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MR Livengood #49

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NOT FOR PUBLICATION

NOTES ON THE THAWING OF FROZEN GROUND BY THE FAIRBANKS GOLD DREDGING COMPANY, FAIRBANKS CREEK, ALASKA

By N. L. Wimmler

The Fairbanks Gold Dredging Company operates two 4 cu. ft. diesel engine driven dredges on Fairbanks Creek in the Fairbanks district Alaska. These dredges can each dig 2000 to 2500 cu. yds. per day during an average season of about 140 days, although the actual total yardage dug during a season averages between 400,000 and 450,000 cu. yds. The company was one of the first to use water for thawing purposes. Thawing has been improved and the operation enlarged during the last few years. Up to 1926 the No. 2 dredge dug only naturally thawed ground in the upper part of the creek so that no thawing was done ahead of it. In 1926, the thawing done ahead of the No. 1 dredge was done with ditch water under a 40 foot head with a supplemental supply delivered by a 6 inch Morris sand pump driven by a 15 H. P. Scandia semi-diesel engine under ralatively low pressure. This pump could supply about 80 points, the total number of points set at that time being about 120. These points were of 1/2 inch ordinary pipe with open ends, the same as now used, and driven to bedrock at 5 foot centers. Some of this ground was 30 to 40 feet deep, although averaging 20 to 25 feet. Driving points was difficult and slow and a thaw required considerable time.

The No. 2 dredge was rebuilt further down the creek in 1927 and is now operating on No. 7 below discovery claim where ground conditions are similar to that now being dug by the No. 1 dredge on No. 5 below discovery claim. Thawing operations are now being conducted ahead of each dredge, the water being supplied by a small ditch for thawing ahead of the No. 1 dredge, while the supply is pumped for thawing ahead of the No. 2 dredge. The thawing equipment is otherwise the same at each operation.

Ground Conditions:

The pay dredging ground ranges from 300 to 400 feet in average width and most of it has formerly been mined to a considerable extent by drift and opencut methods. Much of the ground is covered with old tailings. The depth ranges from 20 to 30 feet and in places, where overlain by tailings, is up to 40 feet deep. Where undisturbed, there is up to 5 or 6 feet of muck overburden. The gravel is of medium size and contains some clayey sediment, and some clayey bands up to

18 inches thick. The bedrock is mostly a schist decomposed to a soft clayey mass for several feet in depth. Naturally, thawed channels and patches exist, so that the ground on an average is about half naturally thawed, leaving the other half to be thawed. Some of the ground is also naturally thawed from the surface down to a maximum depth of 20 feet. The ground under the old tailing piles of heavier rocks is generally frozen, while that under the smaller material of the old scraper dumps is generally thawed. The irregularity and the existence of these naturally thawed areas and channels complicate thawing procedure and the results. Much prospecting by driving down steel bars must be done in order to limit these areas. No stripping of the muck overburden is done, although the tailing piles are blown down and more or less leveled off with water under pressure.

Thawing Equipment:

The details of the pipe layout were not recorded. The standard thawing point consists of ordinary 1/2 inch gas pipe with open end point. The top is fitted with a "T" turned sideways, the upper arm being fitted with a steel plug for a drive head, the base being fitted with a short nipple for 1/2 inch ribbed garden hose connection. The headers have two way take offs with 1/2 inch connections. The various lengths are joined together as required by ordinary sleeves. Some of these pipe points cannot be driven to bedrock because of the depth of the ground or landing on a large rock. At times, if down 20 feet or so, these are left there to thaw and another may be put down to bedrock nearby, but as a rule the present practice is to withdraw the point, insert a special driving point in this hole, and drive it to bedrock. This point is made of 3/4 inch extra strong gas pipe to which is welded a piece of drill steel drawn into a cross bit of 1-5/8 gauge and having two slotted or drilled holes 1/4 to 3/8 inch in width or diameter, one opposite the other and about 1½ inches above the cutting edge. Holes are so put in that the water will jet downward and ahead of the bit.

Driving the Points:

Both types of points are driven with an 8 lb. hammer, one man driving while another man turns the point. The driving is hard and the progress is slow as a rule.

Experiments have been made here, and on Fish and Goldstream Creeks by other companies at the suggestion and with the aid of Irving Reed, whereby a small jackhammer air drill was utilized in driving these 3/4 inch points at that time equipped with a chisel bit, similar to those used by the Fairbanks Exploration Company on Goldstream Creek.

While the speed of driving was considerably increased, numerous difficulties were met. These points did not hold up well, not enough water could be delivered to the point to keep it clear, the drill rotation was too weak for this bit and in the opposite direction to the threading on the points, and the method of delivering the blow to the point was not practical. Changes were made. Single extra steel pipe in 5 foot lengths was then used with the ends ground true and threaded so they would butt in the sleeves which were also specially tapped and threaded for this. The best bit was found to be a cross bit of 1-5/8 inch gauge bored with a center hole and four other holes, one between each angle of the bit, centered around it. These holes are all 3/8 inch in diameter. These points were found to be satisfactory, all threads, however, being left handed to be in the same direction as the drill rotation.

A special combined water head, swivel, and drive head was designed by Reed which consists of a piece of 7/8 inch hexagon solid drill steel welded to the end of a piece of 1 inch extra heavy hydraulic steel pipe which passes through a specially designed packed water swivel with a water connection at one side. A series of 1/2 inch holes are drilled through this pipe so the water as admitted through the water swivel can pass through to the point. A steel ring is shrunk around the upper end of this pipe where the drill steel is welded to it to strengthen this join and to also act as a stop. Another ring is welded around the pipe as another stop below the water swivel. The lower end of the pipe is threaded inside to permit it to be turned onto the thawing point pipe. The piece of 7/8 inch drill steel is provided with a steel shoulder similar to the chuck end of the regular machine drill steel. As the drill operates, the blow is transmitted to the pipe, the water swivel being independent of the drill's action.

This equipment and method of driving points has improved the speed, but has been adopted only to a small extent by the Fairbanks Gold Dredging Company who used it with their 3/4 inch cross bit points in continuing with points which have landed on boulders at depths 20 feet or deeper or have encountered extra hard driving. Mr. Ray Humphries, the superintendent for this company, states that for this purpose the method has some application as it saves considerable footage which would otherwise have to be redriven with much difficulty and questionable success. Further improvements and experiments are planned by Reed. It however seems that this method has very limited application and it is very doubtful if it holds any advantages over the usual methods except as already mentioned. The cost of equipment, air, and its delivery into the field which would be additional to the usual thawing equipment are large factors against its adoption.

Thawing ahead of No. 2 Dredge:

Water for thawing is supplied by a 10 inch low pressure Byron Jackson pump and a 5 inch high pressure pump, belt driven by a 110 H. P. Scandia Pacific semi-diesel engine. All of this equipment was formerly used on the No. 1 dredge. The water is obtained from the immediate creek and reused. The average water temperature is stated to be 55° F. but this is no doubt incorrect and is probably a little colder than the average ditch water. It is attempted to hold the pressure at the cross-heads at around 30 lbs., but it often drops to 20 lbs. which it is stated is all right for thawing, but should be more than 20 lbs. for driving. The ground at present being thawed averages 32 to 33 feet in depth, with some 40 feet deep. The points are set at 10 foot centers and about 21 days are required to complete a thaw under average conditions. The greatest number of points set here is about 300.

Thawing Ahead of No. 1 Dredge:

An erratic and small water supply is provided by a local ditch under a pressure of 15 to 20 lbs. at the cross-heads, but this is stated to vary. About 300 points are set here, the spacing being at 6 foot centers, but in the future it is planned to increase this to 8 feet. The average thaw requires about 14 to 16 days.

