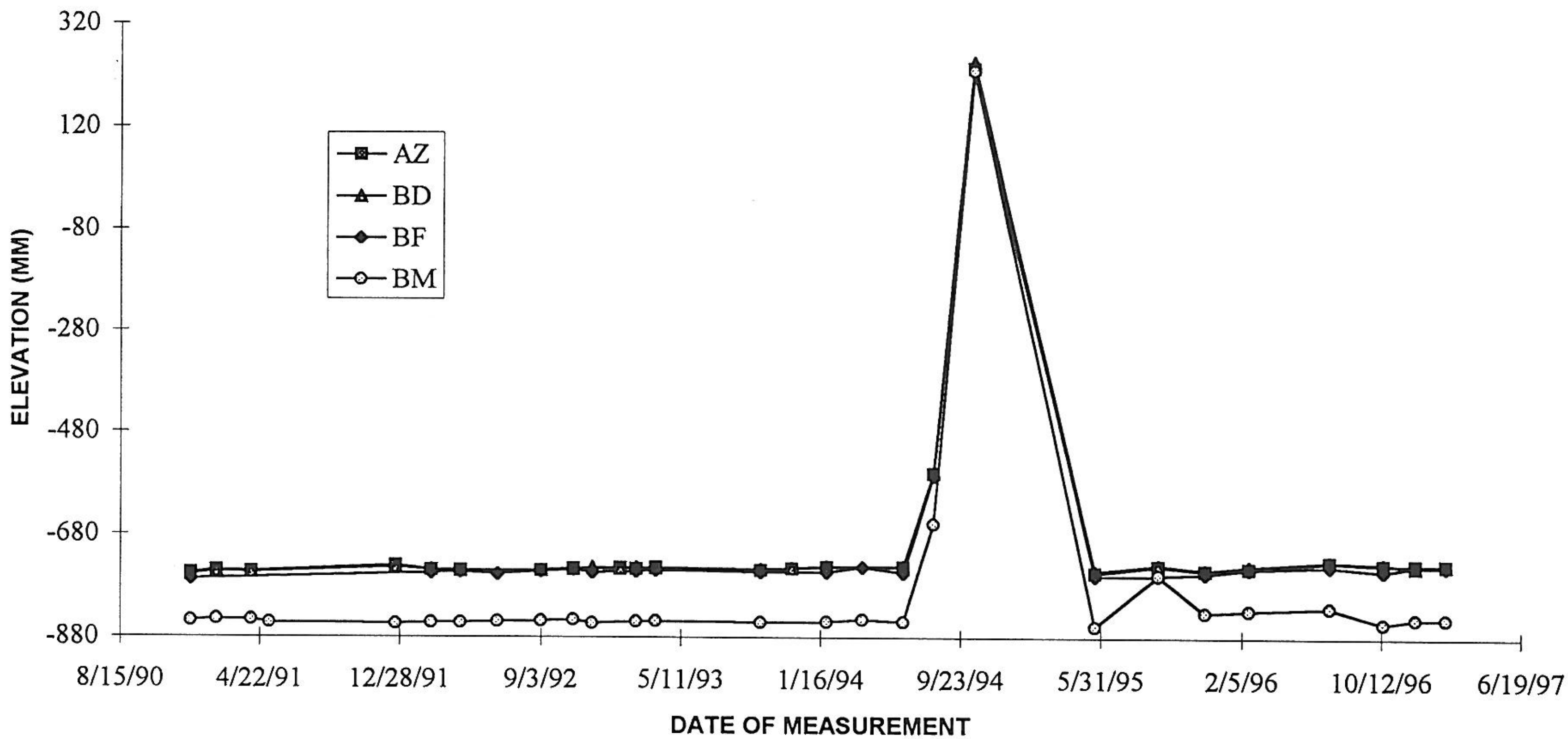
GLACIER CHART 1



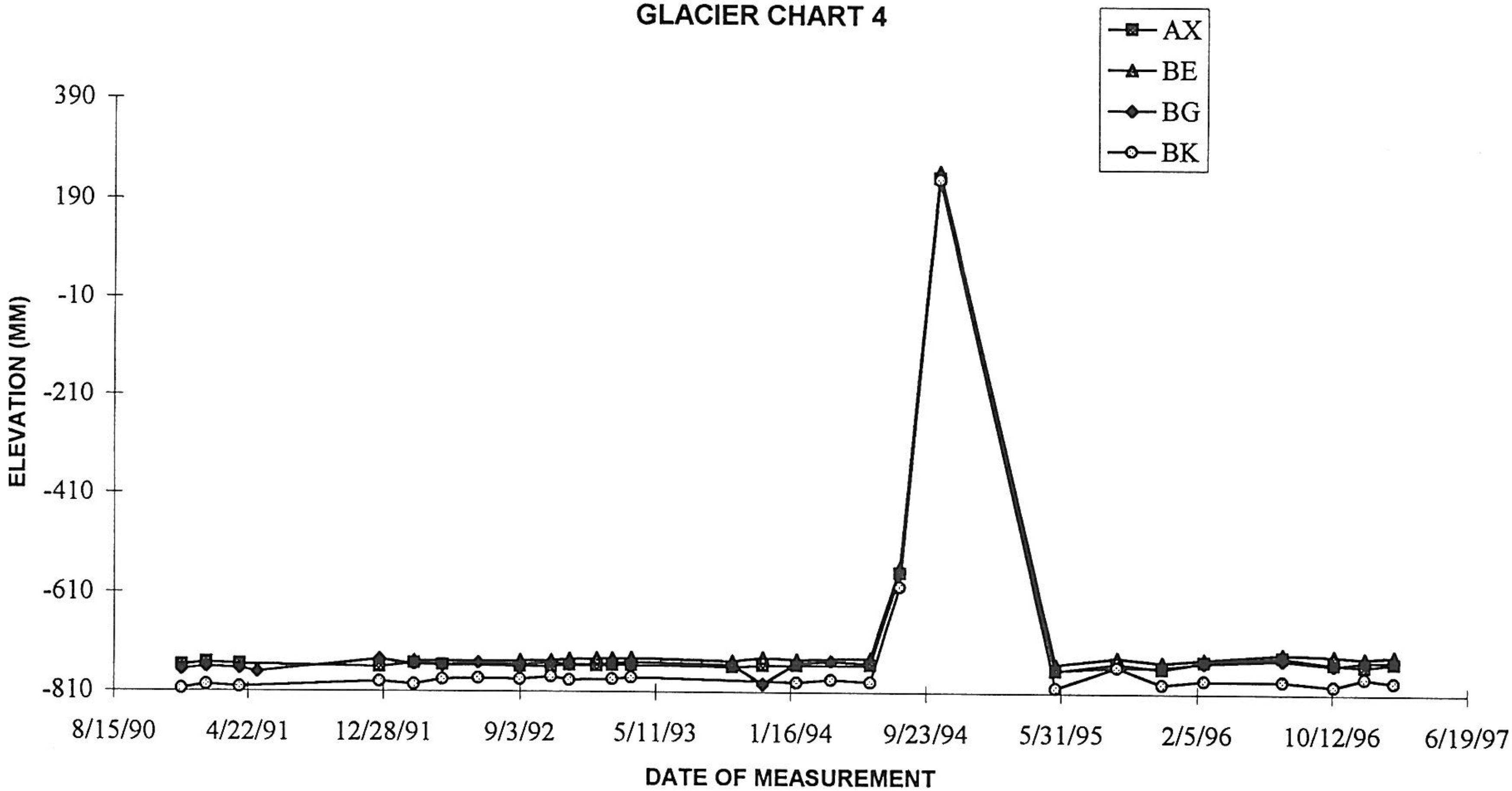
GLACIER CHART 2

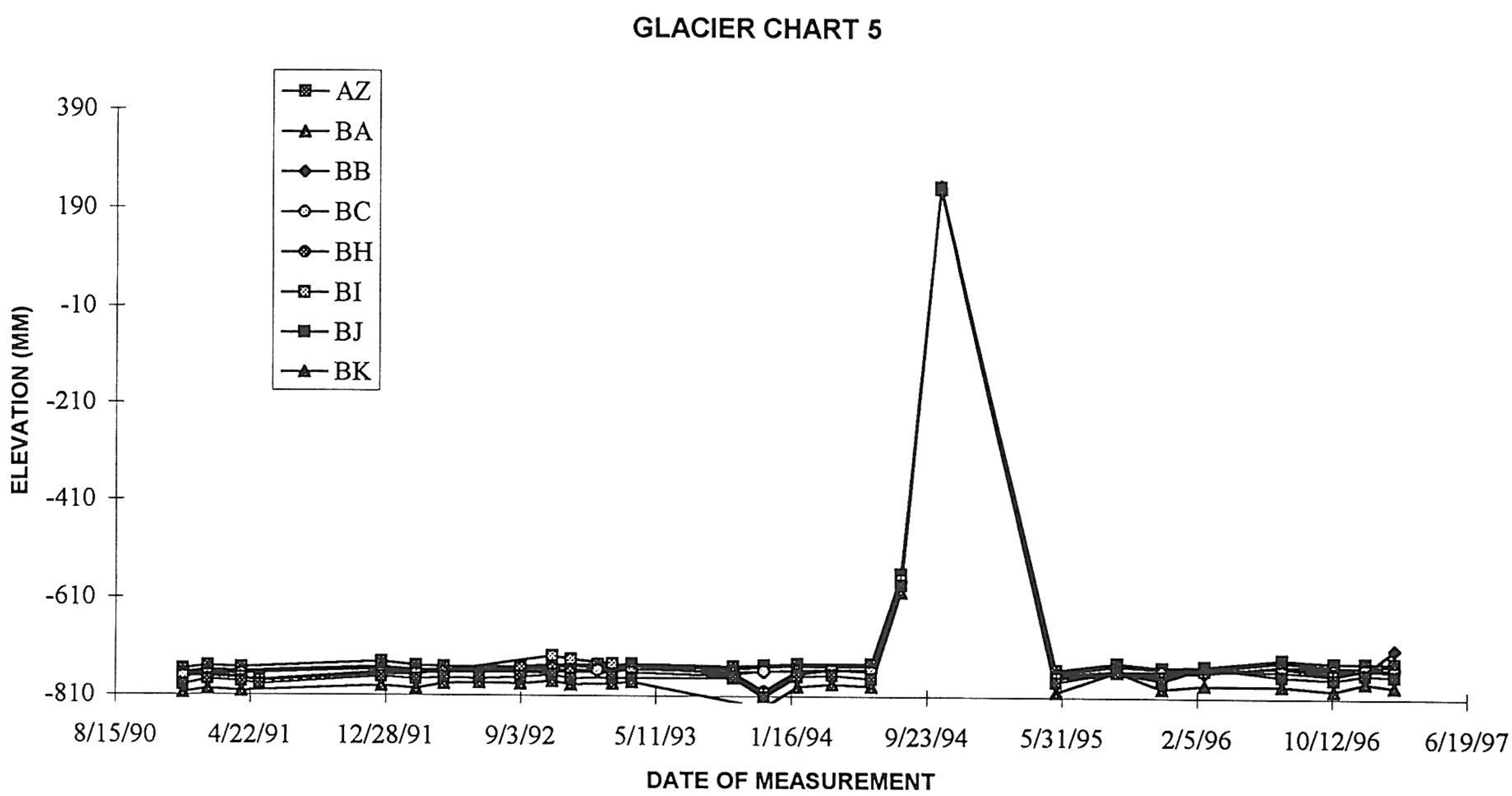


GLACIER CHART 3

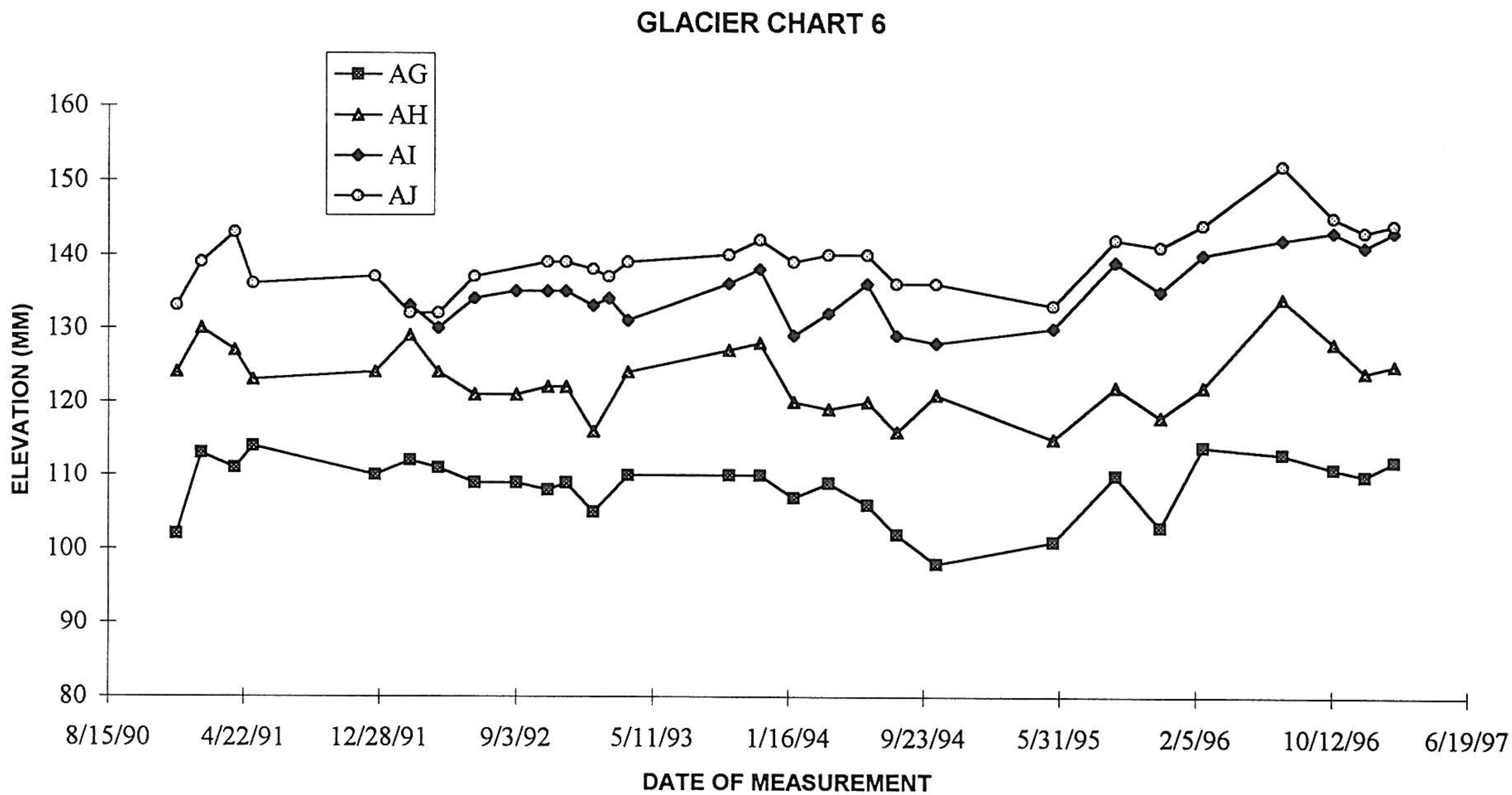


GLACIER CHART 4



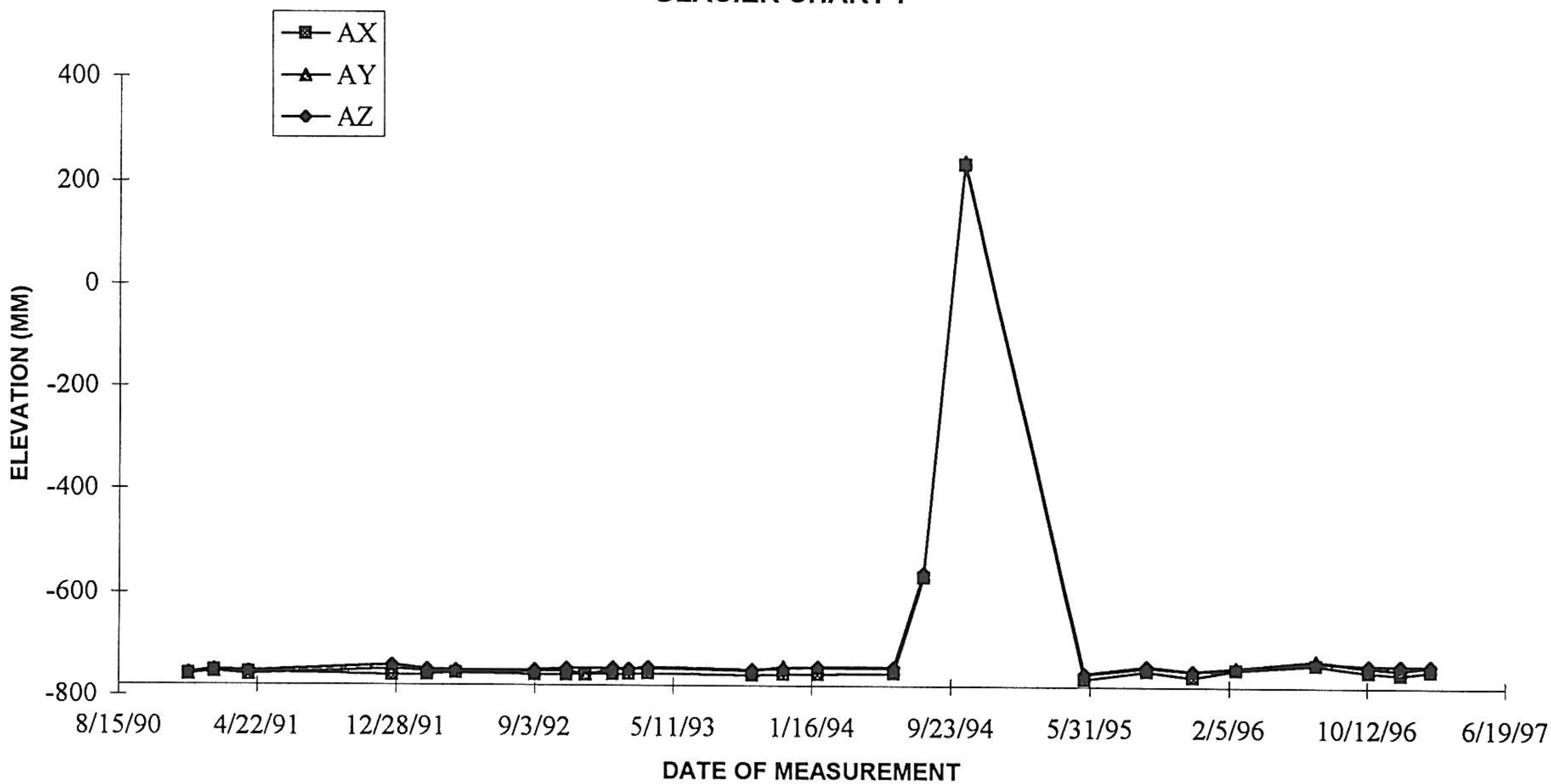


GLACIER CHART 5
AZ
BA
BB
BC
BH
BI
BJ
BK
390
190
-10
-210
-410
-610
-810
ELEVATION (MM)
8/15/90
4/22/91
12/28/91
9/3/92
5/11/93
1/16/94
9/23/94
5/31/95
2/5/96
10/12/96
6/19/97
DATE OF MEASUREMENT

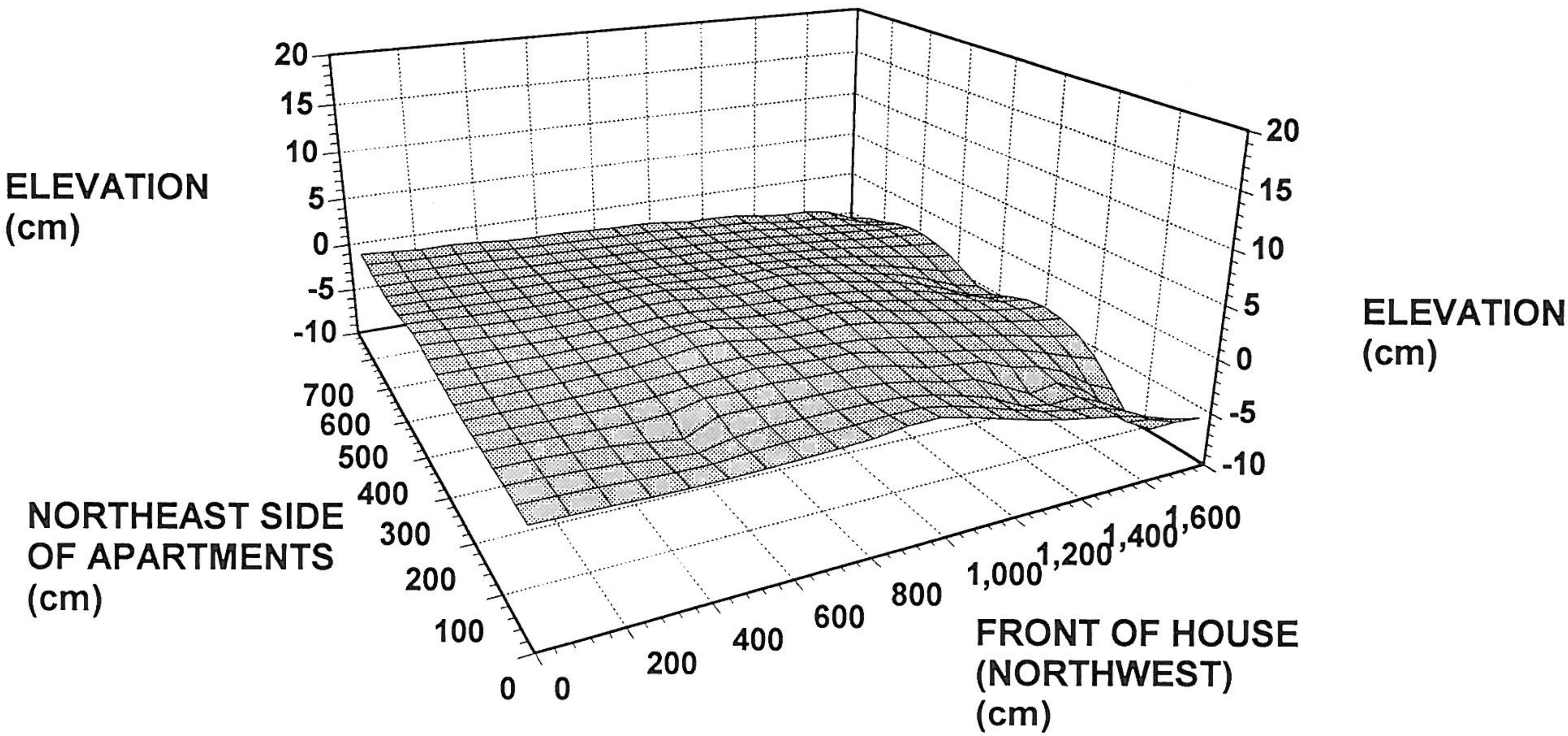


GLACIER CHART 6
AG
AH
AI
AJ
160
150
140
130
120
110
100
90
80
ELEVATION (MM)
8/15/90
4/22/91
12/28/91
9/3/92
5/11/93
1/16/94
9/23/94
5/31/95
2/5/96
10/12/96
6/19/97
DATE OF MEASUREMENT

