Tanana Chiefs Conference
Galena Clinic Foundation Assessment
Galena, Alaska

Foundation Assessment

For:
Tanana Chiefs Conference
201 1st Avenue
Fairbanks, Alaska 99701

July 31, 2023

Design Alaska

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Table of Contents

By:
Design Alaska, Inc.
601 College Road
Fairbanks, Alaska 99701

July 31, 2023

FOUNDATION ASSESSMENT

GENERAL

In early July 2023, Design Alaska was informed of failing pile caps at the steel pipe piles supporting the Edgar Nollner Health Center in Galena. Subsequent correspondence with the clinic staff brought up other foundation movement across the building. On July 12th, Samuel Mitchell with the Design Alaska structural engineering department visited the site to observe the existing foundation condition.

The investigation was composed of visual observation of the interior spaces and the pile foundation as well as preliminary differential measurements of the floor inside the clinic. No observations or measurements were taken in the southernmost City Hall portion of the building, but its foundation was observed. The report that follows summarizes the findings and the next steps that should be taken to resolve the issues observed.

EXISTING CONDITIONS

Original Foundation Construction

The approximately 16,000 square foot structure owned by the City of Galena is occupied by both the city hall and by the health clinic run by the Tanana Chiefs Conference, the clinic occupying most of the space. The building is of wood framed construction supported atop heavy glulam beams spanning between piles. Three distinct pile foundation types correlate to the three phases in which the structure was built:

1. The oldest wing constructed around 1975 is supported atop large-diameter creosote piles embedded approximately 20-feet below grade.
2. In 1979 to 1980, work began designing and constructing the second wing, which is built on 6-inch diameter Thermo Ring-Piles supplied by Arctic Foundations, Inc. of Anchorage, Alaska. Based on the original shop drawings which are attached for reference, these piles are approximately 21 feet-6 inches from pile tip to the base of the pile cap assembly. Based on the exposed portion, the actual embedment of the piles is estimated to vary from 15 feet at the east end to 18 feet at the west interface with the general services wing.
3. The final and largest addition added between 2001 and 2003 is supported on 8-inch diameter steel pipe piles. The depth and installation method of these last piles is unknown because the City of Galena contracted out the pile installation to a local contractor separate from the main building design.

The plan view on the following page shows the relation of these additions to each other.