Costs:

No costs are available. As only about half of the ground has to be thawed, the cost per cu. yd. dredged should be nominal. The thawing operations employed 20 men. Details and cost of thawing at this operation about five years ago were reported by me at that time. The cost of thawing at that time was stated to be 10 to 12 cents per cu. yd. thawed, or about 6 to 7 cents per cu. yd. dredged.

N. L. WIMMLER,
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CONFIDENTIAL REPORT---NOT FOR PUBLICATION

NOTES ON THAWING FROZEN GROUND WITH WATER AT NATURAL TEMPERATURES
AS PRACTICED BY
THE HAMMON CONSOLIDATED GOLDFIELDS CO., NOME, ALASKA.

By
N. L. Wimmler, 1926.

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The company operates three 9 cu.ft. electrically driven dredges,--No.1 dredge operating at Cooper Gulch, No.2 at Little Creek, No.3 at Saturday Creek; and No.4, a 3-1/2 cu.ft. dredge, on Snake River. Four areas, one for each dredge, are being thawed. Some of these areas are divided into different units, but for the purpose of this report each area will be referred to by the number of the dredge now digging it. The character and depth of the ground, the water supply and other conditions, vary in different parts of the field. Accordingly, there are variations in the practice. General conditions in the different areas are as follows:

Area No.1 - The ground varies from 55 to 68 feet in depth, averaging 60 ft. The sod and muck covering averages 2 to 5 feet thick. In this area, as generally in area No.3, the sod and muck covering is relatively thin and is only of slight consideration in the thawing. In the northern part of this area, and Area No.3, some of the gravels are cemented by lime, while at other places in this vicinity, large flat slabs of limestone may overlay bedrock, making the driving of points to bedrock most difficult. Such occurrences are, however, only of local extent, and are beyond the present considered dredging area. An average of 550 to 600 points are set at 32 foot centers in this area as most of points must be set by drilling holes to bedrock. In the more favorable places the points may be driven when they are placed at 16 foot centers, and the number set is proportionately increased. The minimum water pressure used in this area is 20 lbs. per sq.in., with a maximum of

80 lbs. when the Miocene ditch water is available. (See photos W14 & W15)

Area No.2 - The ground varies from 33 to 45 feet in depth, of which 5 to 15 feet, average 7 feet, is sod, muck and ice. The depth of this overburden causes notable subsidences in places of greatest depth or ice content. (See photo W16) In this area the points are all driven at 16 foot centers, so that 2400 points are required to thaw sufficient ground for one dredge. Pressure of the water used here varies from 20 to 80 lbs. per sq.in., according to the source of supply.

Area No.3 - The ground varies from 53 to 85 feet in depth. As a rule, the sod, muck and ice covering is 2 to 5 feet thick and is not a factor although at several places, especially ahead of the present dredge face, this covering is over 10 feet thick. Pioneer ditch water under 10 to 12 lbs. pressure at the manifold is mainly used in this area, except when water is pumped at 20 lbs. From 550 to 600 points are set in drill holes at 32 foot centers in this area. (See photo W17.)

Area No.4 - The ground is 10 to 23 feet in depth, only parts being covered with sod and a little muck. Much of this area is not frozen, being in the bed of Snake River. Water from a small ditch is available for a comparatively short period at a pressure of 7 to 8 lbs., most of the supply being pumped under 20 lbs. pressure. All points are readily driven to bedrock. About 250 points are set at 7 foot centers.

Water Supply.

Water supply for thawing is provided by three ditch lines. During periods of reduced ditch water supply, three pumping plants are available for returning the water to the points. The details of the ditch supply follows:

Ditch	Carrying Capacity Miners' Inches	Pressures at Manifold Lbs. per sq.in.
Miocene	4000 - 4200	80
Seward	1200 - 1600	40 - 85
Pioneer	500 - 600	10 - 12

The water from the Miocene ditch is conducted through a 54-inch diameter wood stave pipe line to the main "Y", thence thru three branches of 26-inch diameter steel pipe to areas Nos.1 and 2. Seward ditch water goes to separate "Y" and thence can be delivered to main lines leading to areas No.s 1 and 2. Pioneer ditch water is delivered to area No.3. Each pumping plant contains two 12-inch centrifugal pumps, each pump being directly connected to a 200 h.p. induction motor. Each pump will deliver ~~4000~~ 4000 gals. per minute. Pressure at the pump is usually maintained at 40 lbs., or about 20 lbs. in the field.

Water Temperatures.

The average temperature of the water during the four summer months ranges from 45 to 50 degrees F. It is highest during a dry or low water supply period when it usually reaches 67 to 68 degrees. On May 2, 1926, the minimum temperature of the water was 40°. The highest recorded during the summer was 73°. On August 25, 1926, during a rainy period and high flow the temperature of the water in the Miocene ditch was 50° and in the Pioneer ditch 51°. The Pioneer ditch water is usually 1 to 2 degrees warmer than that of the Miocene. It receives its water from Nome River, considerably below the intake of the Miocene. A considerable difference is also noted between the day and night temperatures. The pumped water is usually colder than the ditch supply. The coldest water used for thawing has a temperature of 40°, the contention being that the results obtained with colder water are not economically satisfactory.

Equipment.

The manifolds, which take the water from the main pipe lines and conduct it to the headers, are of 11 or 6 inch diameter, hydraulic, riveted, steel pipe with slip joint connections. Twelve headers taking off from one manifold, generally at intervals of 32 feet, usually make up one thawing unit. These headers are of 6 or 4 inch diameter 16 gauge hydraulic, riveted, steel pipe with slip joints made with a standard 2-inch water pipe connection every 16 feet. At each header connection, standing vertically, is a short 2-inch pipe nipple, or "riser", to which is joined a 2-inch "T" for the crosshead. For the 16-foot spacing of points, this crosshead has a 5-foot arm extending each way from the "T", made up of a short length of 1-inch pipe, a valve, another length of 1" pipe at the end of which is the male part of a special patented hose lock coupling. (See photo #19.) Where 32-foot point spacing is done, only every other header outlet is used and while a similarly constructed crosshead, as above described, may be used, it is customary to take off directly from the "T" with one short arm. The entire discharge from one header outlet goes to 1-1/2 inch point, at times thru two hose connections.

All points used for driving and thawing at 16-foot centers are constructed of 3/4 inch single X heavy pipe, in lengths of 10 to 20 feet joined together with standard sleeves. Two forms of steel bits are used. They are welded to the pipe. The Nome or straight bit, which is drawn to a point, is used for average driving conditions. The straight chisel bit is used in hard driving or bouldery ground. Both forms of bit are provided with two 3/8-inch round openings set 1-1/4 to 1-1/2 inches above the point and pointed straight down so the water will play ahead of the point. A goose neck of 3/4-inch pipe is fitted to the upper end of the pipe to which the 1-inch hose with the female end of the hose coupling is attached. (See photo W19.)

The points set in the drill holes, or at 32 foot centers, consist of 1-1/2 inch standard pipe with full opening at the lower end; and a 1-1/2 inch "T" at the upper end. The 1-inch hose connection to the "T" may be by a straight 3/4-inch nipple or a 3/4-inch goose neck. All pipe and fittings are of standard sizes and thread.

Driving and Spacing the Points.

The thawing points are usually driven to bedrock in ground not deeper than 45 feet. Occasionally some small local areas are encountered where conditions are too difficult for successful driving, while at other places where favorable conditions exist, points have been driven to a depth of 60 ft. Only the 3/4-inch points are driven and are spaced at 16 foot centers in equilateral triangular relation to each other. Frozen ground, being practically like concrete, must first be thawed ahead before the point can be advanced. The point drivers therefore work from point to point advancing each to the depth thawed ahead which varies usually from 3 to 12 inches and more per hour.

Devices for Driving Points.