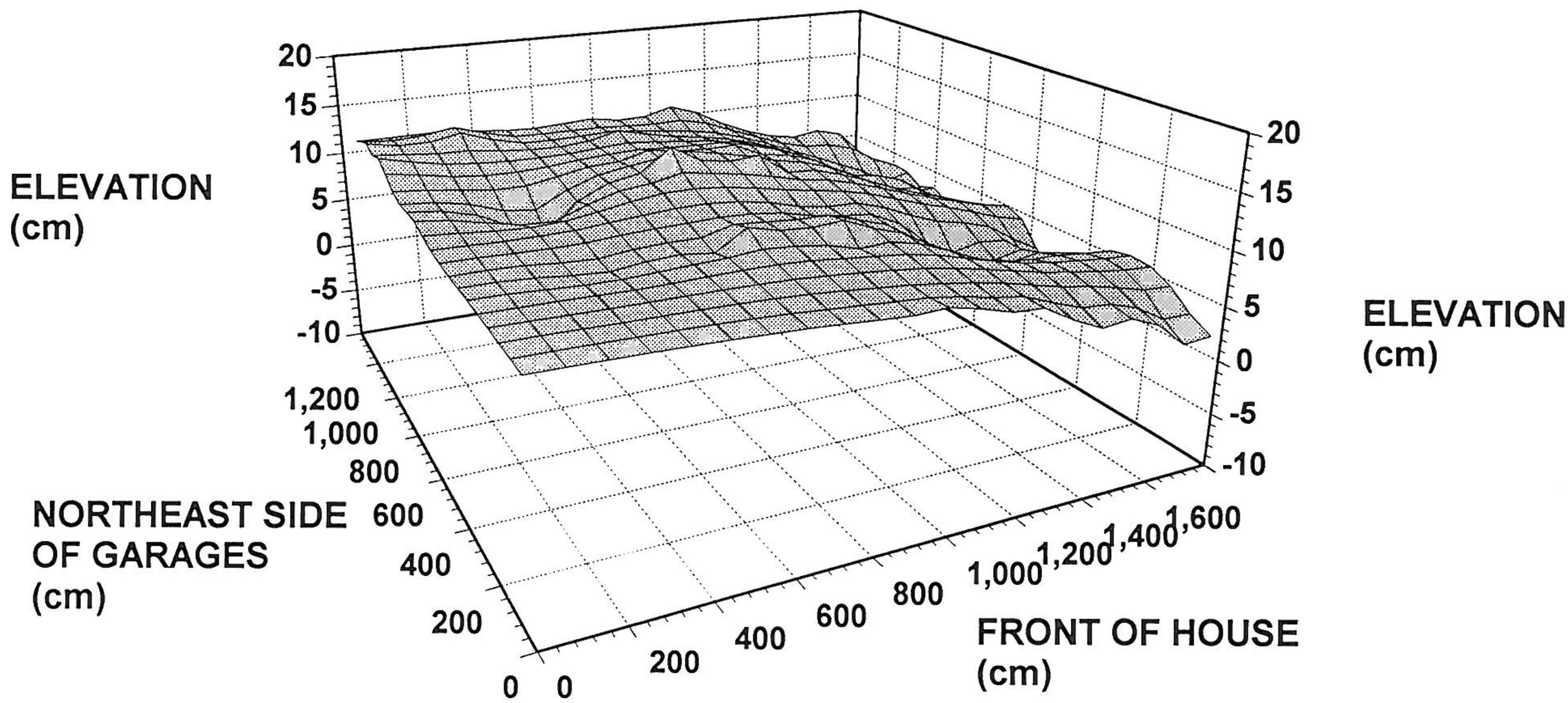
GLACIER CHART 7



GLACIER
FEBRUARY 4, 1997

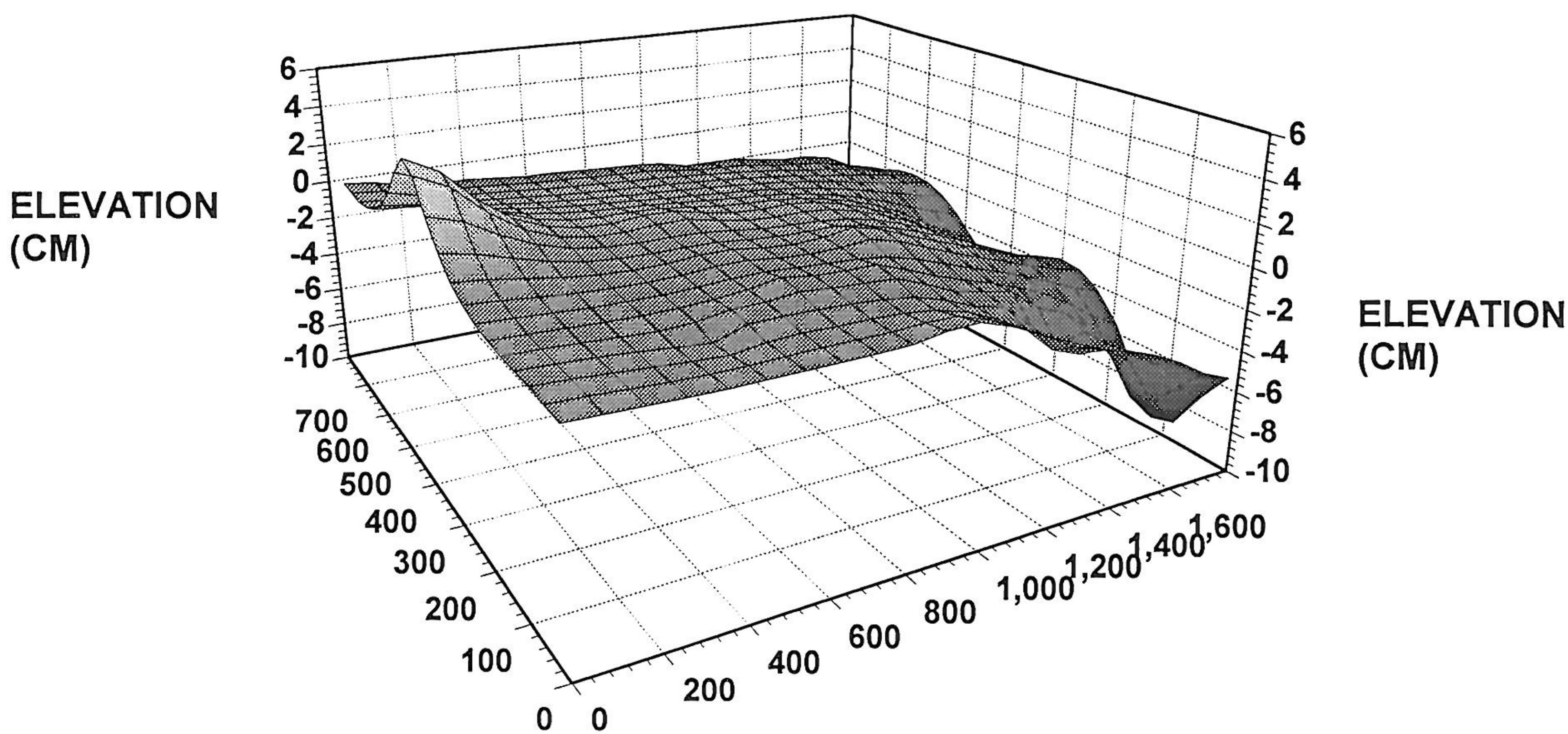


GLACIER GARAGES
FEBRUARY 4, 1997



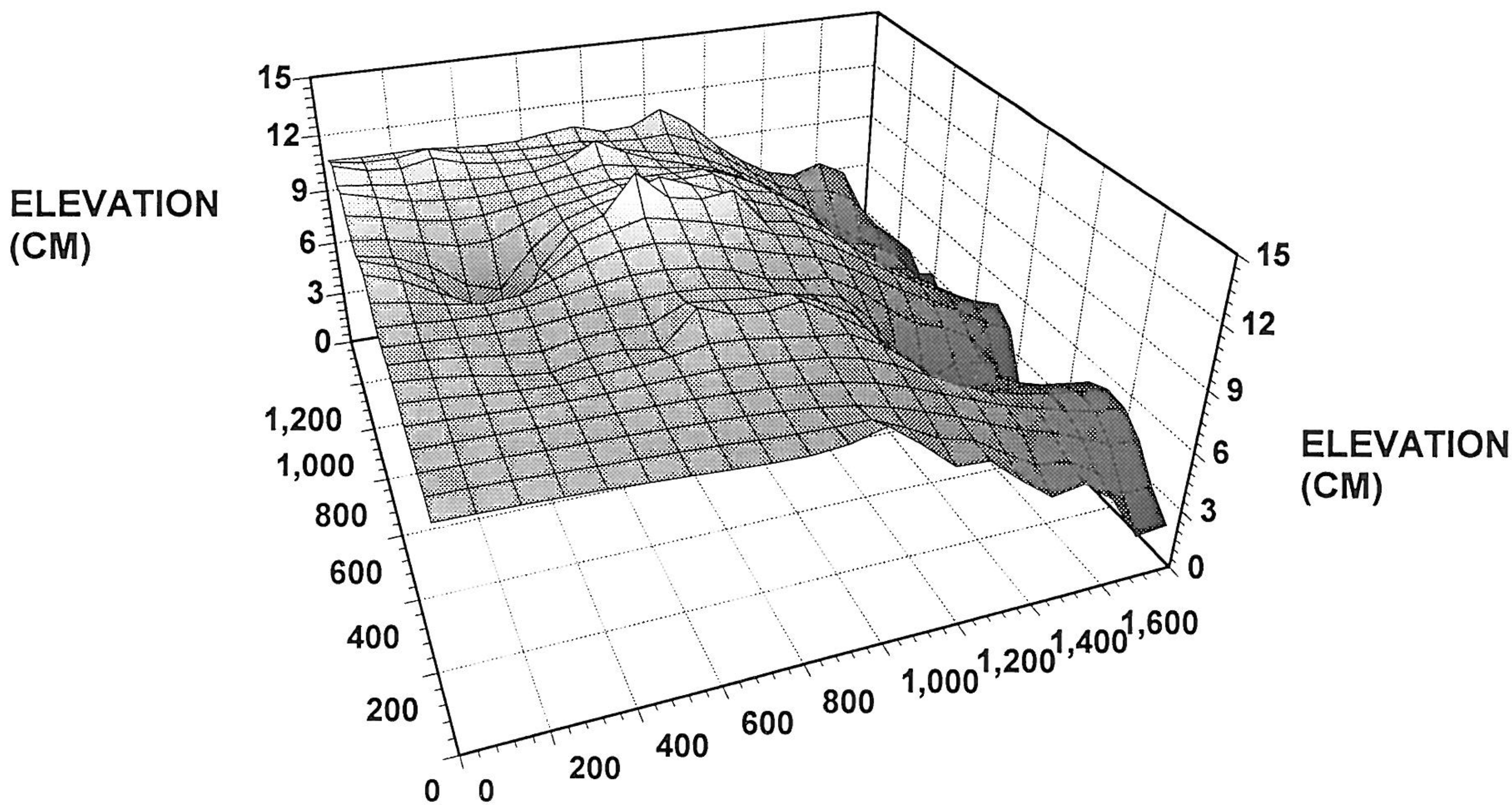
GLACIER

APRIL 14, 1992



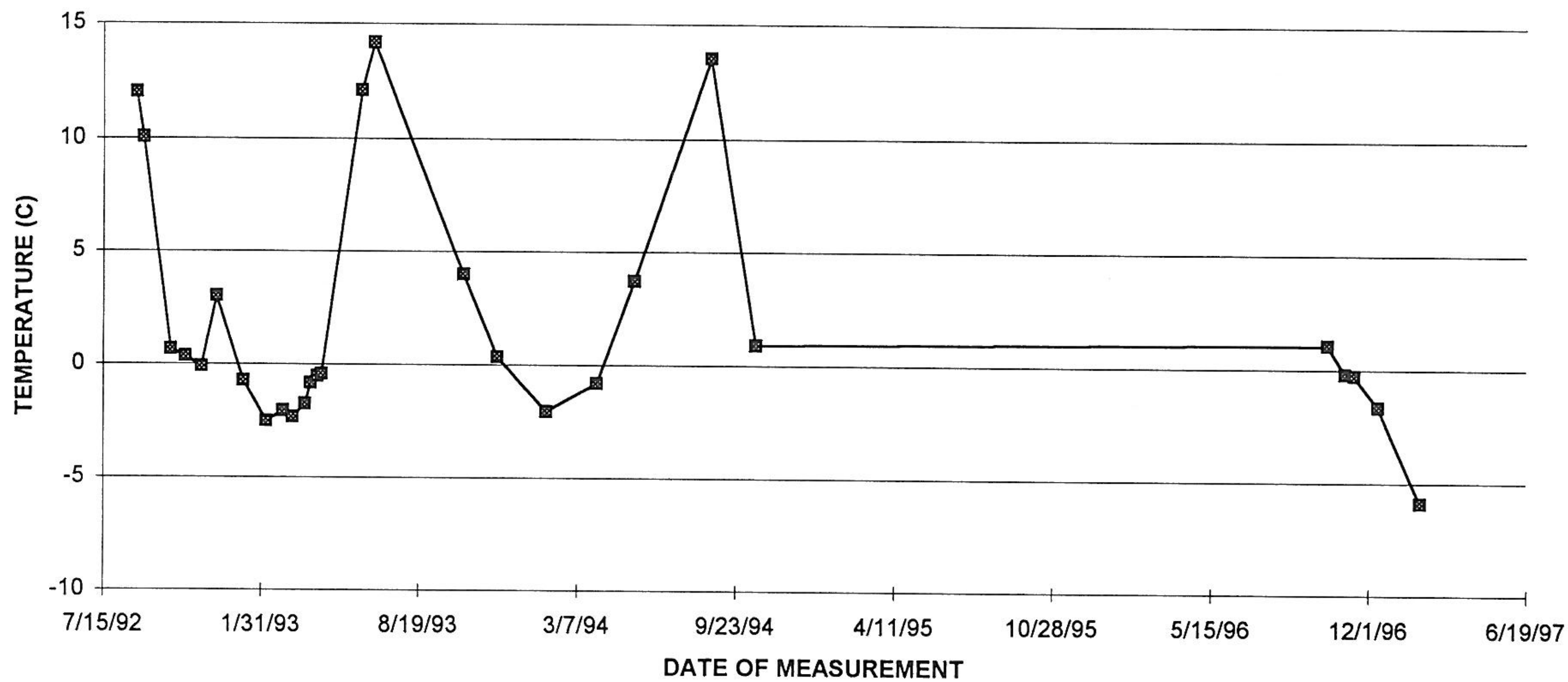