FOUNDATION ASSESSMENT

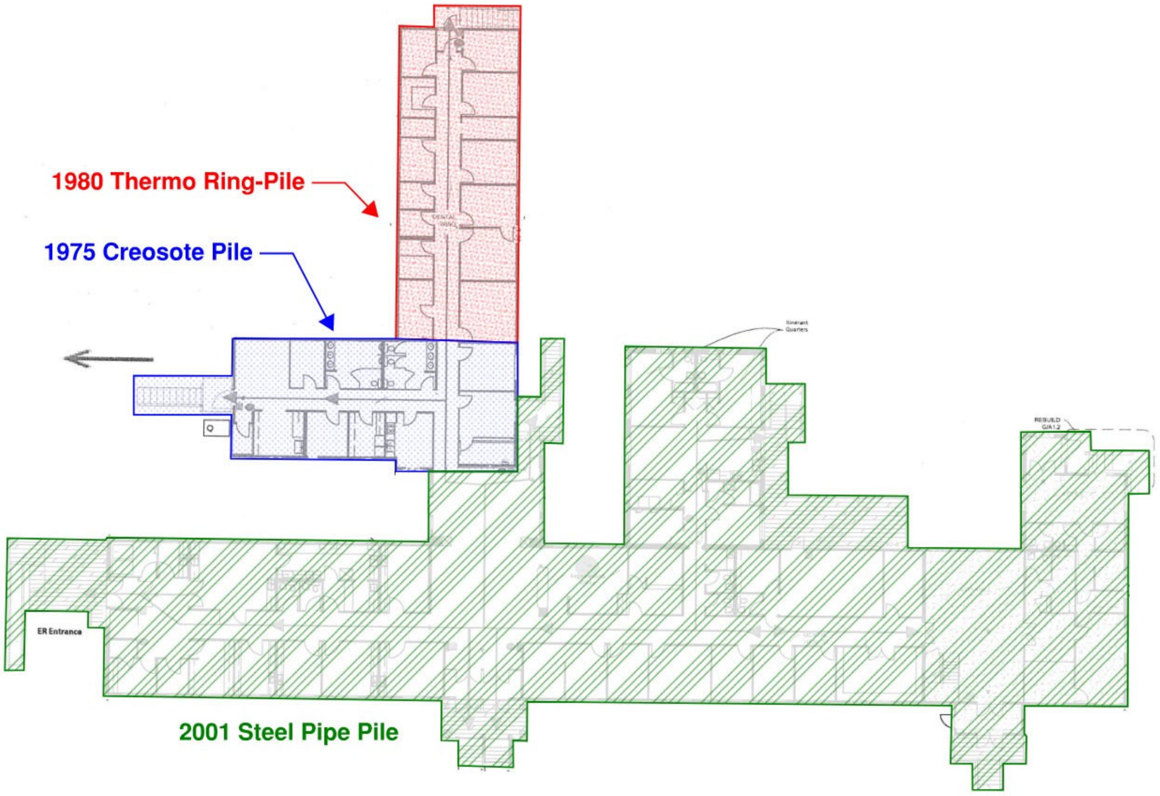


Figure 1: Pile Foundation Type Layout

General Observations

The entire clinic is experiencing various levels of differential movement. The decks, ramps, and stairs appear to be the most prone to movement. Maintenance staff has to this point maintained the door swings at all locations observed, but some of the side door stairs and ramps have slopes outside of accessibility tolerances as the soil they bear on subsides and the supporting structure jacks, making them too steep.

A 1980 geotechnical report by Harding-Lawson Associates (attached for reference) included the results of two borings beneath the current dental wing (supported on the Thermo Ring-Piles). These borings showed continuous warm permafrost (around 32-degrees Fahrenheit) throughout the sample, giving some indication of why the older timber and newer steel pipe piles are behaving the way they are. The relatively shallow pile embedment paired with the general trend across the State of thawing warm

FOUNDATION ASSESSMENT

permafrost makes frost jacking a likely cause for movement as the ad-freeze pile bond breaks down. Since more lightly loaded piles are more susceptible to frost jacking, the more extreme movement of the decks supports this thinking. Subsidence of more heavily loaded piles is also probable since the bearing capacity decreases as the ad-freeze bond is lost and the thawing soil creates down-drag on the piles. Both mechanisms have a similar result of uneven structures.

Creosote Pile Foundation – General Services Wing

Of the clinic, this wing has the most differential movement. Three glulam beam bearing lines supported directly on creosote piles run the length of the building to support the floor of the structure. The center glulam timber has blocking between the pile and beam, whereas the two outer pile lines have either minimal or no shimming. It is unknown if this blocking is original or the result of past movement. The piles have no adjustable caps to accommodate releveling. Additionally, some of the piles are no longer plumb.

Across the approximately 28-foot width of this wing of the clinic, the floor is crowned about the center beam approximately 1-1/2 inches. The cross slope is noticeable when walking the floor.

The entrance to the north end of the general services wing is accessed via a ramp. This ramp has unstable supports along its length and a step at the end to reach grade due to ground subsidence.

Thermo Ring-Pile – Dental Wing

The dental wing of the clinic built atop the Thermo Ring-Pile is more level than the adjacent portion built on creosote piles. Preliminary measurements found the structure to have less than 1 inch of relative displacement. This displacement is greatest at the easternmost extent of the building. In this location, the building floor slopes from the high point at the south wall to the low point along the north wall.

Looking down the central corridor, small regularly spaced waves in the floor are visible. Since the main glulam support lines run parallel to the corridor, these high points do not correspond to the support beams as is the case in the adjacent general services portion of the clinic. A possible cause for the regular waves in the floor may be the mixed use of engineered wood or built-up sawn lumber sections and standard sawn lumber joist framing. Since sawn lumber shrinks with age more than engineered wood or built-up lumber sections, the locations of the stiffer sections often become more pronounced over time. Since no as-builts could be located for this portion of the building, the only other option to confirm this condition is destructive investigation. Since this slight unevenness does not appear to disrupt the operation of the dental wing, this investigation is not an immediate priority.

The emergency exit stairs at the east end of the dental clinic have soil subsidence at their base. This has caused distress at the upper connection to the deck and has increased the slope of the stairs. These

FOUNDATION ASSESSMENT

stairs should be rehabilitated to maintain safe emergency egress from the offices and exam rooms at this and of the clinic.

Depressions are forming in the ground around many of the piles. These depressions were also noted in 1997 by Edward Yarmak, PE, of Arctic Foundations, Inc. He recommended mounding soil around these piles to reduce water infiltration at the pile, substantially improving the late summer capacity. In addition to the local depressions at the piles, the ground surface also slopes to underneath the east end of the dental clinic wing. Likely coincidentally, this portion of the clinic also has the greatest differential movement.

The Thermo Ring-Pile caps are not readily adjustable to accommodate releveling.

Figure 2: Distressed Stairs at East End of Dental Clinic

Figure 3: Depression Around Thermo Ring-Pile

Steel Pipe Pile Foundation – Main Clinic and City Hall

Preliminary differential measurements showed most of the central portion of the clinic building to be relatively level. Towards the emergency room entrance in the north, the interior building elevation increases about 1-inch, with even more jacking present on the exterior deck beyond. The itinerant quarters wing toward the southeast of the clinic has between 1-1/2 to 2 inches of jacking at the interior of the clinic along the south wall.