Various devices for driving the points have been used, but all of the earlier ones but one have been discarded, and it is only used to a small extent. It consists of a heavy slotted drive head, or anvil, fitted with handles for turning and is keyed by wedges to the point at a convenient height. One man strikes this drive head with a heavy sledge hammer while another turns and works the point to keep it free. (See photo W18.)

New types of drive heads and slotted sliding hammers were designed last year by the men in charge. One of these consists of a case hardened cast steel drive head in the form of a heavy hinged clamp and is fitted with handles for turning the point. The other, is a case hardened cast steel ring which is slipped down over the point. The center is a tampered hole so it will key down over ~~the~~ wedges. A light clamp with handles is fastened below the ring for turning the point and also to hold in the wedges.

The hammers are made of cold rolled shafting, with a slot cut lengthwise so they can be slipped onto the point and freely raised and dropped. Two keys across the slot act as guides. One of these hammers weighs 23 pounds and is fitted with short handles. One man works this outfit, raising the hammer and driving it down against the drive head, turning the point from time to time to keep it free. (See photo W19.)

The other hammer weighs 44 pounds, being capable of striking heavier blows. A block with rope tackle swung from a light folding tripod made of pipe, supplies the mechanism for raising and dropping the hammer. One man operates it. (See photo W20.)

An experiment made to determine the relative efficiency of the three methods of driving showed the average advance per point by the old method with two men to a point to be 3.2 feet per man day; while with the two new one-man methods, this was a little over 5 feet per man day, with very little difference between them.

The best driving results are obtained when the water pressure is 40 lbs per sq.in. or more,--60 lbs. is generally better. At least 20 lbs. pressure at the cross head is wanted when driving in 40 foot ground. The loss of water pressure between the manifold and the cross head averages about 8 lbs.; between the cross head and the ~~point~~ outlets of the 3/4-inch point, from 12 to 15 lbs., and 5 to 6 lbs. with the open-end 1-1/2 inch point.

Drilling Holes and Setting the Points.

In all frozen ground 60 feet or more in depth, or ground in which it is very difficult to drive points, usually 45 feet or more in depth, the practice of drilling holes to bedrock and inserting the points in these holes, has been adopted. All of these holes are drilled at 32 foot centers. Only the 1-1/2 inch open-end pipe points are placed in the holes.

This drilling is done by 8 or 10 Keystone drills during the winter months, only a day shift being worked. A short piece of casing at the collar of the hole to keep out any surface water or foreign matter is all the casing used in drilling solidly frozen ground. A 5-3/8 inch drill bit is used which generally cuts a round, regular hole 6-1/2 to 7 inches in diameter. One drill will average 75 to 100 feet of hole in a 10-hour shift. The hole being completed into bedrock a short ways, it is pumped dry, and the 1-1/2 inch pipe (thawing point), the lower end of which has previously been sealed with an ice plug about 6 inches or so long, is lowered into position in the hole. Moss or hay is then packed around the pipe to a depth of about 5 ft. below the collar of the hole, covered with sand, wetted and frozen. This forms a seal for keeping out any surface water. The top of the pipe is covered with a t~~h~~in can. As soon as practical in the spring, water is run down the inside of the pipe by a 3/4-inch hose with a piece of pipe for a nozzle. This thaws and works its way down, taking out the ice plug in the pipe and soon the water works its way up around the outside of the pipe taking out the upper seal. The hose is then removed, the regular water connection made and the point starts its work.

Temperature Points.

Drill holes are also drilled to bedrock 96 feet apart between the rows of thawing points or one to every three points in that direction and 110.88 feet apart at right angles, or one to every four rows of points so that each temperature point will govern 12 thawing points. (See sketch showing arrangement.) A 3/4-inch pipe sealed at the top and bottom with a cap, with all joints coated with red lead to keep water tight, is set in these holes. As thawing proceeds, usually at intervals of every ten days, temperature readings are taken at different levels to ascertain the extent and height to which the thawing may have advanced. A resistance thermometer of the galvanometer type is used in taking the temperature. An insulated cable with a thermo-couple at the end is lowered down the temperature point and after allowing 10 to 25 minutes to permit a constant reading it is hooked up to the thermometer and the temperature for that level recorded. Temperatures recording more than 32° indicate that the ground at that place and particular level is thawed. Further readings are taken to determine the height to which the thawing has advanced. These are recorded and plotted on diagrams showing in section each temperature point, there usually being three of these in one line or row. The thawed area is filled in in black and the approximate contour of the level or horizon to which the thawing has advanced can then be drawn. When all of these points show thawed ground from bedrock well up to the surface, the area within their scope is considered to have reached a satisfactory thawed condition. In some ground, usually deep, an irregular unthawed horizon may still exist, frequently in the upper portion, that may lag in thawing. Intermediate thawing points of 3/4-inch diameter may then be driven to with a foot or two above the bottom of the frozen horizon and the thawing of this completed.

At the time the holes are drilled for the thawing points records are kept of any unfrozen ground encountered. These records are placed on a map showing the depth to which the ground is thawed, the particular horizon, etc. In a few places the ground may be unfrozen to bedrock and in other places one, two or more horizons may be frozen with unfrozen ground between.

After an area shows that the thawing has been complete the points are withdrawn. In the deep ground they are pulled with jacks. The 1-1/2 inch points are easier to pull than the 3/4 inch ones, being stiffer they stand more strain.

THAWING PERIOD.

The time required to complete a thaw is governed mainly by the character of the ground, the spacing of the points, the temperature of the water, the water supply, etc. The average time required when the points are set at 16-foot centers is from 30 to 35 days, and at 32-foot centers it is about 100 days. In the comparatively shallow ground in area No.4, at Snake River, where the points are set at 7-foot centers, it requires 20 to 25 days. After the ground has once been thoroughly thawed from well in bedrock to the surface there is no freezing back. However, the seasonal surface frost naturally does return. Ground that has only been partly thawed will freeze back some but can be readily thawed again the following season.

Water Consumption.

After the thawing point has been set, as much water is generally turned on as it can handle. As a rule, the more water that can be put into the ground the better the results. The amount of water turned in, however, is governed by ground conditions and the supply of water available.

The average amount of water used by a 3/4-inch point is 1 to 1-1/4 miner's inches, and 3 miner's inches for the 1-1/2 inch open-end point.

Efficiency of the Water.

The efficiency of the water is governed by many conditions and not enough is known about it to make any definite statement. So far, it has been found that about one-third of the heat units available in the water are used regardless of the temperature of the water going into the ground, whether it be 45 or 65 degrees. Experiments are now being conducted whereby the water is used intermittently. As the water going to one header and its points is automatically cut off at intervals of ten to fifteen minutes, it is at the same time turned into the next header and its points for an equal period. Thus, half of the headers and their points are flowing while the other half are shut off. It is hoped that this will increase the efficiency and economize water. The result of this experiment has not yet been determined.

Labor.

The crew employed on thawing varies, mainly according to the water supply. The average number employed during the summer is 85 to 90 men besides 18 men employed on the ditches, and the pump attendants who are employed at this work only when needed. The base wage scale is 70¢ per hour, exclusive of board. This wage holds for general labor and point-men. The winter drill crews are recruited from regularly employed men who would otherwise probably be without employment.

Confidential Data, Costs, etc.

Detailed costs or any direct statements as to the cost of thawing were not available, although indirectly it was learned that the average cost of thawing was at least 10¢ per cu.yard. Material reductions have been made in the cost since 1924, and it was intimated that the company expected to reach a cost of 8¢ per cubic yard in the main areas, if normal conditions prevail. This would include the operating, water, overhead, and all other costs chargeable to the thawing.

The thawing done at Snake River where easy driving conditions in shallow ground prevail, but where much of the water must be pumped and the work is conducted on a comparatively small scale, the costs ~~of thawing has been~~ 12 to 15 cents per cubic yard thawed. A considerable amount of the ground in this area is not frozen and the thawing in this area was completed this season.