GLACIER GARAGES

APRIL 14, 1992

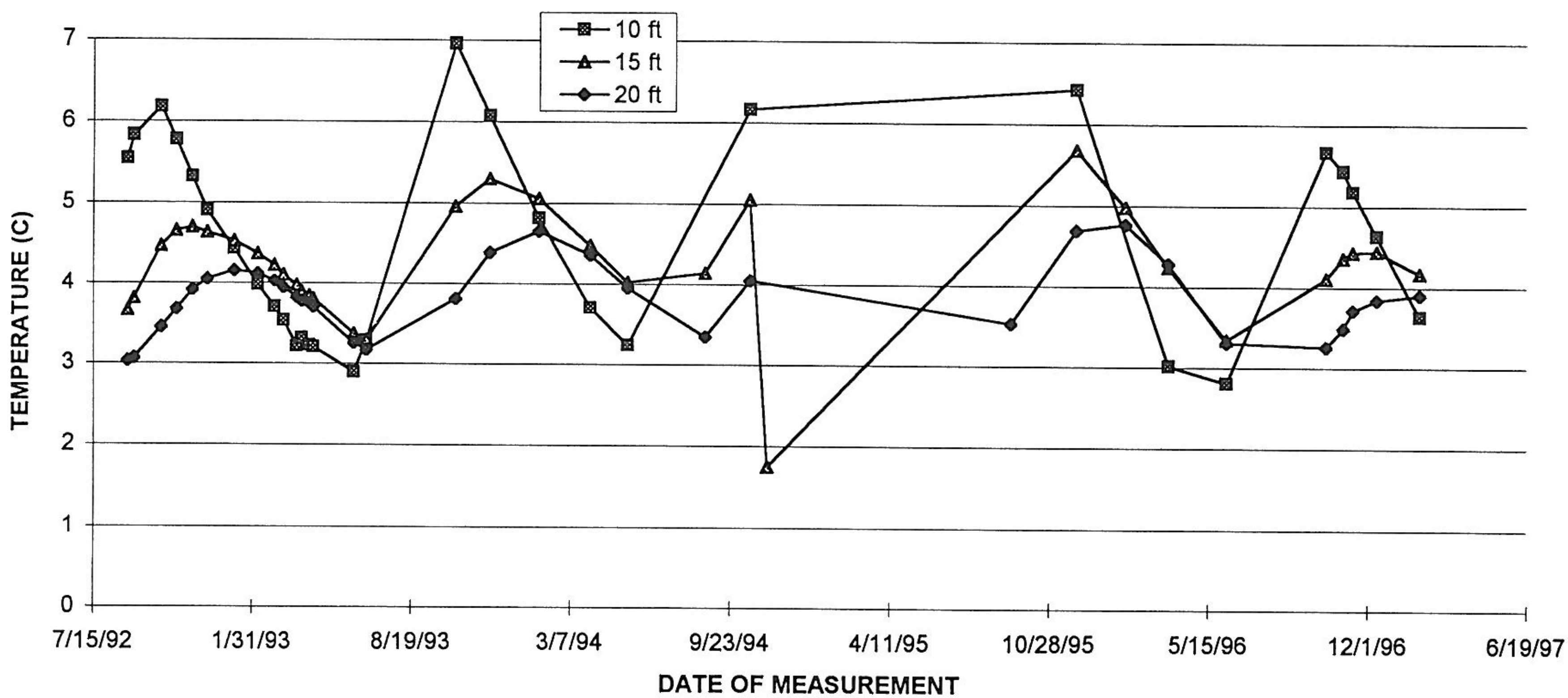


Temperature Measurements

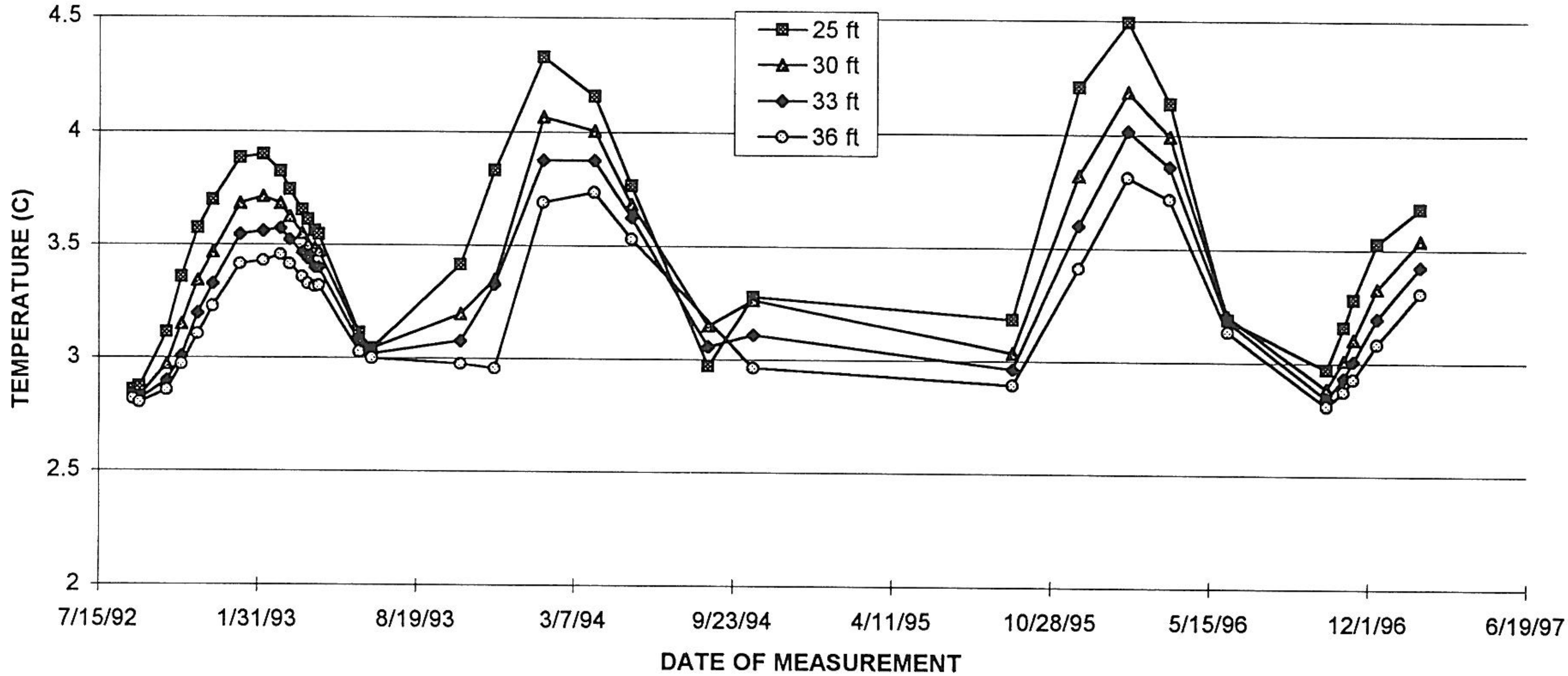
GLACIER STRING # 1 SURFACE TEMPERATURE



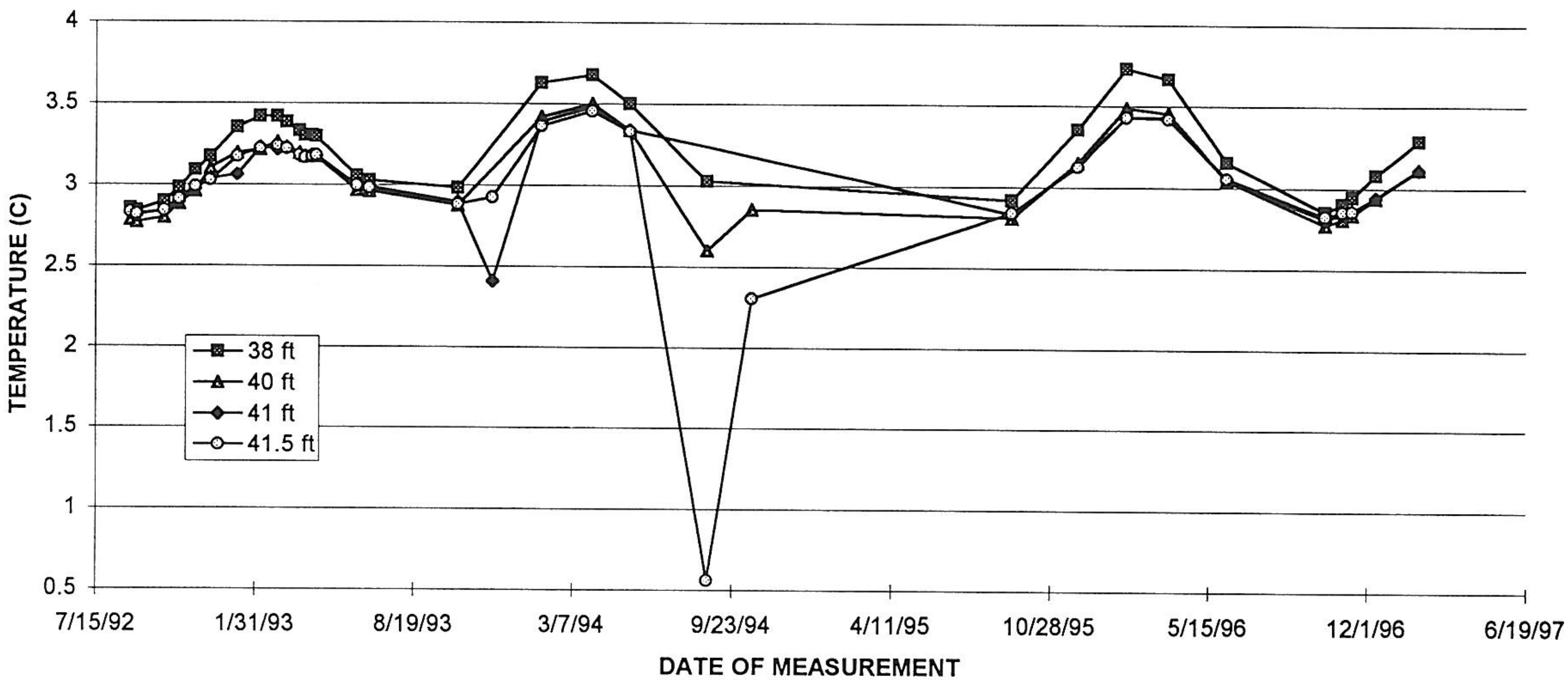
GLACIER STRING # 1 at 10, 15 & 20 ft.