FOUNDATION ASSESSMENT

The piles supporting the perimeter of the adjoining deck were reported to have jacked substantially. Recent deck releveling by maintenance personnel required as much as 18 inches to be cut off the deck piles to remove the extreme cross slope that was developing.

The original pile cap configuration is a structural steel beam saddle welded directly to the pile. This connection provides robust lateral and gravity load transfer from the floor structure to the foundation but allows for no adjustment.

Since original construction, some of the piles beneath the city hall and the itinerant quarters have been cut free of the beam saddle and retrofit with a poorly designed adjustable pile cap. This assembly is made up of a single 1-1/4 inch diameter threaded rod welded to a cap plate and bearing on a single nut at a plate welded to the pile. The cap plate is welded to the beam saddle. There is no positive attachment to the plate at the pile. Many of the retrofits are beginning to fail. Where this cap is used at the deck support piles, it is beginning to roll. At one heavily loaded main building pile, the load is deforming the 1/4-inch pile cap plate downward where the threaded rod and nut bear. Along the south and east perimeter of the itinerate quarters, this pile cap assembly is overextended, and the threaded rod is bending. This yielding appears to be worsened by lateral displacement of the pile. Additionally, at these locations, the nut on which the assembly typically bears is no longer in contact with the cap plate.


Figure 4: Original Main Clinic Pile Cap


Figure 6: Failing Adjustable Pile Cap

Each of the steel piles at the main clinic/city hall addition have galvanized pipe thermistor tubes installed beside them. In some locations, these tubes are jacking and getting close to the underside of the structure.

Along the perimeter of the clinic interior, staff pointed out numerous locations where building movement created gaps between the interior partitions and the exterior walls.


Figure 5: Frost Jacking Thermistor Tube

FOUNDATION ASSESSMENT

RECOMMENDATIONS

Priority Items

1. Build up grade around stairs and ramps as required to ensure proper support and safe egress.
2. Install temporary steel members to bypass failing threaded rod supports to allow time to investigate and design a permanent retrofit for piles.
3. Mound soil around base of Thermo Ring-Piles to reduce water intrusion.