The cost of drilling averages about 75¢ per foot of hole or 2-1/2 to 3 cents per cubic yard of ground thawed.

About three million cubic yards were thawed in 1925. The thawing during 1926 was greatly handicapped because of lack of water, occasioned by the exceptionally dry season. Even the returning water supply to the pumps became so slow and thick that most of the pumps were not operated. Sufficient ground will, however, have been thawed to keep well ahead of the dredges.

CONCLUSION.

The deep frozen ground of the Nome tundra and vicinity presents many difficulties in thawing, many of which are met in no other fields. Through costly scientific research and systematic operation this company has developed a thawing practice by which they are, to a great extent as least, able to meet these difficult conditions and successfully thaw this ground at a reasonable cost. Further experimental work is under way and improvements in the practice and reductions in the cost are anticipated. The ground is now thoroughly thawed at bedrock and, possibly, excepting a few small localities where exceptionally unfavorable conditions may prevail, all of the ground is satisfactorily thawed to the surface, as this season's dredging has demonstrated. The development of this thawing practice is most commendable. Many features of it will be of great benefit to other dredging fields where deep, frozen ground exists.

CONFIDENTIAL REPORT—NOT FOR PUBLICATION

MK Fairbanks 58
Livengood 49

NOTES ON STRIPPING AND THE THAWING OF FROZEN PLACER GROUND WITH WATER AT NATURAL TEMPERATURES, AS CONDUCTED BY THE FAIRBANKS EXPLORATION COMPANY AT FAIRBANKS ALASKA IN 1929

By N. L. Wimmler

CONFIDENTIAL FOREWORD:

The Fairbanks Exploration Company at Fairbanks, like the Hammon Consolidated Gold Fields Company at Nome, is a subsidiary of the U. S. Smelting, Refining & Mining Company. These subsidiaries follow the same policy as the parent company in that they will not give out any data of a confidential nature concerning their operations, and further, any data whatever obtained from them is given under the agreement that none of it be used for publication unless first submitted to the manager for censorship. This is also requested for any information concerning their operations regardless of the source. During the month of August, 1929, I again visited these operations and obtained certain information from, or by the permission of, Mr. O. J. Egleston, the general manager of both Alaska subsidiaries, with this understanding, although none of it so obtained pertained to the stripping and thawing operations. As Mr. Egleston may not be aware that much of the data herein presented is in my possession, it is requested that this report be held strictly confidential and therefore is for our office files only.

I was courteously shown over these operations by the company's engineers in charge of such work, and through discussions in the field with these engineers and through personal observation, extensive notes were made. None of the information herein presented can however be considered as official or exact, but only as general and approximate, although as complete and correct as conditions and source permit.

After visiting the Hammon Consolidated Gold Fields Company operations at Nome in 1926, I wrote a similar report on the thawing procedure there. It will be noted that the Fairbanks practice closely follows that developed at Nome. Thawing equipment, methods of driving and setting points, the spacing of points, etc., have been practically standardized, although the physical characteristics of the placer ground at Fairbanks differ somewhat from those at Nome. The Nome ground contains more clay and locally has features not encountered at Fairbanks, while at Fairbanks there is usually a deeper covering of muck and the placer is tighter and contains more fine silt. Such features affect the time required to complete a thaw.

The thawing procedure at both Nome and Fairbanks has been well developed and is producing satisfactory results, although all thawing results within economic limits are not perfect or can they be, for under certain conditions encountered it is not always practical, and almost impossible to obtain 100 per cent thaws over large areas. Under favorable conditions, and if deemed advisable because of the additional cost, and the time required, a thorough thaw can no doubt be obtained. Under most conditions, however, some incompletely thawed areas still containing some small irregular frozen blocks or "horses" may remain. Such remaining unthawed ground is difficult and more costly to dig and the gold recovery may be lowered, but fortunately, where the thawing procedure has been properly conducted, this is generally not a serious factor.

Acknowledgment is here made to R. B. Earling, W. H. S. McFarland, D. C. Beyer, F. S. Mulock and others, all company engineers, for courtesies and assistance in the field and for much of the information herein recorded.

AK Nome 52

CONFIDENTIAL REPORT-----NOT FOR PUBLICATION.

NOTES ON THAWING FROZEN GROUND WITH WATER AT NATURAL TEMPERATURES, AS PRACTICED BY THE HAMMON CONSOLIDATED GOLDFIELDS CO., AT NOME, ALASKA.

By

N. L. Wimmler, 1926.

CONFIDENTIAL FOREWORD:- Acknowledgment is made to Mr. R. B. Earling, in charge of the thawing operations at Nome, who so kindly accompanied the writer in the field and supplied most of the following data. Cost data and others of a confidential nature could not be given. Permission to publish the details of this thawing practice was requested of Mr. O. J. Eggleston, the General Manager, at Nome, but was not granted, he requesting that only general mention, if any, be made of it. His contention was that the company had expended large sums of money in experimental work and was still doing so, and as the present practice was in many ways still in the experimental stage, the time had not yet arrived to give the information to the public. This is most regrettable, for such data would be of great value and interest to the placer mining industry of Alaska, and other similarly situated countries.

The thawing started in 1922 by the original Hammon Company was far from satisfactory, both from the thawing and the economic standpoint. Much of the thawing done was not complete, particularly at bedrock, and frozen, irregularly shaped masses remained between points. Difficulty was met in driving points to bedrock in the deep ground, and in areas of local occurrence and extent where cemented gravel occurred or where bedrock was overlain by slabs of limestone. The drilling of holes to bedrock in such ground, at 32-foot centers, was then developed, but was only partly successful due to various reasons. This company was acquired as a subsidiary to the U. S. Smelting, Refining & Mining Company, in 1924. Exhaustive experimental and research work was then started and conducted along scientific lines by a staff of technical men. The results of some of this work are embodied in the present practice. Further experiments are being conducted, mainly, toward reducing the cost of setting the points and conserving water.

The patent rights to the Miles method of thawing frozen gravels with water at natural temperature were acquired by the original Hammon Company, which were in turn acquired by the present company. The present company has licensed several small dredging companies on the Seward Peninsula to use the Miles method without charge. Their policy seems to be to make no charge, but to license others merely as an acknowledgment of the patent rights.

CONFIDENTIAL REPORT--NOT FOR PUBLICATION

NOTES ON STRIPPING AND THE THAWING OF FROZEN PLACER GROUND WITH WATER AT NATURAL TEMPERATURES, AS CONDUCTED BY THE FAIRBANKS EXPLORATION COMPANY AT FAIRBANKS, ALASKA IN 1929

By N. L. Wimmler

GENERAL:

The Fairbanks Exploration Company entered the Fairbanks district, Alaska in 1924 and since then has prospected, and acquired most of the dredgeable placer ground on Goldstream, Gilmore and Cleary Creeks, thoroughly equipped the properties with water supply, stripping and thawing equipment and plants, erected a 6,000 K. W. steam electric power house, etc., and in 1928 began dredging operations with three electrically driven dredges. These are operating this season and before the season is over two more dredges, now under construction, will be completed and placed in operation. Some of the details of these dredges follow:

Dredge	Location	Bucket size	Av. daily digging capacity	Depth of ground (2)
No. 2	Lower Goldstream Creek	10 cu. ft.	8,500 cu. yds.	30-40 ft.
No. 3	At Chatanika, Cleary Creek	10 cu. ft.	8,500 " "	40-60 "
No. 8	Gilmore & upper Goldstream Creeks	6 cu. ft.	3,500 " "	8-15 "
No. 6 (1)	At Wagners, on Goldstream Creek	6 cu. ft.	---	10-20 "
No. 5 (1)	Upper Cleary Creek	6 cu. ft.	---	12-25 "

(1) Nos. 5 & 6 dredges under construction at this time.
(2) Average depth of ground dug or to be dug after preparation, see report elsewhere for details.