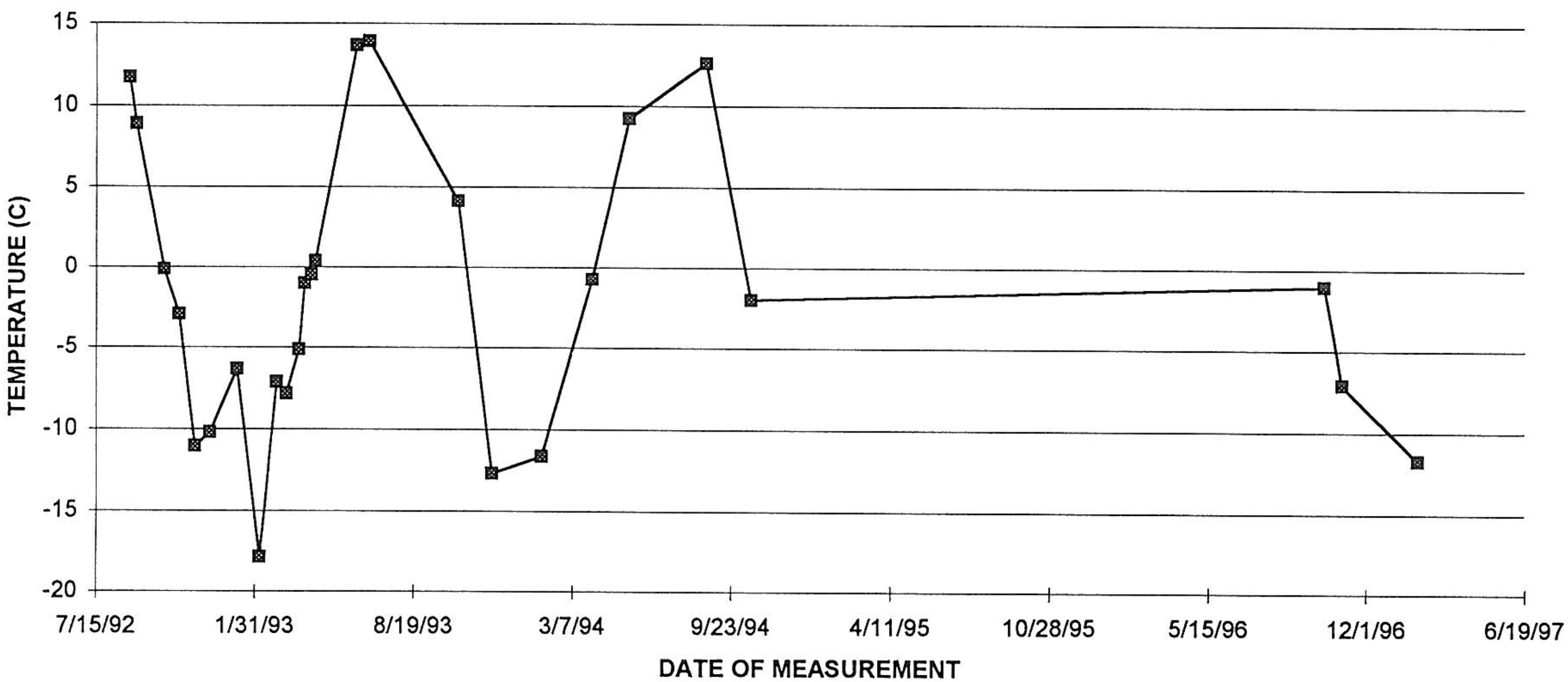
GLACIER STRING # 1 at 25, 30, 33 & 36 ft.

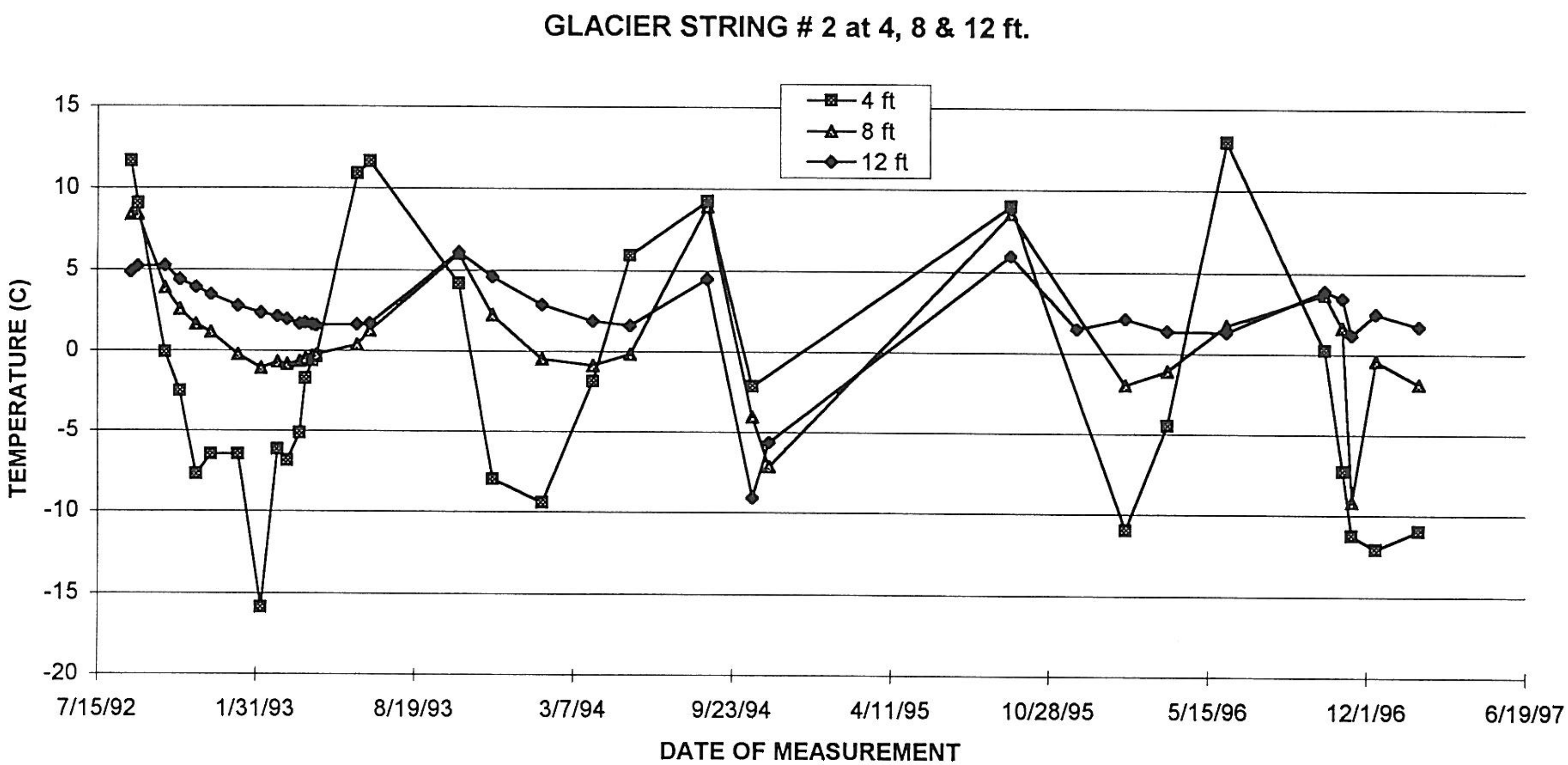


GLACIER STRING # 1 at 38, 40, 41 & 41.5 ft.

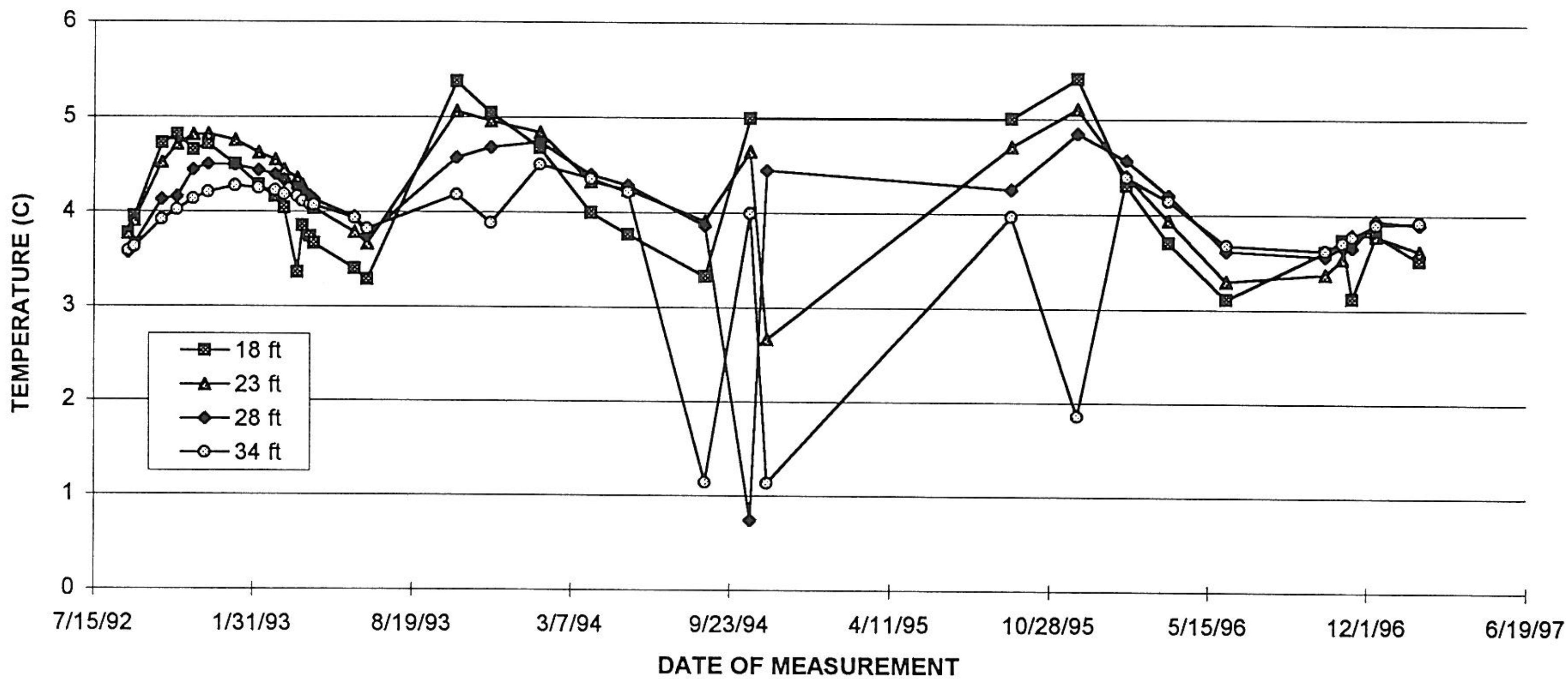


GLACIER STRING # 2 SURFACE TEMPERATURE

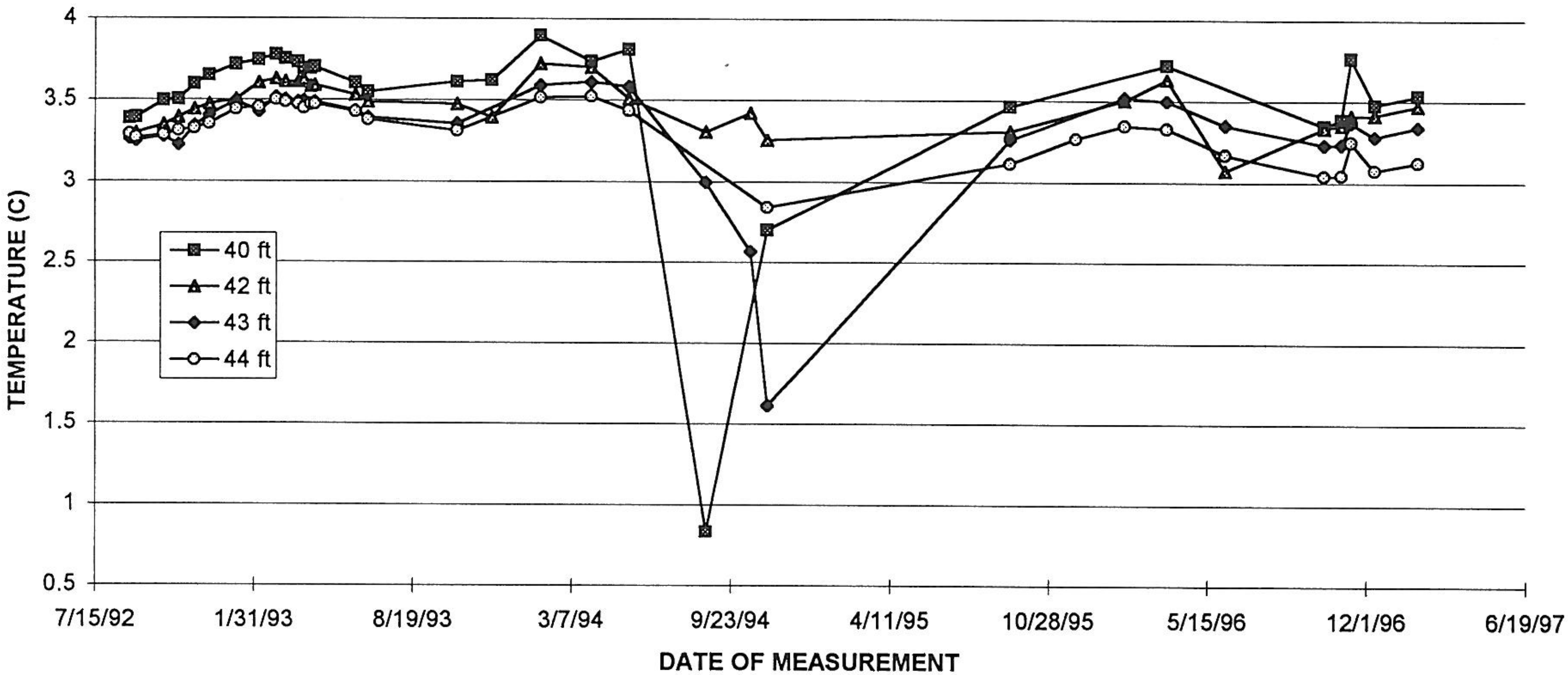



GLACIER STRING # 2 at 4, 8 & 12 ft.
4 ft
8 ft
12 ft
TEMPERATURE (C)
15
10
5
0
-5
-10
-15
-20
7/15/92
1/31/93
8/19/93
3/7/94
9/23/94
4/11/95
10/28/95
5/15/96
12/1/96
6/19/97
DATE OF MEASUREMENT

GLACIER STRING # 2 at 18, 23, 28 & 34 ft.