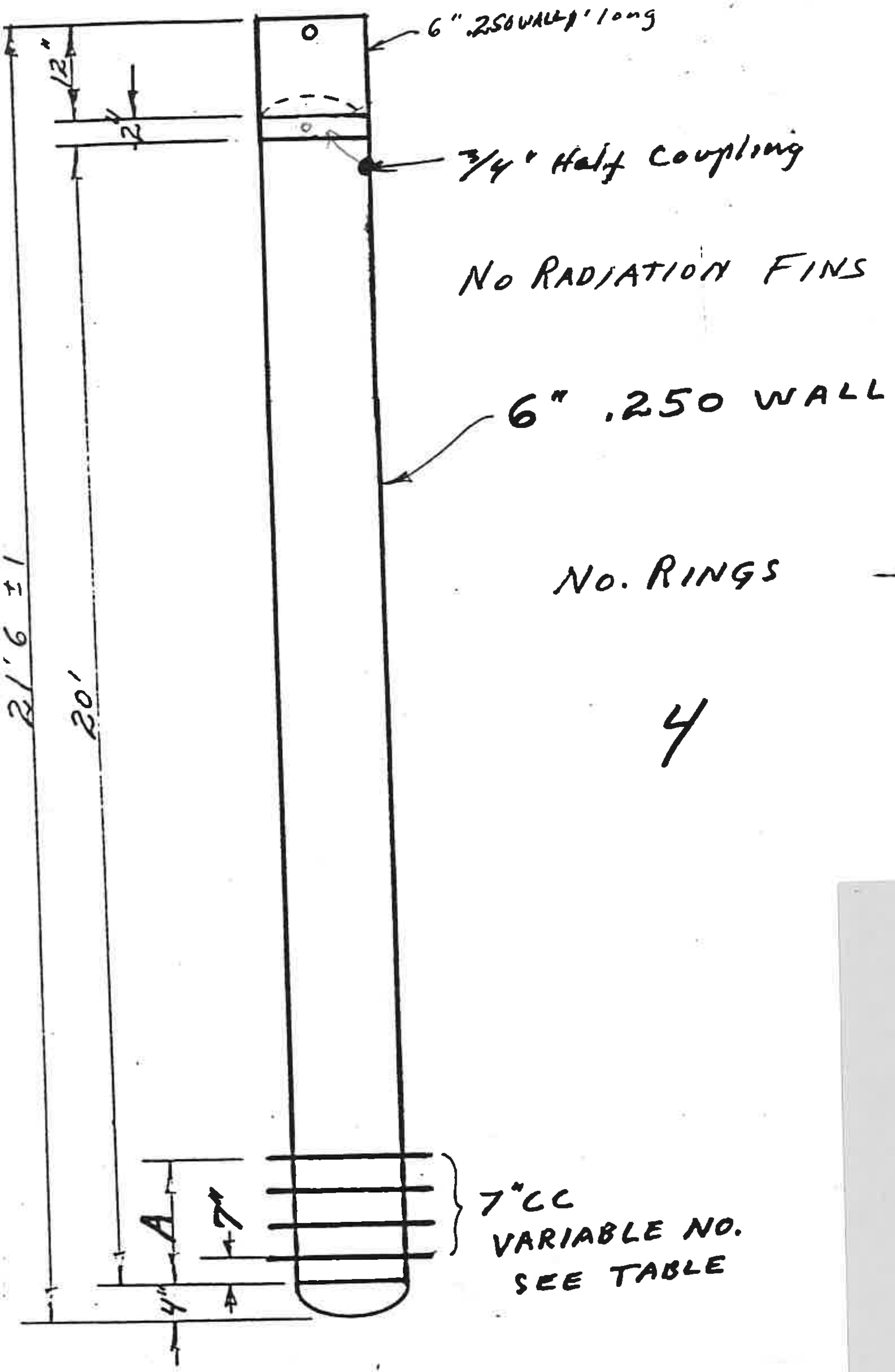
Recommended Future Work

1. Conduct thorough multi-day site visit to measure the elevations of glulam floor beams and piles.
2. Inspect Thermo Ring-Piles using infrared camera to confirm proper function.
3. Build-up grade in any depressions beneath the clinic to ensure water drainage away from foundation.
4. Investigate subgrade temperature gradient around piles across the site using thermistor strings and existing thermistor tubes.
5. Use findings from more detailed investigation to development permanent foundation solutions for all three pile types discussed herein.

Attachment 1
Thermo Ring-Pile Shop Drawing

GALENA CLINIC ADDITION

KING HARNESS



No. RINGS	QUANITY	A
4	~~15~~ 19	28"

ELL 4/14/80

Attachment 2

Harding-Lawson Associates Soils Investigation

Galena Health Clinic Addition

HARDING-LAWSON ASSOCIATES
624 W. International Airport Road, Anchorage, Alaska 99502
(907) 276-8102 Telex (090) 25-149

Engineers, Geologists and Geophysicists

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RECEIVED APR 0 7 1980

April 4, 1980
9642,001.08

City of Galena
c/o THE HAEG ASSOCIATES
825 West Eighth Avenue
Anchorage, AK 99501

Attention: Mr. Steve Bettis

Gentlemen:

This report presents the results of the soil investigation we performed for the planned addition to the existing medical clinic in Galena, Alaska. The work was performed in accordance with the scope outlined in our Service Agreement dated November 21, 1979. During the work, we consulted with Messrs. Steve Bettis and Gregg Strom of The Haeg Associates and Mr. James Filip, Galena City Manager.

The project will consist of a 59 by 28-foot single-story, wood-frame L-shaped addition to the east side of the medical clinic. At the time of our investigation, the building design had been finalized and a timber pile foundation was specified. Total loads of less than 20 kips per pile are anticipated. The purpose of the investigation was to explore the subsurface soil conditions at the site and to verify that permafrost conditions were adequate for the specified pile scheme.

Field Investigation

On February 13 and 14, 1980, our engineer directed the drilling of two test borings at the locations shown on the Site Plan, Plate 1. The site is bordered on the north, east and west by above-ground utilidors and the existing clinic on the west. Forest growth that is to remain blocks access from the south. Because the site is inaccessible to vehicles, the borings were drilled with a portable Mobile Minuteman drill rig utilizing 3-inch outside diameter (O.D.) augers and a 2.5-inch inside diameter (I.D.) modified thin-walled sampler used for coring frozen soil. The borings were drilled to depths of 18 and 22 feet as shown on the Logs of Borings, Plates 2 and 3.

During the drilling, our engineer logged the soil and ice encountered and obtained samples of representative soil types by extruding the soil retrieved by the modified sampler. The samples were sealed in plastic bags to retain their moisture (ice) content during transport to our laboratory in Anchorage. The soil and ice have been classified in accordance with the Unified Soil Classification System and Explanation of Ice Symbols described on Plates 4 and 5, respectively. Immediately upon completion of the first boring, a one-inch I.D. plastic casing was installed in the hole and filled with fluid. Temperatures were read at three-foot intervals in the casing 6.5 and 25 hours after the boring was drilled. As shown on Boring 1, the ground temperatures were at or below freezing, but had probably not yet stabilized from the drilling disturbance. Our engineer also interviewed city employees about local soil and permafrost conditions and problems with existing structures.