The average digging capacity of each of the 10 cu. ft. dredges is about 8,500 cu. yds. per operating day, they have dug as much as 10,000 cu. yds. per day. The 6 cu. ft. dredges dig about 3,500 cu. yds. on the average and have dug as much as 5,000 cu. yds. This means that the five dredges will dig, under average conditions, between 25,000 to 30,000 cu. yds. per day. The length of dredging season, or the number of days operated by each dredge is governed by many conditions. However, by assuming each dredge as digging for 150 days each season, and some will do better, it will mean that 3,750,000 to 4,500,000 cu. yds. of ground will be dredged in a season. Besides thawing this ground, much of the muck overburden must be removed by hydraulic methods.

This will give some idea of the scale upon which these operations must be conducted. The big task is to keep sufficient ground prepared ahead of the dredges so they will not be retarded. Much ground has been prepared, but even so several of the dredges, having dug up to the edge of the prepared ground, were obliged to shut down for two weeks to one month this season until the thaw under way just ahead was completed. Most of this trouble is being adjusted and unless unforeseen conditions arise, thawing will have advanced sufficiently well ahead of the dredges now operating, and ground has been thawed in the areas to be dredged by the two dredges now under construction, that there should be little if any further delay in this respect. How much ground has been prepared ahead is not known, but 12,000 to 15,000 thawing points are in operation. A very large sum of money is invested in thawing equipment. This season from 150 to 200 men were employed in the thawing operations and about 100 on stripping. These do not include a considerable number employed in providing some of the water supply.

GROUND CONDITIONS:

The depth and character of the muck and gravel vary, although bedrock is in practically all instances a schistose formation of varying kind and character ranging in structure from thinly laminated to blocky and in hardness from soft to hard. This bedrock can be readily dug by the dredges and usually from 1 to 3 feet is dug, but varying according to the gold distribution. A clay ranging from stiff to sticky, formed mainly from the decomposition of bedrock, overlies the more solid formation to a thickness ranging from an inch or so to a foot or more. The gravels can be classified as medium in size with but few large boulders. Considerable silt is generally present in the gravels and in general the gravels are tighter than average especially in the deeper ground, particularly on Cleary Creek. The pay channel on these creeks has been intensively mined in the past by drifting and opencut methods, although a considerable area remains which is practically virgin or very little cut up by former mining. Many tailing piles cover the surface of the ground. Where undisturbed, several feet of moss cover the muck which overlies the gravels to varying depths. The muck is composed of organic matter and ice in varying proportions and usually contains some fine silt and sand. Some interbedded layers or streaks of sand and silt are generally present. A tough peat or root growth overlies or imbeds the upper muck beds in places. Roots, brush, fossil remains, old mining timber, etc., are present. At places solid clear ice constitutes the principal portion of the overburden.

The depth of the muck and gravel, as well as local variations, will be stated in the discussion of the stripping and thawing operations as conducted at the different localities.

STRIPPING OF OVERBURDEN:

The method of stripping overburden will be discussed but briefly, but certain details of the method employed at these operations are of special interest. Until this season the water from the Davidson ditch was not available. A small and erratic supply under low head, as a rule, was provided by the local creeks. This supply was not sufficient to conduct systematic work or to strip the less favorable ground, especially that overlain by heavy tailings. This considered, some excellent results were, however, obtained. Although handicapped, considerable ground was thawed where only a portion of the overburden was removed or could be removed because of creek water gradient. In other instances no water was available to strip to the extent desired. There were, therefore, areas where from several feet to as much as 20 feet of overburden remained. The underlying gravels were thawed, also some of the muck overburden, but in many places considerable frozen overburden remained to be dug by the dredges. The question arises as to whether it would not be cheaper to strip off the rest of this muck, if conditions permit, or if under the conditions it is cheaper for the dredges to dig it. I am informed and believe it cheaper to strip it. The same would hold wherever the muck overburden is more than 6 feet or so thick. The best practice is no doubt to strip off all overburden and this will no doubt be done as far as practical. The drainage level of the creeks, however, regulates the depth to which overburden can be removed. At places, particularly on lower Goldstream and lower Cleary Creeks, this prohibits the entire removal. Much of this remaining muck is thawed during the thawing operations, or, after the moss covering is removed from the shallower muck, much of it then thaws naturally.

Numerous bad breaks in the Davidson ditch occurred this summer handicapping stripping operations especially on Goldstream Creek, as most of the breaks occurred on Dome and Eldorado Creeks. Water for stripping on Cleary and lower Goldstream Creeks must be provided by this ditch. It is also used on upper Goldstream, although here an additional supply is provided by the small Guise ditch from Pedro Creek.

On lower Goldstream Creek, using Davidson ditch water under 365 foot head through No. 2 giants with 2½ to 4 inch nozzles, from 10 to 20 feet of muck is stripped off. Stripping often goes to the gravel, but from 3 to 8 feet of muck may still remain. This to some extent at least is due to the drainage level of the Creek. The water duty here in stripping is stated to be 14.5 cu. yds. per miner's inch.

At upper Goldstream, just below Gilmore Creek, only the water from the Guise ditch was available at the time of my visit, although Davidson ditch water is also used here when available. With Guise water under 70# pressure a large area has been opened up for stripping. This supply only permits the use of 2 giants at a time, using from $2\frac{3}{4}$ to $3\frac{1}{2}$ inch nozzles. Very little bank-head water is available. The depth of muck ranges from 5 feet or so at the creek to an inner face up to 40 or 50 feet high. Much of this is clear ice. The main distributing pipe-line is laid along the creek bank from which there are 26 take-offs leading to as many giants, spaced so that each giant can sweep a circular area about 450 feet in diameter. Two men work from one giant to another piping off the muck as it thaws. Some excellent work has been done here and the water duty is stated to be about 20 cu. yds. per miner's inch. Fifteen men are engaged at this operation which includes those on the Guise ditch. The stripping cost here is probably around 3 or 4 cents per cu. yd. The creek gradient is about $1\frac{1}{2}$ to 2 per cent.

At central Cleary Creek, Davidson ditch water is used for stripping under pressure ranging from 120 to 160 lbs. Five $3\frac{1}{2}$ inch nozzles are used at one time. From 10 to 20 feet are stripped off. Much of this area is covered with heavy tailing piles. These are blown over on ground already stripped. Duty or cost not known.

Details of stripping operations by this company in 1926 were then reported. Details and cost figures are not available, but the stripping as now being done is very efficient and the average cost is probably not more than 5 cents per cu. yd. and may be a little less.

THAWING

WATER SUPPLY:

Experience at Nome proved the necessity of an adequate and steady water supply for thawing purposes. The solution there, as here, is the use and reuse of water by pumping supplemented by a ditch water supply when and where this is practical. Pumped reused water has some disadvantages, requiring a considerable reservoir for collection and settling and good screens to keep foreign material from entering the pumps as such material may clog the points and otherwise interfere with the water circulation. Dirty water also costs more to pump than the clear.

The water used in the thawing operations by the Fairbanks Exploration Company is mainly local creek water, sometimes added to by ditch supply, and pumped to distributing lines and finally circulated through the ground from thawing points. The water does its thawing in leaving the point, and unless unfavorable features exist, works its way up and around the point to the surface, the area around the point increasing as thawing advances. This water then flows by gravity to the settling pond and is eventually pumped back to the points. All water for thawing purposes is pumped. In average seasons a water supply is available usually only from about May 10 to September 20.