GLACIER STRING # 2 at 40, 42, 43 & 44 ft.



Engineering Reports

STUTZMANN ENGINEERING ASSOCIATES, INC.
P.O. Box 71429
Fairbanks, Alaska 99707-1429
Ph. 907-452-4094 Fax 907-452-1034

December 17, 1997

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

Attn: Terry McFadden

Re: Engineering Report
#19 Glacier Ave.
Fairbanks, Alaska

Dear Mr. Mcfadden,

As requested we have conducted an onsite investigation of the referenced property. We had originally examined this property for Alaska Housing Finance Corporation in March of 1989. The purpose of this examination is to determine the condition of the building eight years after our original investigation.

It is our understanding that essentially no maintenance or repairs have been made to the building in the last seven years except as absolutely necessary.

The structure is a wood framed building on a concrete foundation and has four apartments within it. There are two separate two car garages that are attached. Two of the apartments are daylight basement apartments. The building has been occupied since our last inspection in 1989. The building was constructed in 1983.

In 1989 we discovered the building had substantial differential settlement of the foundation on the west side of the building. Due to this settlement many wall and floor cracks were found in the building. The Permafrost Technology Foundation has conducted research in the building since 1990. Their research data has been supplied to our firm. No reports or conclusions from their work were submitted to us.

Permafrost Technology Foundation Data

Our interpretation of the data indicates that it consists of four categories of information 1) relative elevations in the building 2) logs of the geotechnical drilling 3) temperature data in the bore holes 4) wall and floor crack measurements.

The geotechnical drilling confirmed the results of our original drilling for the west side of the building and added information for the east side. The west side has some soils which have a low bearing capacity and the east side does not. This coincides with the differential settlement found. The west side has settled relative to the east side. No permafrost was found in these drill holes and therefore the soils temperature data is not very useful.

The wall and floor crack widths did not indicate any significant changes during the period in which they were monitored.

The relative elevations taken during the last seven years are of a great interest to us. The data shows that the foundation does not appear to have had any significant differential settlement during that period. No measurements were made from a stable bench mark to determine if the building as a whole was settling.

Current Investigation

Our current measurements of the building foundation agrees for the most part with the Permafrost Technology Foundation's data.

The apartment manager stated that there were no reports of "sticky doors or windows" as did one of the residents. We did notice that the entry door did not close properly.

During our current investigation we found that none of the recommended repairs from our 1989 report have been completed.

Our 1989 reports recommended major foundation repairs. In light of the new information it is now our opinion that the foundation settlement has not continued to increase over the last eight years. It is still possible that some additional settlement could occur in the future. However because the foundation settlement appears to have stabilized we now recommend leaving the foundation as is for now. Please contact our office for recommended repairs if it is desired to relevel the building and not leave it as is.

We do not know the condition of the utility service lines or if they were adversely affected by the original settlement of the building. It would be prudent to check their condition as recommended in the first report. We do not have any knowledge of any reports of utility connection problems. With no problems reported and due to the difficulty and expense in checking for problems we are not recommending checking these connections at this time.

Some minor adjustments i.e. adjusting doors and windows have already been made to compensate for the out of level foundation.

Recommended Repairs

The following repairs are recommended:

1.) Repair damage from settlement:

    A.) Adjust windows and doors as necessary, patch and repair cracks in walls and floors, etc.

2.) Remove earth which is in contact with wood siding around the building and install rain gutters and down spouts.

Conclusion

It appears that the six inches of differential settlement which this building experienced happened sometime during the first six years after construction. For the last eight years the building was monitored for continued settlement and no significant continued settlement was found to have taken place. In addition the building has been occupied for the last eight years without serious impairment of the living conditions.

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.

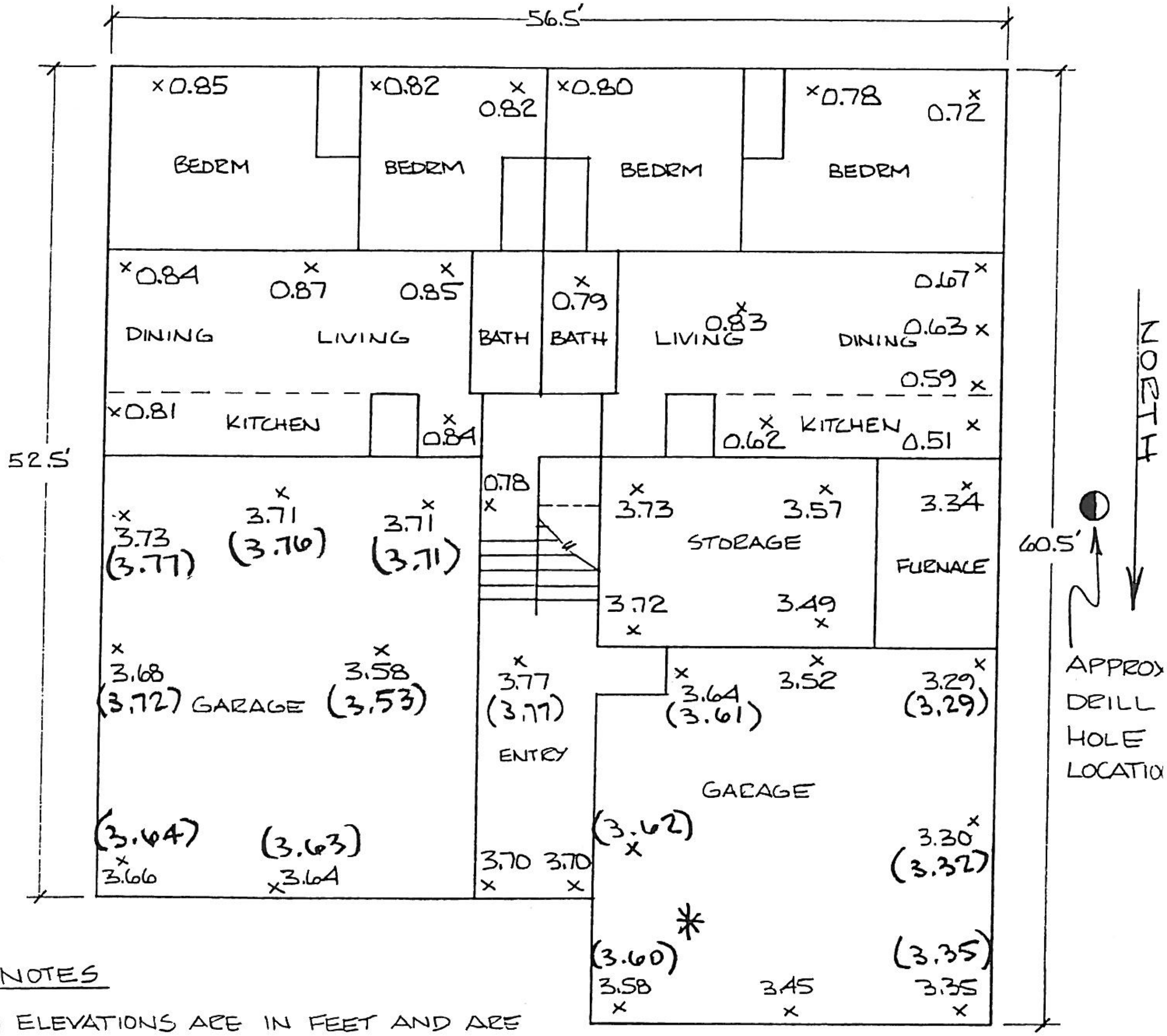
Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

Scott Wortman

Scott Wortman, P.E., R.L.S.
PTF.doc

STATE OF ALASKA
49TH
Scott Wortman
SCOTT WORTMAN
No. 5073
CE
REGISTERED PROFESSIONAL ENGINEER



NOTES

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2) ALL ELEVATIONS ARE ON FINISHED FLOORING WHICH IS CARPET EXCEPT IN THE FOLLOWING AREAS:
- KITCHEN, BATH & LAUNDRY - VINYL
- GARAGE & FURNACE ROOM - CONCRETE

* (3.60) - MEASUREMENTS TAKEN 12/18/97 BY S.E.A.I.

LOWER LEVEL FLOOR ELEVATIONS

AHFC #48739 19 GLACIER FIGURE 1

PREPARED BY: STUTZMANN ENGRG. 3/15/89 JEJ NOT TO SCALE

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

June 26, 1989

Alaska Housing Finance Corporation
100 Cushman, Suite 400A
Fairbanks, Alaska 99701

Attn: Bob Munson

Re: AHFC #48739 (Miller/Mueller)
WA #26843
#19 and #21 Glacier Avenue
Lot 3, Block 51; Hamilton Acres Subdivision

Gentlemen:

As per our phone conversation of June 22, 1989, I have prepared the following preliminary estimate for repairing the structural problems found in the foundation of the above referenced property. As you know we have determined that the damage to the building was caused by a foundation failure. This failure was apparently caused by building an improperly designed foundation for the soils conditions.

I have outlined below one of the original methods of repair that was discussed earlier and the approximate costs:

1.	Move building off and back onto its original location	$ 8,000±
2.	General Construction A. Remove, salvage, store, and re-install existing materials in the lower portion B. Separate building and assist house mover C. Disconnect and reconnect utilities D. Remove and replace decks E. Remove portions of lower partition walls F. Rebuild lower units G. Finish work H. Considerable amount of plumbing work	49,000±
3.	Construct 3166 square feet of concrete slab and 308 lineal feet of foundation wall and footing	$ 20,000±
4.	Earth work, concrete demolition, excavate, and backfill 17 feet of material (1993 cubic yards)	28,000±
	Total	$105,000±

As mentioned, I am investigating an alternate method of soils stabilization which involves chemical grout injection into the soils which, if feasible, may involve a substantial cost savings for the repair work.

Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

Scott E. Wortman, P.E.

cc: ~~K~~Cathy Floerschinger, AHFC Fairbanks
cc: Tom Hovenden, Coldwell Banker

48-BM

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

March 27, 1989

Coldwell Banker Greatland Realty
105 Adak Avenue
Fairbanks, Alaska 99701

Attn: Mike Cotton

Re: AHFC #48739 (Miller/Moeller)
Lot 3 Block 51 Hamilton Acres Subdivision
19 and 21 Glacier Avenue
Fairbanks, Alaska
W.A. #26843

Dear Madam or Sir:

As requested, we investigated the subject four-plex for the purpose of determining the cause of cracks in the gypsum board walls and the garage concrete slab. Several visits were made to the building during the weeks of March 5 and March 12. On March 20, 1989, we hired a subcontractor, the Drilling Company, to drill a soil test hole near the building.

This report presents the findings of our investigation. Figures 1 and 2 show the relative floor elevations which we measured with a surveyor's level. Figure 3 is a copy of the soil test hole log. We have also enclosed a copy of a soil test hole log and its attached letter dated March 8, 1983 from R & M Consultants to Mr. Tim Miller.

Our investigation consisted of a visual inspection of most areas of the building, excluding the upper Easterly apartment, measuring floor elevations and drilling the soil test hole. We discussed the building condition with the tenant in the upper Westerly apartment who moved in to the building after it was constructed in 1983. In addition, the City of Fairbanks building department provided us with their inspection records from the time of construction. During our visual inspection, we were looking specifically for signs of foundation movement. In several locations, cracks have opened up, indicating some differential movement of the foundation. The enclosed photos are evidence of the cracks we found. The majority of the significant cracks were in the garage, furnace room, and storage room.

Because it was difficult to determine the nature of the movement, we measured relative floor elevations. Figures 1 and 2 indicate that, in general, the Westerly side of the building has settled as much as four or five inches relative to the Easterly side. This is based on the elevations found and the assumption that the building was initially constructed level.

The tenant we spoke to mentioned that nearly all of the casement windows in the building were inoperable. He also mentioned that he had, in the recent past, re-hung the doors in the building because many of them were jamming. Both of these problems are indications of significant differential foundation movement.

The building department records indicate that the structure was adequately constructed and founded on a standard 8 inch by 16 inch continuous footing. We were able to determine that the original owner, Tim Miller, hired R & M Consultants to drill a soil test hole on the lot prior to construction in 1983. The results of that drilling are enclosed. In their letter to Mr. Miller, R & M stated that "specific information concerning soil bearing capacities....cannot be determined without additional drilling".

I recently spoke to Paul Sauer of PDS Construction, the builders of the four-plex, and he mentioned he was concerned about the soils in the area prior to building because of the swampy pond like area that was on the lot. Apparently Mr. Miller assured him that he had the soil drilled and it was satisfactory.

We drilled our test hole near the West side of the building as shown in Figure 1. No permafrost was encountered. During drilling, we performed standard penetration tests at several depths to help quantify the strength of the soils beneath the structure. The test at fifteen (15) feet shows the silt to be extremely low strength. We believe the foundation settlement is a result of this loose, low strength soil consolidating under the load of the building. Our assessment is based on the assumption that the soils in the test hole are representative of those beneath the building.

Over the next several years, this soil will probably continue to consolidate, but exactly how much consolidation will occur is impossible to determine. Because of this, and because there is no practical way to strengthen or stabilize the soil we recommend making cosmetic repairs to the structure (i.e. patching cracks and repairing windows). The structure should then be monitored annually to determine if more significant differential settlement is occurring. If the movement becomes excessive, the building may have to be moved at that time on to a new foundation in another location.

If an immediate fix to the problem is necessary, the building should be moved to a new foundation. It may be possible to construct the new foundation where the current one exists, but to do so would require moving the house temporarily, demolishing the existing foundation and excavating out all the loose silt down to water table. The hole would them have to be backfilled, a new foundation constructed, and the building re-set on the new foundation. Prior to recommending construction in the same place, we would have to do more soil testing. For this reason and because of the costs involved, we recommend moving the building to a lot with good soils, if practical.

It should be noted that in moving the house, the vast majority of the basement apartments would be left behind with the existing foundations. The floor and half of the walls are part of the foundation.

Our assessment of this building's condition is limited to the information presented herein and was directed toward the foundation settlement only. The report is not meant to address the adequacy of the remainder of the building.

If it is desired to move the building, we will gladly assist you in planning that move any way we can.

Sincerely,

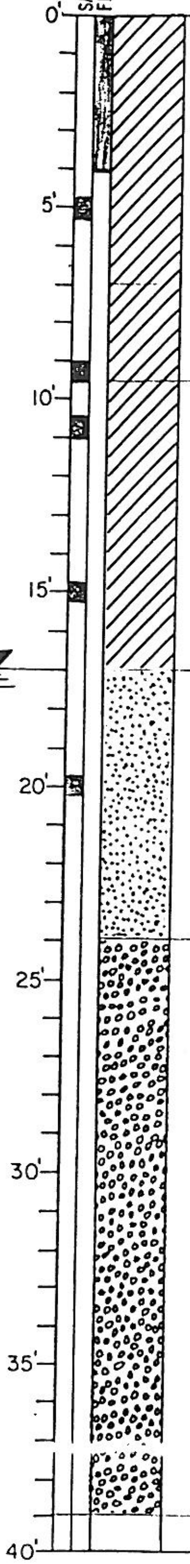
STUTZMANN ENGINEERING ASSOC., INC.