Laboratory Testing

In the laboratory, the samples were re-examined to verify the field classifications and were subjected to testing that included density determination, plasticity index, percent finer than the No. 200 sieve size, and freezing point depression. The results of the laboratory tests are presented on the boring logs.

Site and Soil Conditions

The site contains birch, spruce and cottonwood trees ranging from sapling size to 25 feet tall and six inches in diameter. About 40 trees lie within the planned building area. At the time of our investigation, the site was generally covered with three feet of snow, but snow-free areas adjacent to the existing clinic exposed mosses and high grass and weeds. The site slopes downward about three feet to the northeast.

The borings encountered fairly uniform soil conditions of 1 to 2½ feet of organic soils underlain by 11½ to 15½ feet of silt and sandy silt. The silt contained peat seams and abundant, very thin ice lenses. Silty sand was encountered beneath the silt and extended to the depths explored. All of the soils were frozen and no massive ice was encountered.

Discussion

Galena is known to be underlain by discontinuous permafrost that extends to depths of up to 90 feet. Permafrost encountered at the clinic site is warm, that is, near 32° F. Several nearby buildings have various foundation systems including slurried self-refrigerating and timber piles, refrigerated slabs-on-grade and timber cribbing. Most systems appear to be working satisfactorily. Distress was noted in the City Hall (sagging floor girder, interior wall cracking) and appears to be due to poor pile installation. We understand that nearby timber pile systems are on the order of 20 feet deep.

The existing clinic is supported on slurried timber piles that are reportedly embedded about 20 feet below grade. The clinic is about five years old and has experienced no discernible movement. However, the crawl space beneath the structure is partially obstructed by a boxed-in forced-air heating duct that extends the full length of the building, thus reducing the free circulation of the ambient air.

Conclusions and Recommendations

Based on the results of our investigation, we conclude that slurried timber piles deriving support through adfreeze bond will provide adequate support for the anticipated building loads. However, annual freezing and thawing of the active layer will cause large uplift forces on the piles due to frost jacking. Based on our interviews with local residents, we have assumed an active layer of five feet. Drilling will probably be accomplished with local equipment, which is limited to 21-foot deep holes, and we conclude that 16 feet of pile embedment into permafrost will not be sufficient to withstand the long-term effects of frost jacking. To lessen the amount of uplift and to increase the bearing capacity of the piles, insulation should be installed beneath the addition at the ground level to minimize the depth of annual thaw penetration. For design, we recommend using adfreeze bond strengths of 400 pounds per square foot (psf) of pile area for dead load and 600 psf for total design load. Additional recommendations are as follows:

1. Timber piles should be eight-inch minimum tip diameter ASTM Class B piles. The piles should not be creosoted below the insulation.

2. The pile holes should be dry augered to a diameter of about six inches greater than the pile diameter. The holes should be temporarily cased, when necessary, to seal off groundwater and soil sloughing. The piles should not deviate from the planned location by more than two inches in any direction or from vertical plumbness by more than one-quarter inch per foot.

3. The piles should be embedded at least 21 feet below the ground surface and placed butt down to provide added resistance to frost jacking. To provide a contingency for future freezeback should the permafrost warm, two-inch I.D. galvanized steel or plastic casing should be attached to each pile extending from one foot above finish grade to the bottom of the pile, filled with diesel oil and capped top and bottom.

4. Clean imported sand free of salt, frozen lumps, ice and organics, and which meets the following gradation, should be used for the slurry backfill:

Sand Gradation

Sieve Size	Percent Passing
3/4"	100
#4	90-100
#10	70- 90
#40	40- 80
#200	0- 20

5. The backfill sand should be mixed with clean water to form a semi-liquid slurry and should be vibrated in place for the full depth of the pile hole to insure high density and to eliminate trapped air. The mixing water used in the slurry should be from the water plant and of a quality suitable for drinking. Sufficient water should be added to saturate the backfill material and achieve a six-inch slump as determined by standard concrete slump tests.

6. Thermistors should be attached to the embedded portion of Piles C2, C4 and D4 (YSI Series 401 or equivalent) so that slurry temperatures can be monitored. The thermistor tips should be positioned at a depth of 10 feet and at the bottom of the piles (two thermistors per pile). Lead wires of sufficient length with standard phone plugs should extend above final grade for connection to readout equipment. The lead wires should be marked with the thermistor depths and coiled and stored in metal electrical boxes attached to the piles or floor girders. The contractor should provide suitable readout equipment (Data Precision Corp. Multimeter Model 248 or equivalent) which should become the property of the clinic custodian.