Pumping equipment has been standardized. The eleven pumps used for delivering water to the thawing points are Dayton-Dowds, all 16-inch intake with 14-inch discharge. These are direct connected to 200 H. P., 2200 volt, synchronous G. E. Co. motors, at 1200 R. P. M., and rated to deliver 6,000 gals. per minute at 100 foot lift. The intakes to these pumps are well guarded by screens. Some of these screens are of the mechanical type consisting of two screens which automatically rise and drop by chain and sprocket control. While one guards the entrance of the intake sump, the other is above the surface where high pressure water jets, which are automatically operated, cleanse it of foreign material. These pumps deliver the water to the main pipe line at pressures ranging from 20 to 40 lbs., varying according to locality and conditions.

PIPE LINES, HEADERS AND CROSS-HEADS:

The main pipe lines and distributors or manifold pipes are all of riveted steel hydraulic pipe with slip joint connectins and vary in size according to the requirements. The distributor or manifold pipes, which are usually 12 inches in diameter, some 11 inches, take off from the main lines, each connection having a similar sized gate. With the 16 foot point spacing, these pipes have take-offs every 13.86 feet center to center and with the 32 foot spacing every 27.72 feet. The headers connect at these take-offs to a 6 inch valve and connection.

The headers are of two standard sizes, 6 inch and 4 inch, 16 gauge steel riveted pipe, all having a connection welded to them every 16 feet apart. To these are connected the cross-heads composed of a short 2 inch nipple or "riser" to which a 2 to 1½ inch "T" is connected. Where the 3/4 inch thawing point is used these connections are usually 1½ inch riser and 1½ to 1 inch "T". A 3/4 or 1 inch nipple 5 inches long is connected with both arms of the "T", then a 3/4 or 1 inch valve followed by a short nipple to which is attached the male end of a special, patented, brass hose lock coupling. To this is joined the 3/4 inch heavy pressure hose leading to the points. (See photo). Where the point spacing is at 32 foot centers only every other connection is made the header. One cross-head with its two connections delivers water to two points.

THE THAWING POINTS:

All points used for driving and thawing at 16 foot centers are constructed of 3/4 inch extra heavy hydraulic steel pipe in lengths of 10 and 20 feet. These are joined together by special recess sleeves with special thread. The pipe have slightly tapered threads, the ends of the pipe being ground true and threaded just enough so that they will fit accurately and butt together in the sleeve. These points are equipped with a straight chisel bit with two 1/4 inch openings, one on each side, which permit the water to escape downward along a groove or slot and jet ahead of the bit. These openings are $1\frac{1}{2}$ inches above the cutting edge. The gauge of the bit is $1\frac{1}{2}$ inches. This bit is made of a mixture stated to be high and low carbon steel, drop forged and butt welded to the pipe.

The water hose is connected to the point by a piece of 3/4 inch pipe bent to form a goose neck, and a sleeve.

Where the 32 foot spacing is used the points, which are constructed of $1\frac{1}{2}$ inch standard pipe with full opening at the lower end, are inserted into drill holes. The water connection for these points consists of a $1\frac{1}{2}$ inch "T", one arm connecting to the pipe, the other fitted with a plug, and the base connection reduced for a downward curved 3/4 inch nipple about 6 inches long to which the hose is attached. (See photo). The goose neck connection is also used. All pipe and fittings for these points are of standard size and thread.

DRIVING AND SPACING OF POINTS:

Where the depth to bedrock is not over 40 feet, up to 45 feet at times where favorable conditions exist, the 3/4 inch point is used and these are driven, being spaced at 16 foot centers. In deeper ground, the maximum being about 85 feet, holes spaced at 32 foot centers are drilled down and into bedrock with a Keystone drill. The $1\frac{1}{2}$ inch open end pipe points are then inserted in these drill holes. All points are spaced in equilateral triangular relation to each other, although experiments are now under way with points set at right angular relation; i. e., a point at each corner of a parallelogram which, in the case of the 3/4 inch point, would be 16 feet by 13.86 feet. The contention is this simplifies the locating of the points and equipment, and the thawing results are expected to be as satisfactory.

METHOD OF DRIVING POINTS:

Various devices and methods have been tried for driving the points. Experience has led to the adoption of but one device and method. This consists of a case hardened cast steel drive head in the form of a heavy hinged clamp which fits around and is tightened by a clamp screw to the thawing point. It is also fitted with two wooden handles for use in turning and twisting the point as it is driven. The hammer is made of drop forged steel, being 12 inches long and 4 inches in diameter and weighs 27 pounds. A slot or opening is cut lengthwise to the center so it can be slipped over the point and freely slide up and down. A 1/2 inch round steel bar passes through the hammer and slot, acting as a guide and key and also for handles. With the water turned on, the point is first jetted and twisted down as far as it will go, the driving device is attached, the hammer is raised by the one man operating it, and thrown down against the drive head. The point is then turned by the drive head handles to keep it free and another blow is given, etc. (See photo). Frozen ground, being practically like concrete, must first be thawed ahead before the point can be properly advanced. The pointmen are therefore allotted 16 points each to drive, and so work from point to point. The driving duty varies according to the ground conditions, water supply, the pointman, etc. At lower Goldstream the duty averages about 7 feet per man hour and at central Goldstream about 10 to 12 feet. The best driving results are obtained when the water pressure is higher than that used for thawing. Colder water can also be used for driving than would be considered efficient for thawing. Driving can therefore be started earlier in the spring and continued later in the fall. Where the muck covering may be deep, points are driven intermediately between the regular points. These points are usually only driven to within 4 feet or so of the bottom of the muck layer, when after thawing for about $2\frac{1}{2}$ days or so are removed and the rest left to the regular settings. Intermediate points are also set where after the thaw has well advanced, it has been found by barring that isolated or intervening frozen spots or horses remain.

As soon as a point has been driven into bedrock and set, a red twine is tied to it to so designate it. Loops of wire are also hung over the connection to show the depth to which the point has been driven until it has been finally set and tied with a red twine.

DRILL HOLES:

Keystone drills are operated during the season only for drilling holes at 32 foot centers in which the $1\frac{1}{2}$ inch points are inserted. At Nome drilling has been done during the winter also, when the holes and points are given special handling. So far no winter drilling has been done here, but the demand may arise. The ground drilled is usually frozen solid when no casing is required except a short length at the collar. Occasionally the ground is partly thawed or the hole may slough in drilling when casing becomes necessary, but is withdrawn after the point has been inserted in the hole. The regulation churn drill bit is used for drilling and where not cased, the diameter of the hole averages about $5\frac{1}{2}$ inches. The speed of drilling varies according to the ground, but it is stated will average about 4 to 6 feet per hour. See Nome report). These drillings are usually not sampled although every other hole drill in the line for the temperature points is often sampled as a check against former prospecting. Until the water connection has been made to an inserted point the top is capped by an inverted can to keep things from falling into it.

THAWING:

When the points are set, water under different pressures and varying temperatures is turned into the ground through the points and thawing proceeds. Varying character and depth of ground, water supply and temperature, etc., govern the pressure of the water applied, the time required for thawing etc. These features differ at the various thawing operations conducted by this company and will be stated in more detail later in this report.

Practically ideal thawing and control of the water could be maintained if all of the water leaving the point would return to the surface evenly around the periphery of the circular area surrounding the point which increases in diameter as thawing advances and if the ground were all of the same character so as to permit even circulation and thawing. However, it is seldom that all of these conditions are encountered. Thawed channels may exist or develop at some horizons so that water from one point may not come to the surface for some distance away. Clays thaw slower than loose gravel or sand, etc., so that some beds will thaw faster than others. These and other conditions may prohibit the control or application of the water to the frozen faces, or, due to varying rates of thawing, some irregular frozen spots or areas known as "horses" may easily develop and usually do. In shallow ground a steel bar, or a "doctor" which can be jetted or driven readily in thawed ground, is used in prospecting for such "horses." In the deeper ground, however, a steel bar can seldom be driven to bedrock or is it practical to use a "doctor." Temperature points are therefore used at these operations to observe the advance of the thawing, as well as 7/8 inch round steel bars for locating unthawed areas or horizons in the shallower ground. Where the thawing is lagging or where such horses exist intermediate thawing points are driven into them.