John Johansen, P.E.
45-mc

STUTZMANN ENGINEERING ASSOC., INC.

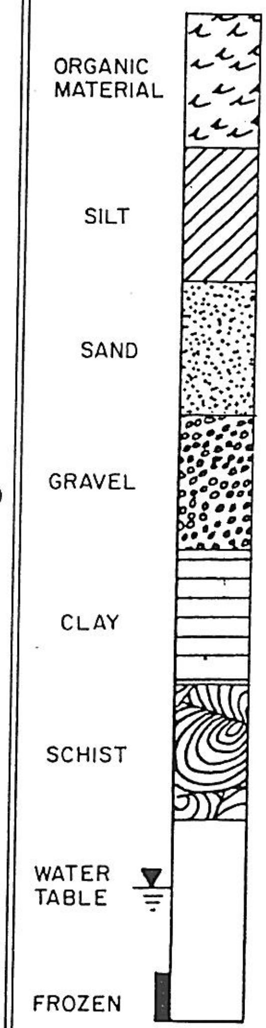
P.O. BOX 1429, FAIRBANKS, ALASKA 99707 — (907) 452-4094

CLIENT: [illegible] Banker GLR	JOB No. A-F [illegible] # 48739
HOLE No.: 1 of 1	DATE 3/20/[illegible]
LOCATION: 6' West [illegible] of the West [illegible] 4- [illegible] 10 [illegible] Avenue	DRILLER: The Drilling Co.- Ed Clarke
	LOGGED BY: J. Johansen
	SHEET No. 1 OF 1



	SOIL DESCRIPTION	SAMPLE DATA
0'–7'	SILT, sandy, [illegible] [illegible] 1 [illegible]-3'	W = 15.4% N = 6
7'–9.5'	SILT, gray, wet, fine	W = 29.1% N = 6 W = 21.3%
9.5'–17'	SILT, some sand, wet, gray	N = 3 W = 31.6% GSS = 0,10,90
17'–24'	SAND, [illegible]	N = 10
24'–39'	GRAVEL, [illegible], loose, [illegible]	
39'	E.O.B @ 39'	

LEGEND



N = SPT blows/ft.

W = % Moisture

GSS = % Gravel/Sand/Silt

FIGURE 3

R & M ENGINEERING CONSULTANTS

SUMMARY OF LABORATORY TEST DATA

PROJECT NAME Stutzman Eng

PROJECT NO. 912101

DATE 3/22/89

PAGE ____ OF ____

TEST HOLE NO.	SAMPLE NO.	DEPTH FT.	PERCENT PASSING 3"	2"	1 1/2"	1"	3/4"	1/2"	3/8"	4	10	40	100	200	PERCENTAGE GRAVEL	SAND	SILT	ORGANIC CONTENT %	MOISTURE CONTENT %	LL	PL	PI	CLASS
	1	5'																	15.4				
	2	9'																	29.1				
	3	11'																	21.3				
	4	15'												90.1			✓		31.6				

R&M ENGINEERING CONSULTANTS

SIEVE ANALYSIS SUMMARY

DATE: 3/22/89 R&M PROJECT NO. 912101

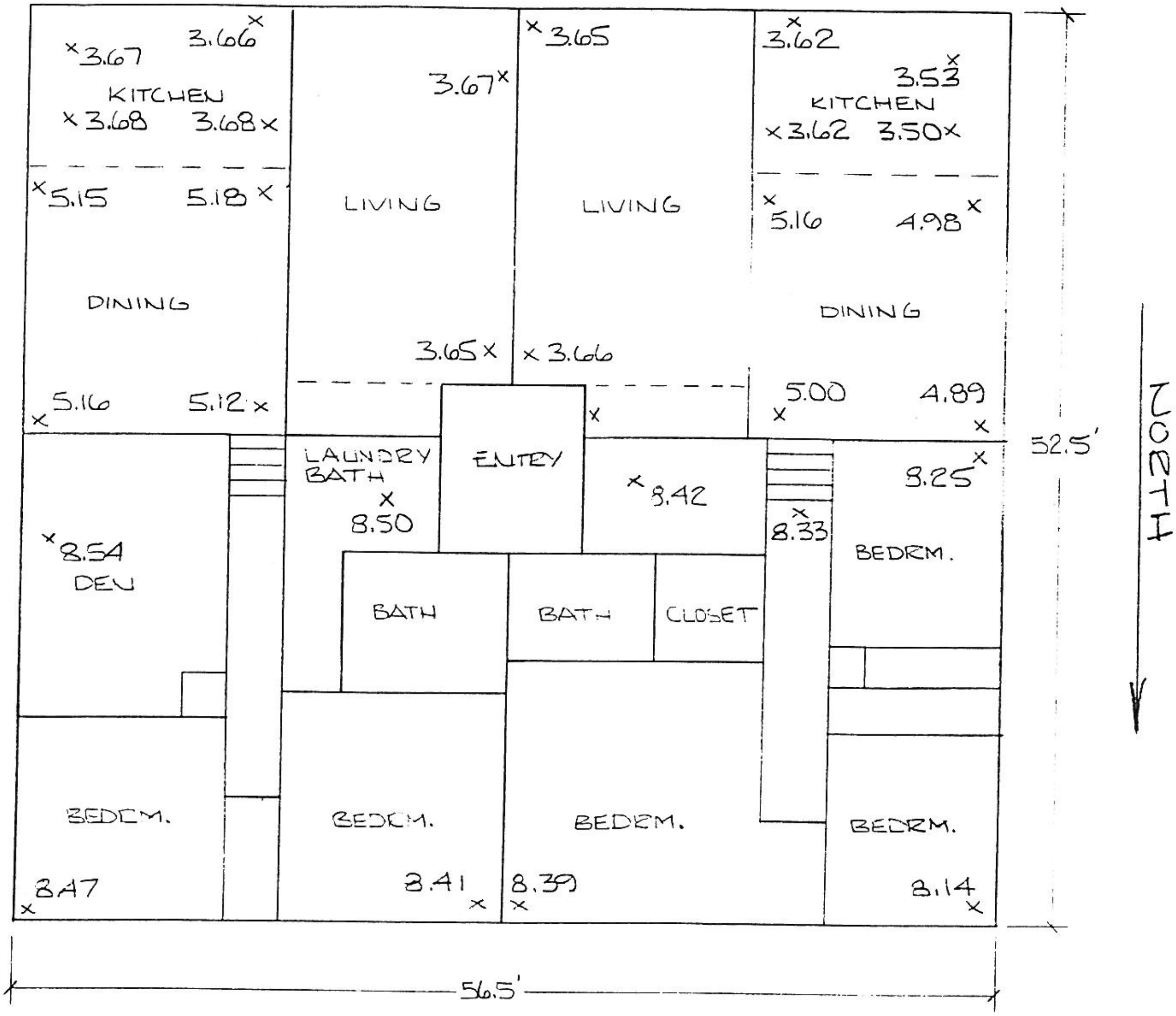
FIELD TRIP: YES ☐ NO ☒

CLIENT: Stutzman Eng

PROJECT: AHFC # 48379 Sample #4

MATERIAL	S.It					
SOURCE	15'					
SIEVE	% PASSING	SPECS.	% PASSING	SPECS.	% PASSING	SPECS.
4"						
3"						
2"						
1 1/2"						
1"						
3/4"						
1/2"						
3/8"						
4						
8						
10						
16						
20						
40						
50						
80						
100						
200	90.1~~6~~					

TESTED BY: Ken Gray



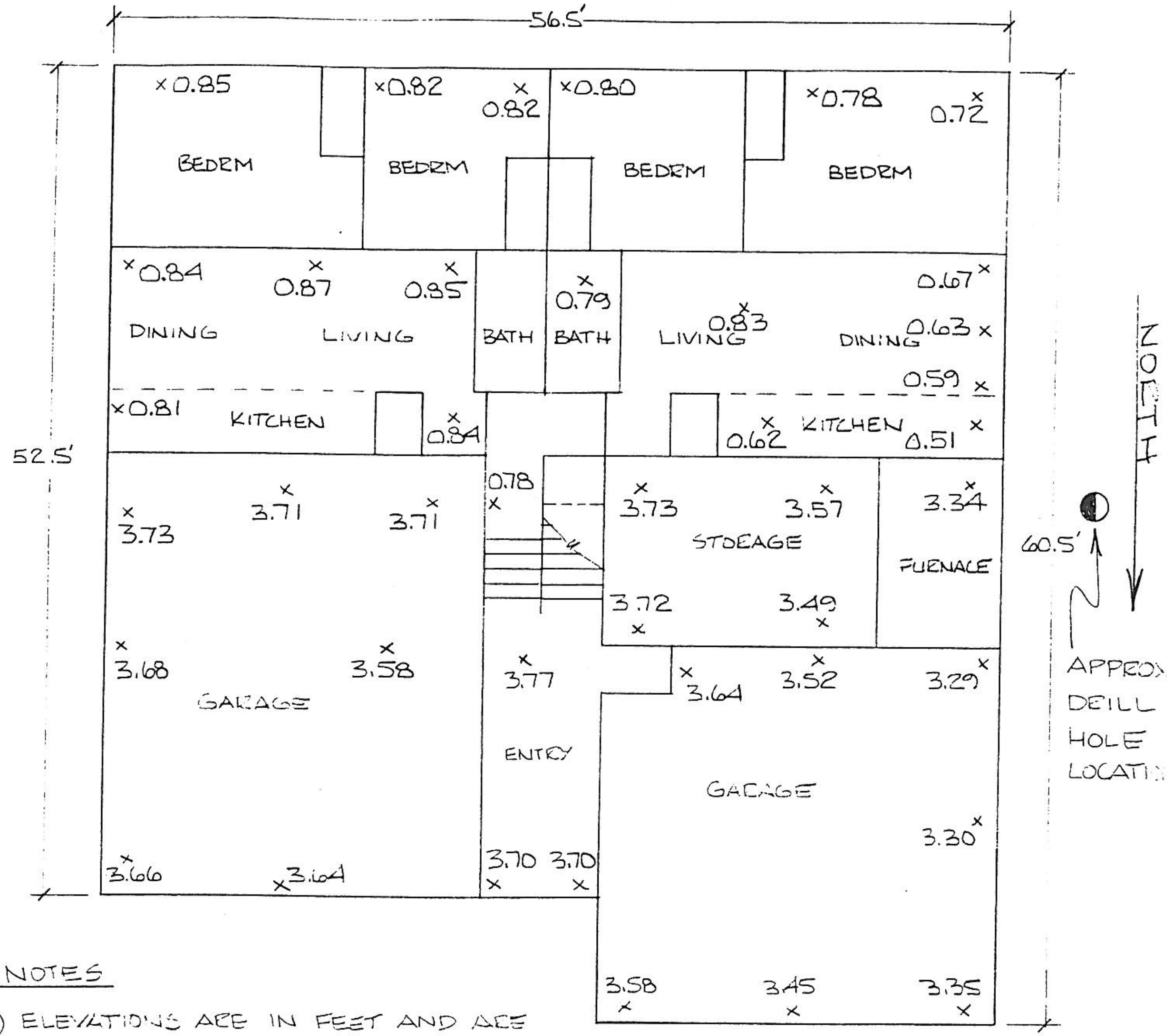
NOTE

NOTES 1 AND 2, FIGURE 1, ARE APPLICABLE TO FIGURE 2

UPPER LEVEL FLOOR ELEVATIONS

AHFC #48739 19 GLACIER FIGURE 2

PREPARED BY: STUTZMANN ENGRG. | 3/15/89 | JEJ | NOT TO SCALE



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2) ALL ELEVATIONS ARE ON FINISHED FLOORING WHICH IS CARPET EXCEPT IN THE FOLLOWING AREAS:
- KITCHEN, BATH & LAUNDRY - VINYL
- GARAGE & FURNACE ROOM - CONCRETE

LOWER LEVEL FLOOR ELEVATIONS

AHFC #48739 19 GLACIER FIGURE 1

PREPARED BY: STUTZMANN ENGRG. 3/15/89 JEJ NOT TO SCALE

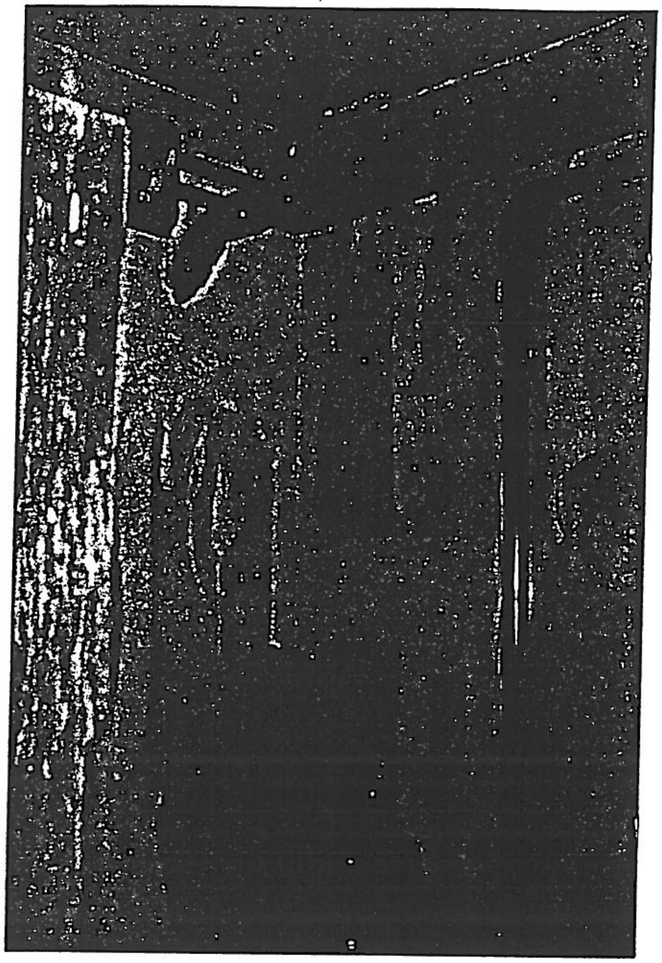


PHOTO #7: SHEARING DRYWALL TAPE IN SOUTHWEST CORNER OF EASTERLY GARAGE.