7. The piles should be placed and slurried as soon as possible after drilling the hole. Temporary bracing should be provided to maintain piles in alignment during backfilling and freezeback. Freezeback should be verified by thermistor readings. The piles should not be loaded until the slurry temperatures are 31.5° F. or colder. Conceivably, freezeback could require several weeks if the piles are placed in summer. To lessen the freezeback time, the contractor should consider mechanical freezeback methods.

8. Immediately upon completion of the pile installation, the cuttings from the holes should be spread across the site to provide a leveling course and bedding for the insulation. Two layers of 1½-inch thick rigid board insulation with a thermal conductivity of 0.24 BTU/inch-hr/ft^2 °F. or less should be placed over the site, with the joints lapped to prevent cold leaks. The insulation should be placed tightly against the piles and should extend eight feet beyond the perimeter piles. The site should be free of snow prior to placing insulation. A one-foot thick layer of gravel fill should be placed over the insulation to protect it from construction traffic and wind damage. If insulation is not installed immediately, the active zone could thaw sufficiently to reduce pile capacity against uplift. Additionally, refreezing time of the thaw beneath the insulation could require more than one winter.

9. The surrounding ground cover vegetation should remain in an undisturbed condition during and after construction. Trees should be cut off by hand at ground level. During construction, mats should be laid on the ground surface to protect the site from construction traffic damage. Adequate drainage

should be maintained around the site. We recommend that fill material be mounded around the piles to direct surface water away from the piles.

10. The open crawl space beneath the addition should match the existing clinic, should not be skirted and should be kept free of both temporary and permanent obstructions to allow free circulation of ambient air.

11. Drilling and pile placement should be observed by a qualified soil engineer who should document pile location, date drilled and placed, tip elevation, ground temperatures, and soil, ice and salinity conditions. After the piles are installed, the construction contractor should read and document the ground temperatures regularly. After the building is occupied, clinic personnel should document the ground temperatures quarterly.

The following plates are attached and complete this report:

Plate 1	Site Plan
Plates 2 and 3	Logs of Borings 1 and 2
Plate 4	Soil Classification Chart and Key to Test Data
Plate 5	Explanation of Ice Symbols

Very truly yours,

HARDING-LAWSON ASSOCIATES

Randolph R. Ross

Randolph R. Ross
Project Engineer

Paul G. Hansen
Civil Engineer - 3710-E

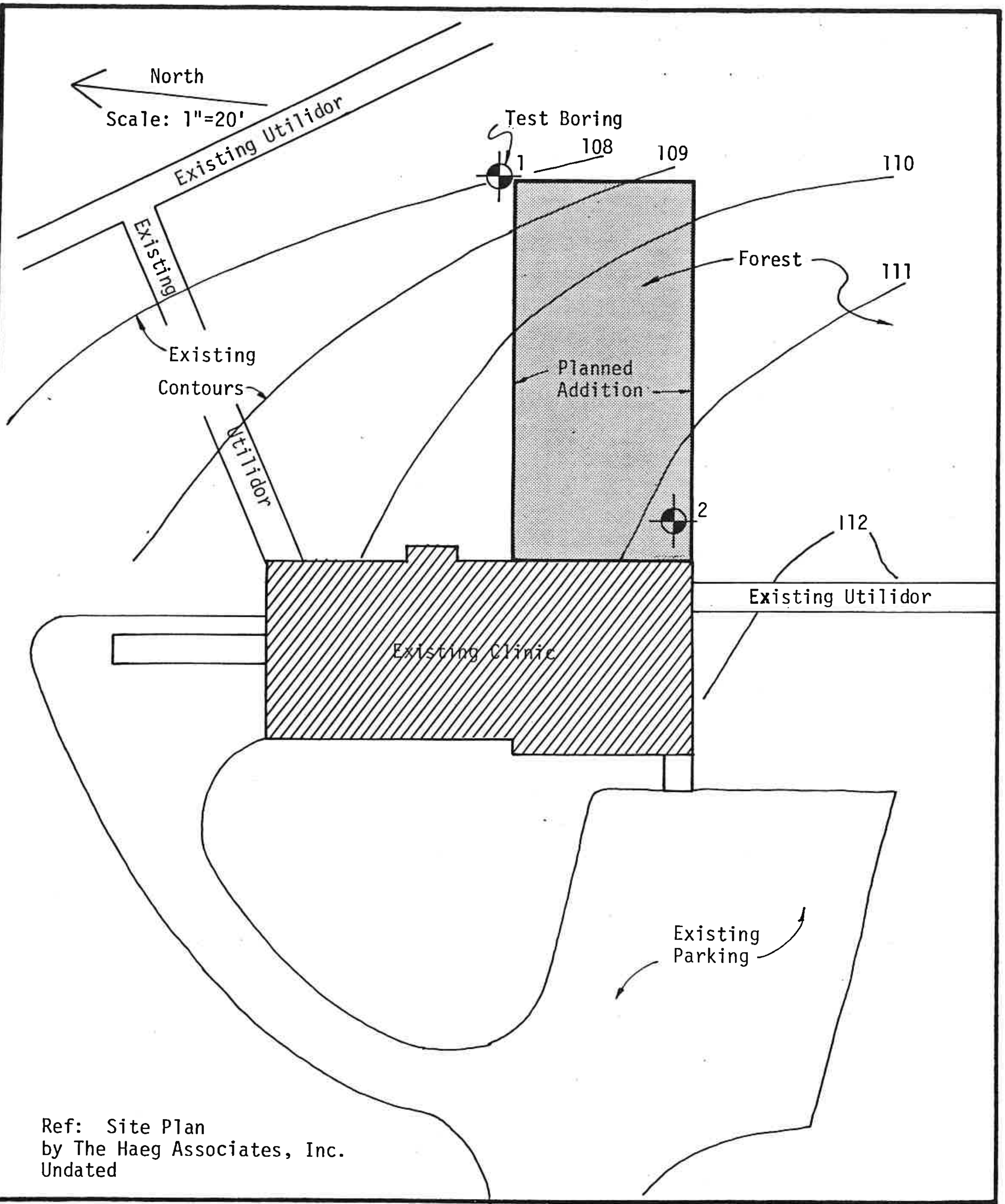
Quality Control Review By:

Keith H. Bergman

Keith H. Bergman - Civil Engineer

RRR/PGH/KHB/r

RF1



Ref: Site Plan
by The Haeg Associates, Inc.
Undated

HARDING - LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 9642,001.08 Appr: Date 3/80

Site Plan
Galena Health Clinic
Galena, Alaska

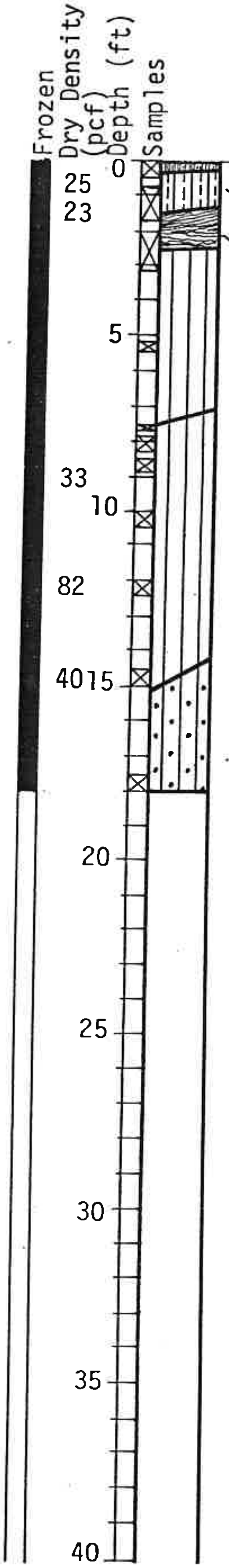
PLATE
1

LOG OF BORING 1

Equipment 3" O.D. Flight Auger

Elevation 108* Date Drilled 2/13/80

Laboratory Tests	Ground Temp. (°F)	Blows/Foot (N-Value)	Moisture Content (%)	Dry Density (pcf)
			255.8	25
			129.3	23
Minus #200 = 92.1%	27.6		110.7	
			162.1	
	30.9			
			606.2	
			84.0	
Minus #200 = 90.9%	31.5		83.0	33
PI - Nonplastic				
			82.1	
Freezing Point				
Depression =.03°C	31.9		33.7	82
			231.2	40
	32.0			
			25.9	
	32.0			



2-3" Forest litter & roots

DARK BROWN ORGANIC SILT (OL, V_r)
with paper thin ice laminations

WOOD

LIGHT BROWN FINE SANDY SILT (ML, N_b)
with ice lenses 1/8" thick

GRAY FINE SANDY SILT (ML, V_x)
with abundant thin peat seams

with papery laminations of silt and ice

without laminations (V_x), with some very fine sand

LIGHT GRAY-BROWN SILTY FINE SAND (SM, V_x)

*Ref: Site Plan
by The Haeg Associates, Inc.
undated

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Consulting Engineers and Geologists