TEMPERATURE POINTS:

Temperature points are set in order that the temperature may be taken and the advance of thawing gauged thereby. These points are made of 3/4 inch extra strong hydraulic pipe in the same lengths and with the same thread and sleeves as the 3/4 inch thawing points. These are set in the center of the equilateral triangle and spaced so as to be 96 feet apart in one direction and 110.88 feet in a direction at right angles, forming a large parallelogram. Where the holes are drilled, these points are closed at the bottom with a cap and all joints are tightly sealed. A cap is also connected to the top. Where points are driven, this driven point is withdrawn and a temperature point fitted with a solid steel point or straight bit without water openings is driven down into this hole and sealed at the top with a cap. The temperature points must be kept dry inside.

GROUND TEMPERATURE READING:

As thawing advances, the temperature at various horizons in the temperature points are taken. This is done with a resistance thermometer with the whetstone bridge type of instrument. (See photo). The thermometer itself consists of a thermocouple attached to a long insulated three lead cable. This is lowered down the temperature point say 5 or 10 feet below the surface of the ground and left for one hour to adjust itself. To save time, a number of these are used. The recording instrument mounted on a tripod is then set up alongside and levelled to read zero on right dial. The thermometer table is then attached and the release button is pressed whereupon the point of the left dial records the temperature. This reading is then entered in field book as for that hole at that depth. Subsequent readings are then similarly taken after each reading, the thermometer being lowered 5 feet and left 15 minutes to adjust itself before the reading is taken. In this way the temperature at each 5 foot horizon is taken. Every 10 days new temperature readings are taken. Each set of readings for that date is later recorded graphically on tracing cloth of note book size. When temperatures recorded are 32½ degrees or more that horizon is filled in in black. Subsequent sets of readings are similarly plotted alongside each other and as thawing continues the black area increases. When black shows for the entire depth, or, in case of overlying frozen muck which may still record below freezing, the ground in the vicinity of that temperature point is considered as thawed. The application of water is however continued until all of the temperature points within a large area, or the entire unit, all record 32½ degrees or higher. The area in the meantime has also been barred and intermediate thawing points set and the frost removed there. This area is then considered as thawed.

THAWING PERIOD:

The time required to complete a thaw is governed mainly by the character of the ground, the spacing of the points, the temperature of the water, the pressure and amount of water, etc. The company engineers state the depth of the ground has little effect on the rate of thawing. The temperature of the water during the thawing season ranges from about 34 to 60 degrees, and at times during a few of the warmest days may become a little higher. Water at temperatures less than 40 degrees is not considered efficient for thawing, although suitable for driving and setting points. However, under average conditions and temperature only about 25 to 30 per cent of the available heat units in the water can be utilized for thawing; this, however, fluctuates and also is governed by the pressure, amount of water, temperature, etc.

At lower Goldstream, the average time to complete a thaw is about 45 days, and at all of the other localities where 3/4 inch points and 16 feet spacing is used the average time is 30 to 35 days.

On lower Cleary, where the spacing is 32 feet, and 1½ inch points are used, it requires from 100 to 150 days, to nearly two seasons sometimes, to complete a thaw.

WATER CONSUMPTION:

The water used by a 3/4 inch point ranges from 3 to 5 miner's inches on Goldstream and on lower Cleary Creek where the 1½ inch open end point is used, 1.2 to 1.5 miner's inches. In comparison, I am informed that the 1½ inch points at Nome now use about 2 miner's inches, the amount of water now used there being apparently considerably less by all points than in 1926.

SPECIAL LOCAL FEATURES:

The depth of ground at lower Goldstream ranges from 40 to 50 feet including the muck. The average depth is 37 feet after stripping some of the muck but still including up to 7 or 8 feet of muck which still remains at places.

Three pumps are operated here, the water from Engineer Creek providing the original supply which fluctuates from 5 to 100 miner's inches. It is reused and usually there is a small excess to overflow. The pumps here work at 27 lbs. at the intake and 37 lbs. at discharge. A total of 1600 miner's inches are pumped here and delivered to three lines of 14 to 18 inch pipe. These deliver to a 30 inch line which delivers to 12 inch lines with 12 inch gates. It is stated that a 15 inch gate would be better. Five units of points are operated here or a total of 4500. The average pressure is about 30 lbs. at the cross-head, the minimum 20 lbs. which is considered a little low for this work. Headers here are 600 feet long--first 300 feet of 6 inch pipe followed by 300 feet of 4 inch. The pipe line here is connected with the Davidson ditch, which supply may be used when and as available. Temperature of water here ranges from 36° to 60°, averaging about 44 degrees for the season. The temperature of this water on July 9, 1929 was 9 degrees lower than same time in previous year. Thaw requires 45 days here with average water.

CENTRAL GOLDSTREAM--WAGNERS:

Total average depth of ground 25 to 30 feet. Much opencut mining formerly done here. Heavy tailing piles. Ground around old opencut pits mostly naturally thawed. Average depth of gravel 12 feet with 12 to 15 feet of muck. Thawing so far done without much stripping. One pump delivering at minimum pressure of 12 to 15 lbs., about 650 miner's inches of water to 1400 points. Intermediate points set in the muck. Plan to strip off more muck after gravel is thawed as ditch water so far not available. This pumped water pretty thick. The ground is, however, considered as the most favorable for driving points and thawing and to be the least expensive to prepare in this respect. Thaw requires 30 to 35 days with average water. Temperature of water a little lower than that on lower Goldstream.

GILMORE CREEK:

Ground is shallow ranging from 6 to 10 feet of gravel with muck from few feet up to 10 feet, and more at the sides. Some stripped, but where not is 8 to 15 feet deep as average. No. 8 dredge digging near mouth of Gilmore Creek on Pedro Creek where stripping was not completed is digging in ground 12 to 30 feet deep with muck in places 7 to 10 feet deep which is still frozen. Two pumps supply two units on Gilmore Creek, each of 1100 points. Higher lift here because of grade. Use Gilmore water which is cleaner than on Goldstream. The minimum pressure at cross-heads is 10 to 12 lbs., but 20 lbs. at times used and considered better. Temperature of water here about 4 degrees higher than on Goldstream. This shallow depth of ground does not permit the shallower to be stripped because of refreezing in the following winter. Thawing on this creek now practically completed.

UPPER CLEARY CREEK:

Ground averages 30 feet in total depth with 17 to 18 feet of muck to be stripped. One pump delivers water at pressure of 10 to 15 lbs. at cross-head. Usually try to hold within this range. Temperature about same as lower Goldstream. Requires 30 to 35 days to complete thaw.

LOWER CLEARY, CHATANIKA:

The deepest of the ground to be prepared and dredged is here, there being 40 to 60 feet of gravel and 10 to 30 feet of muck. While considerable stripping was done with low pressure water, there still is 10 to 20 feet of muck remaining in many places. Will do better as soon as get Davidson ditch water. Dredge No. 3 was digging ground 60 feet below water level with about a 20 foot bank of muck and light wash. Deepest ground to be dredged here, for present at least, is about 85 feet deep.