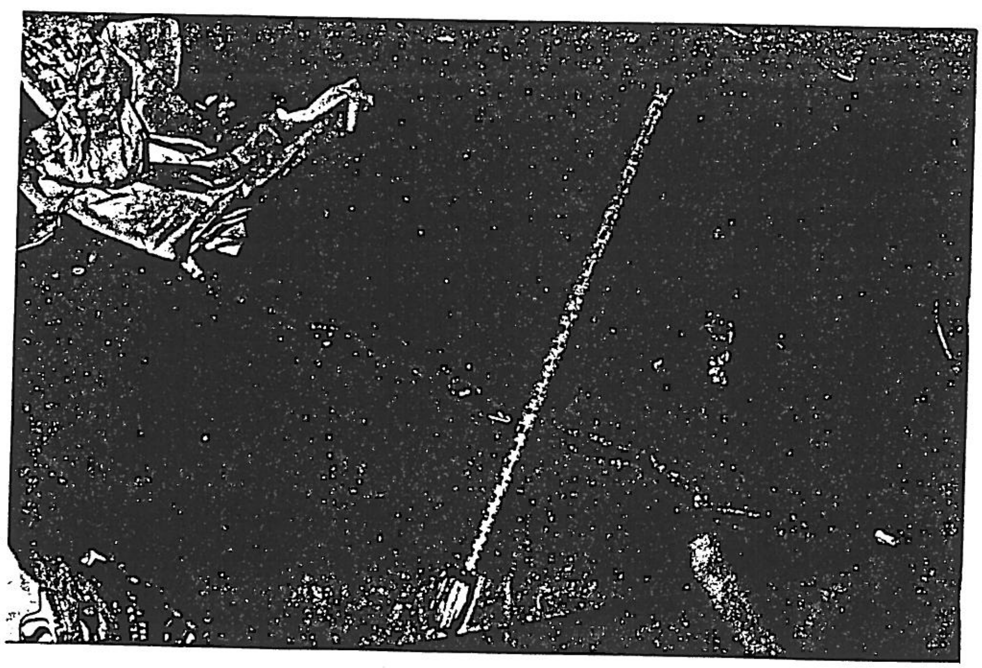


PHOTO #8: WIDE CRACK IN EASTERLY GARAGE FLOOR.

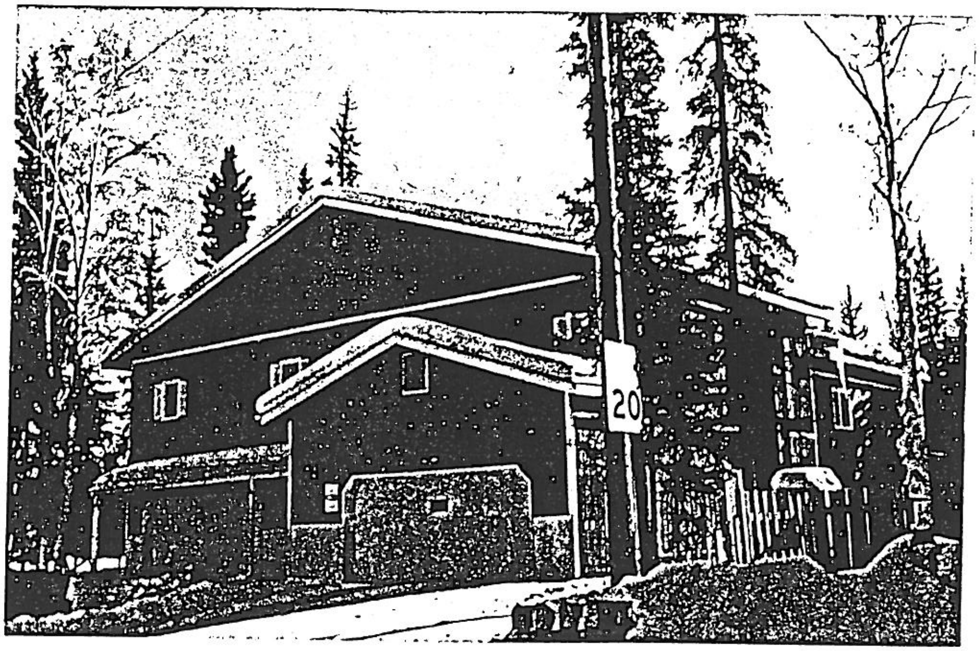


PHOTO #1: FRONT OF BUILDING VIEWED FROM GLACIER AVENUE.

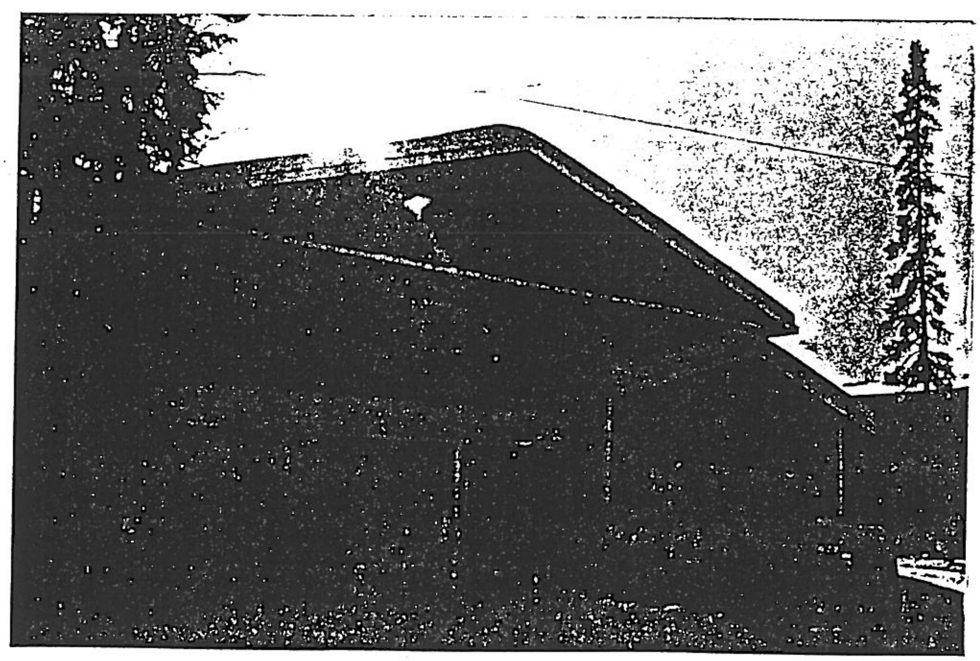


PHOTO #2: FRONT OF BUILDING VIEWED FROM GLACIER AVENUE.

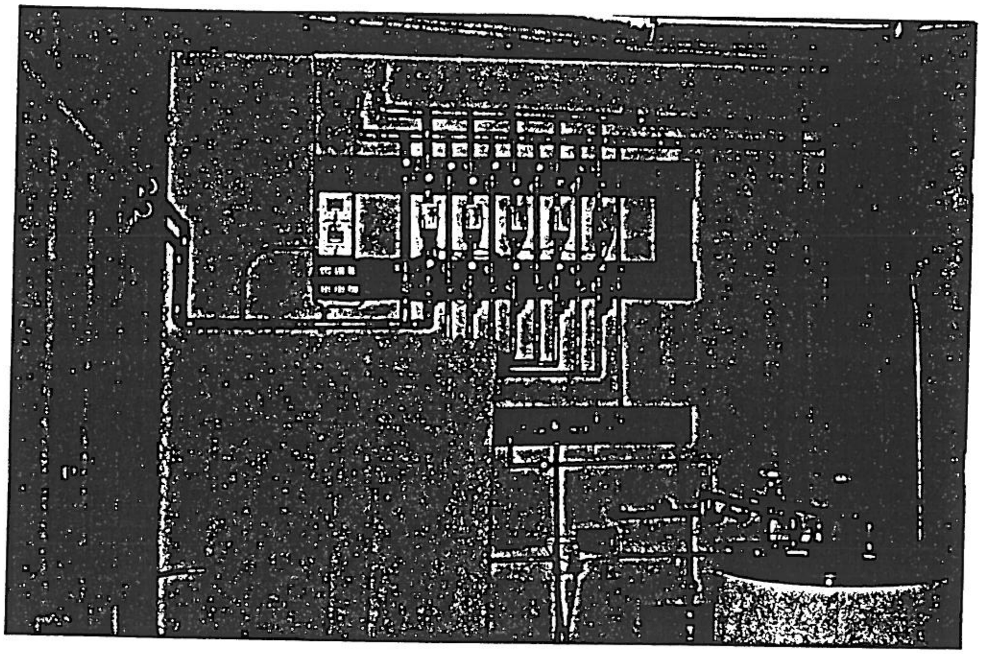


PHOTO #5: SOUTH WALL OF FURNACE ROOM. NOTE THE SHEARING DRYWALL TAPE IN BOTH CORNERS.

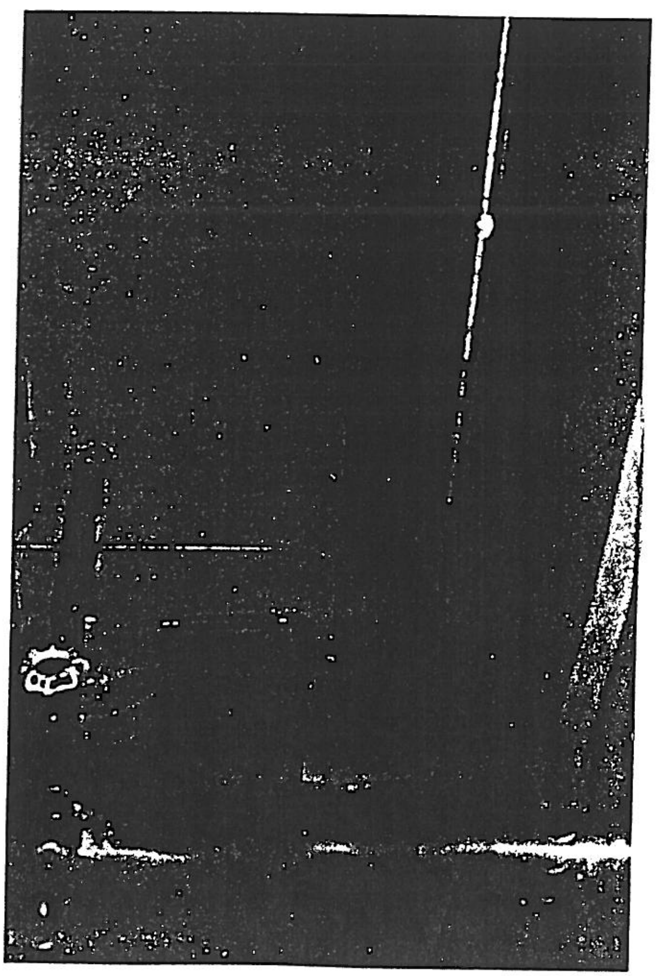


PHOTO #6: SHEARING DRYWALL TAPE IN SOUTHWEST CORNER OF FURNACE ROOM.

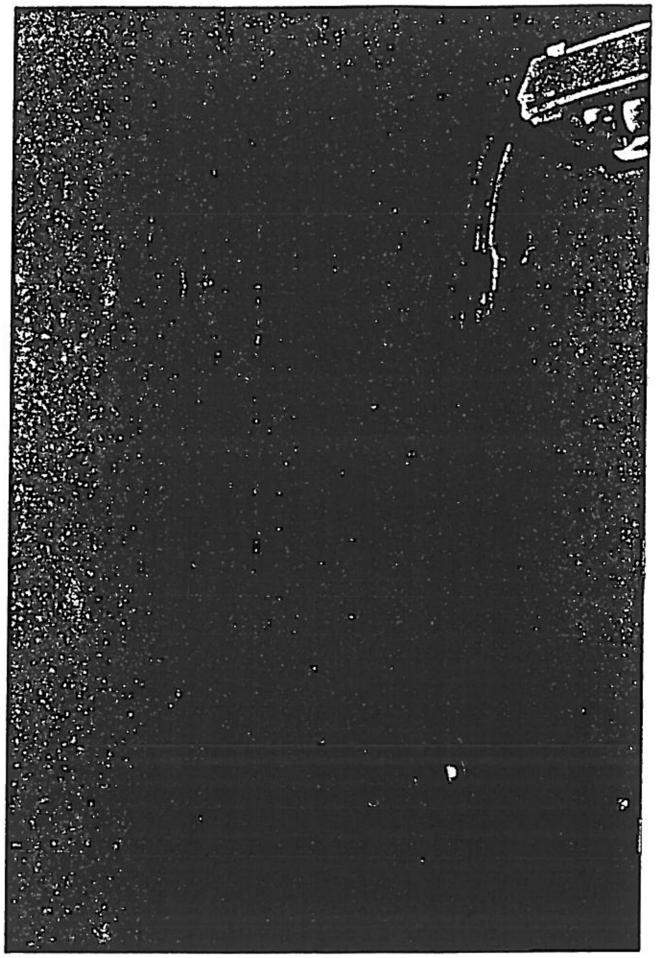


PHOTO #3: SHEARING DRYWALL TAPE IN SOUTHWEST CORNER OF STORAGE ROOM.

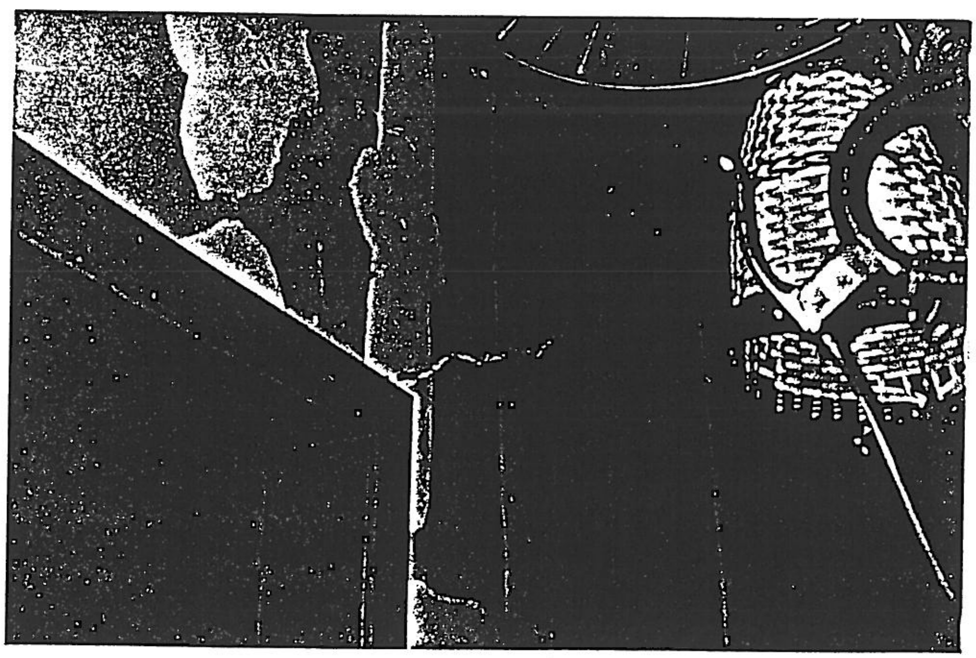


PHOTO #4: CRACK IN GARAGE WALL AT ENTRY TO FURNACE ROOM.

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

July 21, 1989

Coldwell Banker
Greatland Realty
105 Adak Avenue
Fairbanks, Alaska 99701

Attn: Tom Hovenden

Re: AHFC #48739 (Miller/Moeller)
MBS #No Pool
Lot 3, Blk 51, Hamilton Acres Sub.
21 Glacier Avenue, Fairbanks

Gentlemen:

In my reply letter to Mr. Bob Munson of AHFC on June 1, 1989, I made an estimate of the probable construction costs for making the structural repairs on the above complex as recommended in our report of March 27, 1988.

The building has been damaged by settlement of the underlying soils. The underlying soils do not have the bearing capacity to support the building loads as built.

In order to help reduce the cost of repairing the structural damage, the following alternate metho [illegible] epair [illegible]

SOILS STABILIZATION

From 1-17 feet the subsurface soils consisted of unconsolidated sandy silts, overlying very loose sandy silts. The water table was found at 17 feet. Firm, clean sands and then gravel were found below water table.

Solutions for stabilizing the underlying soils without disturbing the existing building or the adjacent building are limited. In our opinion one of the most economical solutions for the stabilization of these soils is the use of chemical grout which would be injected into the soils. I am recommending this method for stabilizing this building.

To do this "3M Chemical Grout #5620 (Delayed Gel)" or "3M Chemical Grout 5610(Gel)" shall be injected by a licensed applicator (Precision Grouting, Inc., 522 West 58th Avenue, Unit "D", Anchorage, Alaska 99578, Phone (907) 562-3775) into the ground at the locations and depths shown on the attached plan.