Job No. 9642,001.08 Appr: V Date 3/80

LOG OF BORING 1
GALENA HEALTH CLINIC
Galena, Alaska

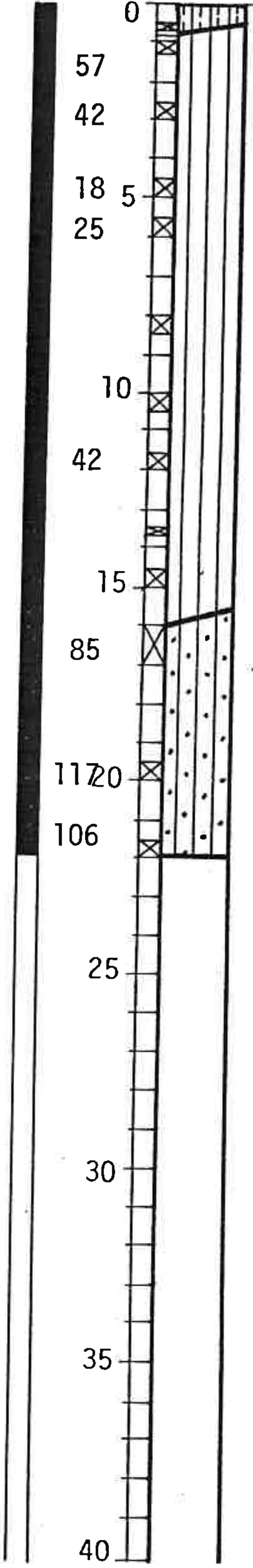
PLATE
2

LOG OF BORING 2

Equipment 3" O.D. Flight Auger

Elevation______ Date Drilled 2/14/80

Laboratory Tests	Ground Temp. (°F)	Blows/Foot (N-Value)	Moisture Content (%)	Frozen Dry Density (pcf)
			196.9	
			85.7	57
			103.2	42
			282.4	18
			196.4	25
			123.4	
			128.4	
			117.2	42
			114.9	
			54.1	
			33.4	85
Minus #200 = 2.5% Freezing Point			35.1	117
Depression =.02°C			31.1	106



DARK BROWN ORGANIC SILT (OL, V_r)
with ice lenses to 1/4" thick

GRAY SILT (ML, V_x)
with abundant organics, with abundant peat seams 1/2 to 1" thick
with abundant ice and occasional peat seams to 1/2" thick, with some very thin ice lenses, with organics @ 8', with small visible ice crystals, with papery laminations of ice and silt, with 1/2"-thick peat layers

with papery laminations of ice and silt

LIGHT GRAY-BROWN SILTY SAND (SM, V_x)
with very small visible ice crystals

grades to SP

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LOG OF BORING 2
GALENA HEALTH CLINIC
Galena, Alaska

PLATE
3

RF3A

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS MORE THAN HALF IS LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	⁘	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP	⁘	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	⁘	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC	▨	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	⁘	WELL GRADED SANDS, GRAVELLY SANDS
			SP	⁘	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	▥	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC	▩	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	▥	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	▨	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	▥	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	▥	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	▨	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	≋	PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION SYSTEM

Consol — Consolidation

LL — Liquid Limit (in %)

PL — Plastic Limit (in %)

G_s — Specific Gravity

SA — Sieve Analysis

■ "Undisturbed" Sample

☒ Bulk Sample

	Shear Strength, psf	Confining Pressure, psf	
*Tx	320	(2600)	Unconsolidated Undrained Triaxial
TxCU	320	(2600)	Consolidated Undrained Triaxial
DS	2750	(2000)	Consolidated Drained Direct Shear
FVS	470		Field Vane Shear
*UC	2000		Unconfined Compression
LVS	700		Laboratory Vane Shear

Notes: (1) All strength tests on 2.8" or 2.4" diameter samples unless otherwise indicated.

(2) * Indicates 1.4" diameter sample.

KEY TO TEST DATA

HARDING-LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 9642,001.08 Appr: Date 3/80

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

Galena Health Clinic

PLATE 4

RF1

ICE DESCRIPTIONS

GROUP SYMBOL	ICE VISIBILITY AND CONTENT	SUBGROUP			
		DESCRIPTION		SYMBOL	
N	Segregated Ice not visible by eye	Poorly bonded or friable		N_f	
		Well-bonded	No excess ice	N_b	N_{bn}
			Excess ice microscopic		N_{be}
V	Segregated ice is visible by eye, ice one inch or less in thickness	Individual ice crystals or inclusions		V_x	
		Ice coatings on particles		V_c	
		Random or irregularly oriented ice formations		V_r	
		Stratified or distinctly oriented ice formations		V_s	
ICE	Ice greater than one inch in thickness	Ice with soil inclusions		ICE + soil type	
		Ice without soil inclusions		ICE	

HARDING-LAWSON ASSOCIATES

Consulting Engineers and Geologists

Job No. 9642,001.08 Appr: Date 3/80

EXPLANATION OF ICE SYMBOLS
UNIFIED SOIL CLASSIFICATION SYSTEM
Galena Health Clinic
Galena, Alaska

PLATE
5