Four pumps take the local water, water from the 10 mile ditch under about 60-65 foot head, and boost it to 30 to 40 lbs., 20 lbs. minimum pressure, at the cross-heads. Pumps deliver 2400 miner's inches of water to four units each of about 500 points. The number varies according to character of ground and the water supply. Water delivered to 11 inch distributor pipe with 6 inch connection and valve. All points here are of $1\frac{1}{2}$ inch pipe set in drill holes at 32 foot centers. Temperature of water about the same as at lower Goldstream. Thaw requires 100 to 150 days to complete, but some requires nearly two seasons. Thawing cost here stated to be higher than at any of the other operations.

About half way between Chatanika and upper Cleary an area is being thawed where both deep ground and ground less than 40 feet in depth is encountered. Here the two kinds of equipment and procedure are more or less combined.

LABOR:

The crew employed on thawing fluctuates considerable and is governed a great deal by the water supply. This season it is stated there were about 150 men employed on the thawing operations, exclusive of any ditch tenders. At times there were probably more employed. About August 20, when thawing points had been placed at several localities for the last thaw of the season, a large number of men were released, although thawing itself will probably continue until late in September. General labor, pointmen, and pumpmen are paid $57\frac{1}{2}$ cents per hour, and pipemen 60 cent, for a 10 hour shift, and board and lodging.

CONFIDENTIAL DATA, COSTS, ETC.:

No data was obtained from the company office so many details are lacking. Costs are unfortunately not available, but one of the company's engineers intimated that the operating cost of stripping, thawing and dredging would be about $22\frac{1}{2}$ cents per cu. yd. The cost of dredging he believes will eventually average about 8 cents. Another company engineer hopes it will not be more than 10 or 12 cents. At present, I estimate the operating cost of dredging alone to be around 15 cents, and the cost of thawing varying from 8 to 15 cents per cu. yd. thawed or an average of around 10 cents or so. These costs will probably be lowered in the future for until now there have been many problems to work out and establish the operations on a more economical and systematic basis. Good progress has been made in this respect and the first real test will be next season when sufficient ground will have been prepared well ahead of the five dredges which will then be operating, and it is hoped the Davidson ditch will be so established as to not cause future serious delays.

N. L. WIMMLER

Sept. 23, 1929

MR Livengood 49
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NOT FOR PUBLICATION

NOTES ON THE THAWING PRACTICE ON FISH CREEK IN THE FAIRBANKS DISTRICT, ALASKA IN 1929 BY THE TANANA VALLEY GOLD DREDGING COMPANY, LTD.

By N. L. Wimmler

The Tanana Valley Gold Dredging Company, Ltd. operates a 5 cu. ft. electrically driven dredge on Fish Creek in the Fairbanks district, Alaska. This dredge has a rated normal digging capacity of about 3000 cu. yds. per day. It is hoped that sufficient ground can be prepared so that in the future 200,000 cu. yds. or better can be dug during a season. In 1928, before changes had been made on the dredge and thawing practice had improved to its present status, this dredge averaged only 1030 cu. yds. per day during the 99½ days of operating season. Only 32 per cent of this time was actually spent digging, while 68 per cent was lost, mainly in making repairs, and delays while ground was being thawed ahead.

Ground Conditions:

The main paystreak on this property was formerly mined by opencut and drift methods and the old tailing piles cover considerable of the surface. The width of dredging pay is contended to be three to four times that of the main paystreak. The total average depth of ground now being prepared or dredged is 20 to 25 feet, about 10 feet of which is muck. This muck is deeper at the sides, reaching a maximum depth up to about 35 feet. Water shortage permits very little stripping. The gravel contains mainly schist, quartzite and quartz, is of medium size, 12 to 15 feet thick, with the upper 5 feet or so relatively free from clay, while the gravel underlying this contains considerable clay and micaceous material which makes it quite compact and more difficult to thaw and dig. Bedrock is a schist, varying from a soft shaley to a hard, blocky, and siliceous variety, and containing stringers and blobs of quartz. It is generally decomposed and for the upper foot or two is mostly soft and clayey. Most of the ground is frozen, although a narrow channel of thawed ground from 25 to 60 feet wide closely follows the present bed of the creek where most of the muck has been washed away.

Water Supply:

When available, as at the time I visited the operations, water for thawing is obtained from a ditch about 2 miles long which seldom provides more than about 300 miner's inches or so, but usually less. This delivers the water to the cross-head at this locality (No. 4 Claim above Discovery) at 20-22 lbs. pressure. Reed reports 18 lbs.

Supplementing the ditch supply, whenever necessary, water is pumped and reused. For this there is one 6 inch Gould centrifugal pump of 1000 gal. rated capacity at 1750 R.P.M. direct connected to a 25 H.P. induction motor; and one 3 stage 6 inch high pressure pump, which can deliver up to 80 lbs. pressure, driven by a 25 H.P. motor. These motors are 3 phase, 60 cycle, using alternating current at 440 volts.

Besides the water thawing, some steam thawing is also done in some of the irregular or isolated areas.

Thawing Equipment:

From the ditch pipe line or the pumps, the water is delivered to a 12 inch line laid alongside of the area to be stripped. A 6 inch lateral 150 feet long is connected to this main line every 31 feet. Every 14 feet along these laterals is a connection for the $1\frac{1}{2}$ inch header pipes. These headers have a connection every 5 feet where a 3/4 inch nipple and "T" are joined on. These "T"s are bushed down for the 3/8 inch nipple and hose connection. Each header extends 13 feet right and left from the lateral and feeds twelve points, or 8 points and 4 "muckers." These dimensions of the pipe layout are those reported by Irving Reed.

The points are spaced at 7 foot centers, usually in a square relation. These points are 1/2 inch ordinary gas pipe with open end and at the top are fitted with a 1/2 inch "T" turned on side, one arm being turned on the point, with the upturned arm being closed with a soft malleable iron plug for driving. The base of the "T" is bushed down for a 3/8 inch nipple and hose connection. These thawing points are made up in 8 and 16 foot lengths and connected with an ordinary sleeve.

Driving the Points:

With the water turned on, the point is jetted and worked down as far as possible and is then driven by a hammer weighing about four lbs., and at the same time twisting and turning the point with a wrench. It is contended the points are difficult to drive in most of this ground. Also, that the open end points get plugged unless a medium high pressure is used while driving. While one man works at a number of points, it is reported it requires from 30 to 50 hours to set a point to bedrock, although this seems pretty long. Points, locally called "muckers" are driven into the muck wherever its thawing lags behind that of the gravel. They are made of 1/2 inch pipe in 8 foot length and fitted with an "L" bushed down to 3/8 inch for hose connection. A 3/4 inch pointed steel bar is used to test for frost. When water conditions permit and everything is going satisfactorily, 400 to 450 points are in operation.

Water Temperatures, etc.:

The ditch water temperature is stated to average about 48 degrees, 58 degrees being recorded during the warmest days. Reed reports the average temperature of the water going into the points during May, 1929 as 37 degrees F., and on reaching the surface 40 degrees. In June, this was 42 degrees and 40 degrees respectively. The May performance is peculiar and questionable, but as stated by Reed to be apparently due to the character of the hole where the temperatures were taken. At the time of my visit, August 5, I was informed it required 9 to 12 days to complete a thaw. Reed reports the average to be about 15 days.

Labor and Costs:

Twenty-eight men are employed on the thawing operations at present, working in two shifts, each of 10 hours. About 4 men per shift are engaged in driving the points. It is contended no records were kept on the thawing operations until this season, although the operating cost for thawing is stated to be $7\frac{1}{2}$ cents per cu. yd.

Comment:

I consider this ground as not unfavorable for both driving and thawing. The dredge was digging in frozen ground when I was there and no doubt the thawing is not very complete. The cost reported is also probably a guess, but if not, may not hold for the entire season. It may be higher, although the cost given can no doubt be realized if the proper equipment was provided and the work more systematically conducted. See report on thawing at Fairbanks Creek by Fairbanks Gold Dredging Company in regard to experiments with jackhammer for driving points.

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