The chemical grout is a polymer solution which readily mixes and reacts with water to form a solid gel. A mixture of chemical grout and water can be pumped into a mass of soil and allowed to gel, thus consolidating the soil. This increases the strength of the soil.

Using this method, the building loads would be transferred by "columns" of grouted soil to the higher bearing capacity soils below. The grout shall have no less than a 15:1 ratio with water. A minimum area of three feet in diameter will be injected with grout in each hole. Depths will be from 3½ feet to 17 feet along foundation walls and daylight basement slabs. Depths for the garage slab would be .5 feet to 17 feet.

OTHER STRUCTURAL DEFICIENCIES AND RECOMMENDED SOLUTIONS

REPAIR DAMAGE FROM SETTLEMENT

The building is out of level (as indicated on the attached figures #2 and 3) by about 5" along the West wall.

It is not absolutely necessary to re-level the building and I am recommending that it not be releveled at this time. To date the existing differential settlement has not severely effected the living conditions.

All doors and windows should be adjusted so they operate properly and the trim is plumb. Sheet rock cracks and other minor damage caused by the settlement should be repaired.

Prior to the grout injection in the daylight basement part of the building, the carpets need to be removed and after grout injection the holes in the concrete need to be grouted with non shrink concrete grout.

UTILITIES

Check and repair the fuel lines as necessary for damage due to settlement. Check and repair the water and sewer service lines especially at the interface with the building.

GARAGE SLAB CRACK

A large 1" wide garage slab crack exists in the East garage. Repair with non-shrink grout.

AREA GRADING

It appears that because of the subsidence along the West wall, the siding is now in contact with the soil. Regrade the West side to insure a 6" differential between any untreated wood and the soil and provide positive drainage away from the building.

Rain gutters, downspouts and splash blocks should be installed on all eaves to direct water away from the building.

SUMMARIZING THE STRUCTURAL REPAIRS NEEDED

1. Chemical grout injection for stabilizing the soil.

2. Repair damage from settlement:

    A. Adjust windows, doors, patch and repair walls, etc.

3. Utilities: check and repair sewer, water and fuel service lines.

4. Repair garage slab crack.

5. Regrade West side of building.

    A. Install rain gutters, downspout and splash blocks.

CONCLUSION

In our earlier report we recommended a method (excavation and backfill) of repair that would definitely stabilize the building. In our opinion the above soils stabilization method will also work and is recommended because of its economic feasibility. To our knowledge no chemical grout injection method for stabilizing soils has been tried in the Fairbanks area, at least not for this type of application. We are, therefore, relying on information provided by the manufacturer's representative.

Cost comparisons for excavation and backfill (involves moving the house) versus chemical grout injection are as follows:

Excavation and back fill method	$105,000.00±
Chemical grout injection	$ 65,000.00±

Cost estimates are approximate.

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 that 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 we can inspect items being repaired. Repairs should not be covered before inspection.

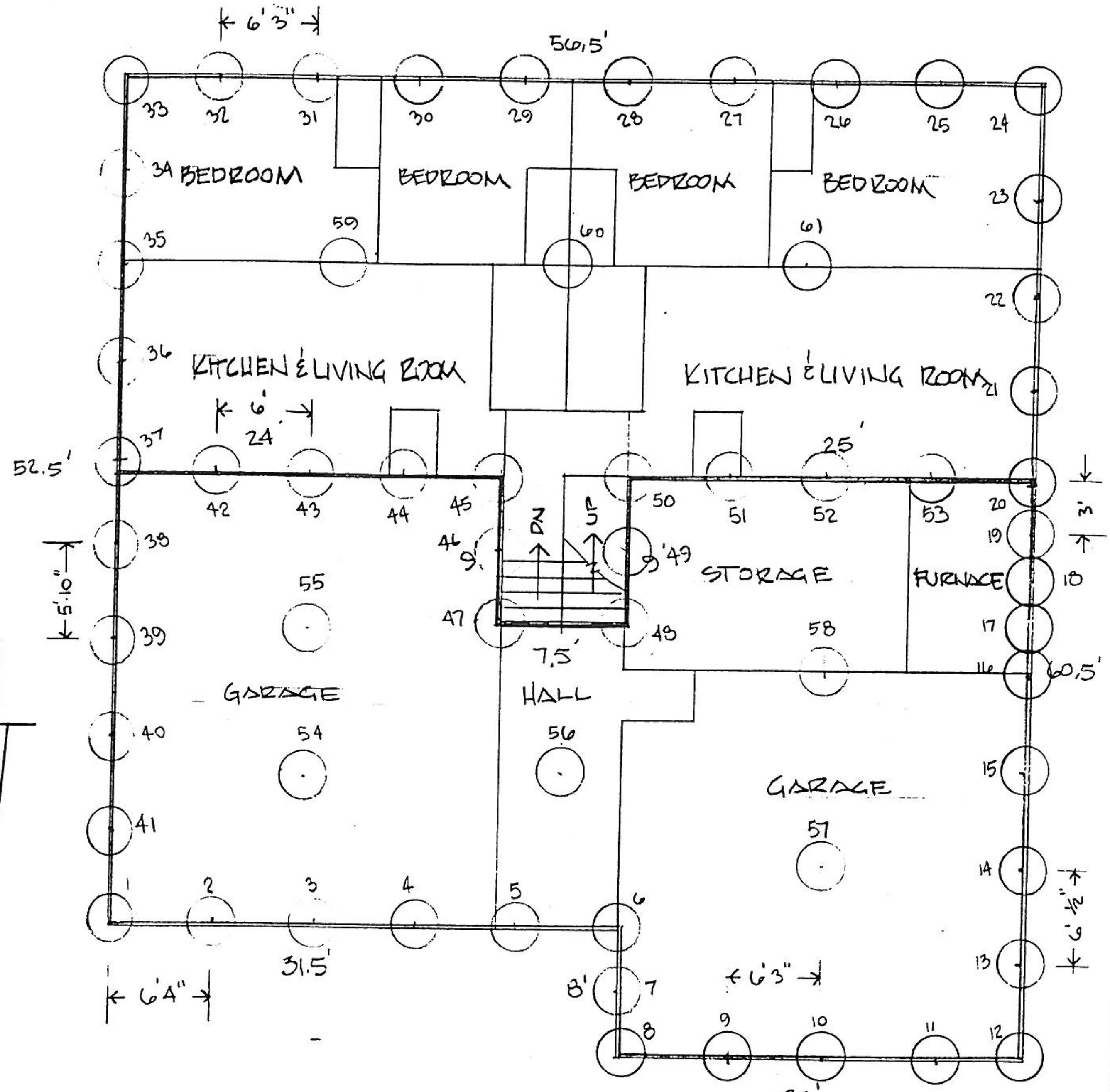
If you have any questions regarding this report, please contact our office.

Sincerely,

STUTZMANN ENGINEERING ASSOC., INC.

Scott E. Wortman, P.E.

50/mm

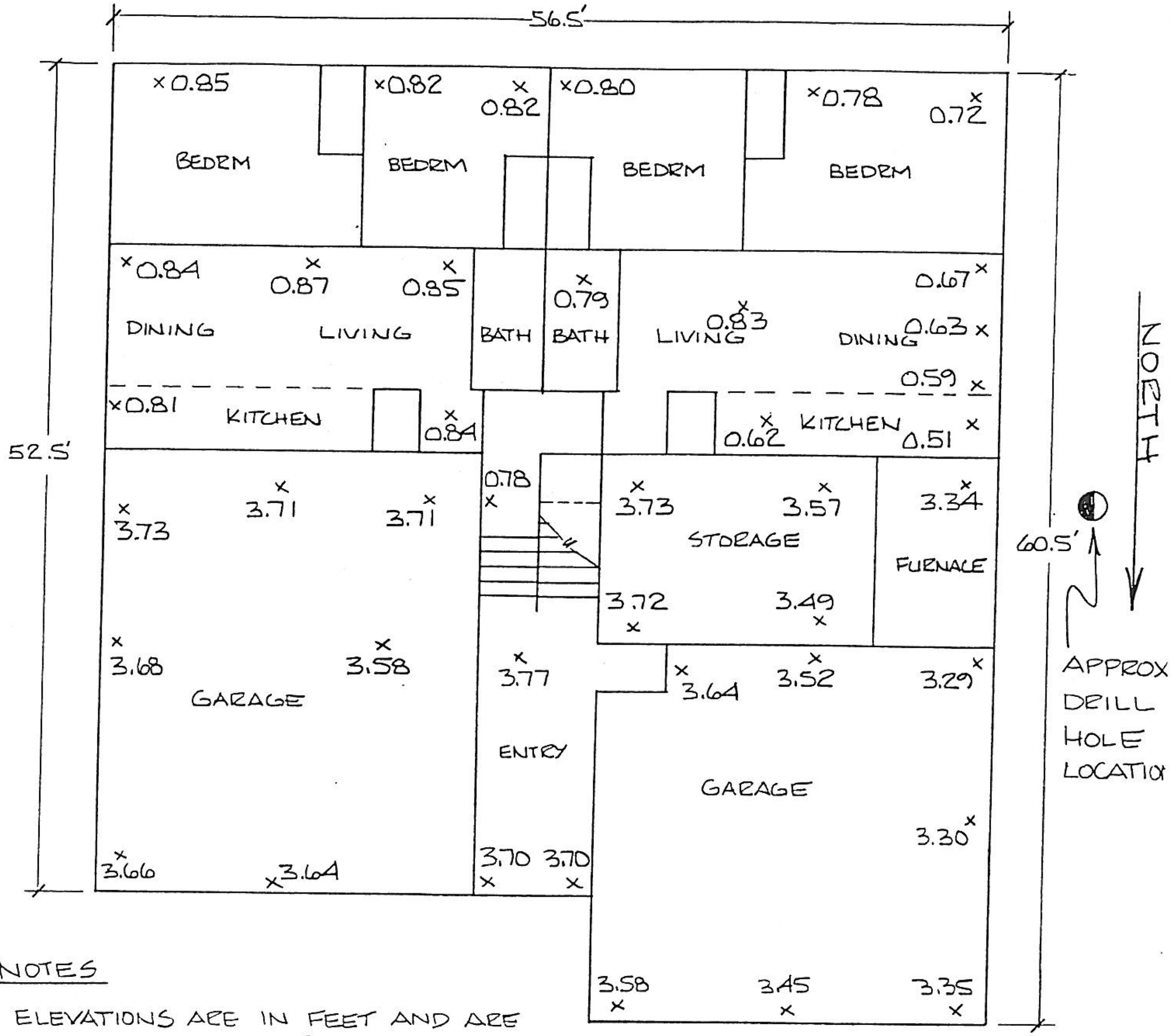


1ST FLOOR & DAYLIGHT BASEMENT

GLACIER STREET

STUTZMANN ENGINEERING ASSOCIATES, INC.
ENGINEERS SURVEYORS PLANNERS
P. O. BOX 1403, FAIRBANKS, ALASKA 99707 (907) 450-4094

A.H.F.C. # 48739 (MILLER / MUELLER) #19 & #21 GLACIER AVE.	DRAWN BY: SEW	DRAWING NUMBER
	DATE: 7/22/89	1
	SCALE: NTS	
FOR: COLDWELL BANKER/AHFC	REVISED:	



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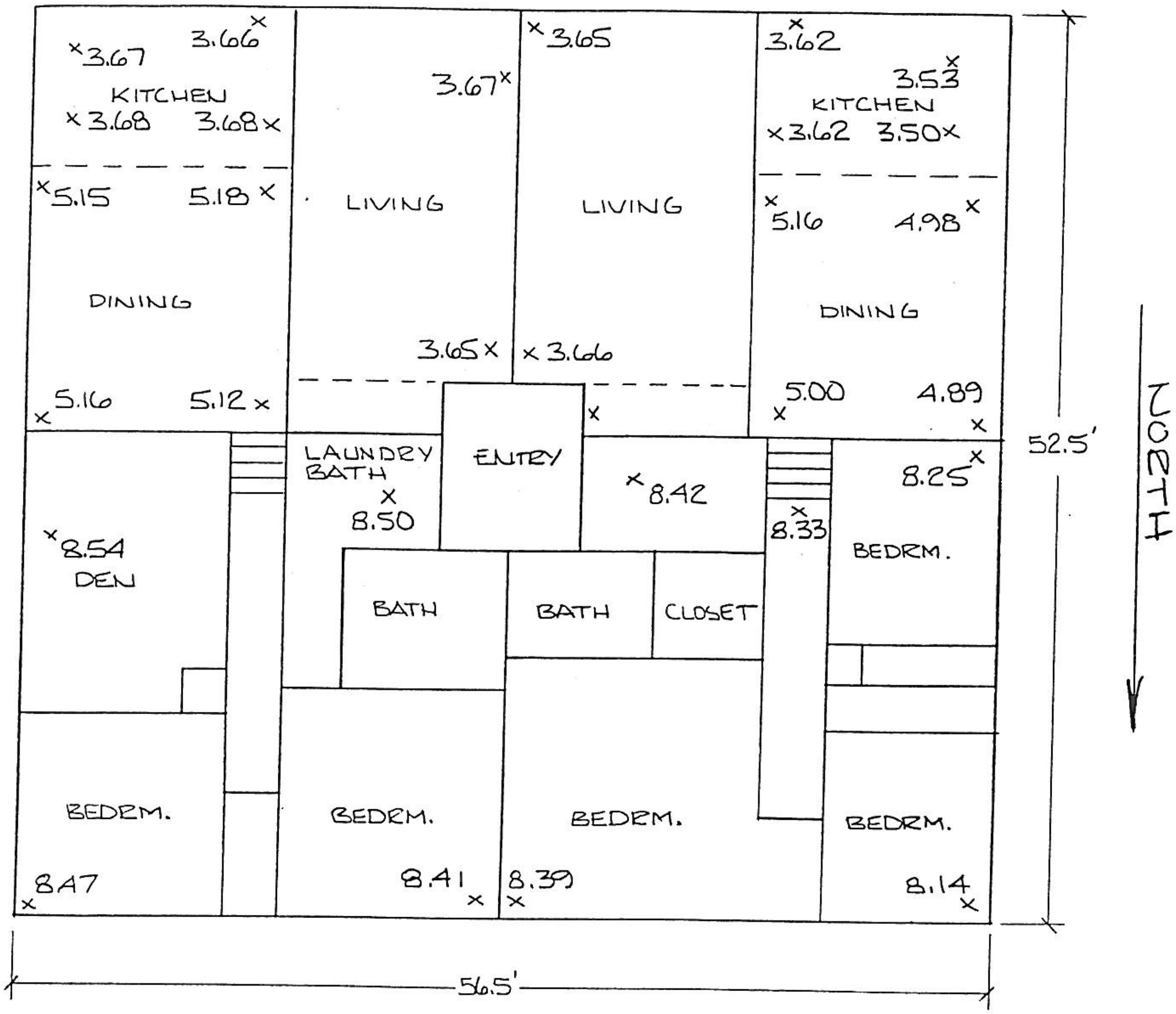
- KITCHEN, BATH & LAUNDRY – VINYL
- GARAGE & FURNACE ROOM – CONCRETE

LOWER LEVEL FLOOR ELEVATIONS

AHFC #48739 19 GLACIER FIGURE 1

PREPARED BY: STUTZMANN ENGRG. 3/15/89 JEJ NOT TO SCALE



NOTE

NOTES 1 AND 2, FIGURE 1, ARE APPLICABLE TO FIGURE 2

UPPER LEVEL FLOOR ELEVATIONS

AHFC #48739 19 GLACIER FIGURE 2

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