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Operations of the Yukon Consolidated Gold Corporation

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(Annual General Meeting, Quebec, Que., March, 1939)

THE Yukon Consolidated Gold Corporation, Limited, a Canadian company, operates alluvial gold dredges in the Klondike goldfields of Yukon Territory. Its operations are of unique interest to Canadian mining as it is the only large-scale placer mining operation of this type in Canada. Its properties lie in the valley of the Klondike river and its tributaries, Bonanza, Hunker, Bear, Last Chance, and All Gold creeks, and in the valley of Indian river and its tributaries, Dominion, Gold Run, Sulphur, Eureka, Montana, and Quartz creeks. At the end of 1938, they consisted of 1,650 placer mining claims and 9 leases or concessions. They cover a belt with an area of approximately 1,000 square miles. This vast area covers in part claims which have been previously worked by other methods such as 'drift' and 'open-cut' mining, and areas which were too low grade for such methods.

The ground held by the Company is not held in freehold but in the form of mining claims and mining leases granted by the Dominion Government under the provisions of the Yukon Placer Mining Act. Full-size creek claims are 500 feet in length by 1,000 feet on either side of the base-line. Hill and bench claims are 500 feet up and down the valley and 1,000 feet at right angles to the valley. All claims are held on the basis of an annual renewal fee of $10 for each claim plus 'representation work' of an assessed value of $200 per claim per annum. For the purpose of such representation work, claims may be 'grouped'. This means that work done by one dredge is sufficient to 'represent' a comparatively large block of claims. It is only in this way that it becomes possible to consider operations on a large scale over a term of years, for such operations would obviously be impossible on low-grade ground if representation work had to be done separately on each individual claim in each year.

Dawson, the operating headquarters, is situated at the confluence of the Klondike and Yukon rivers, about 46 miles east of the Alaska boundary at latitude 64° 05′ North, longitude 139° 20′ West of the meridian of Greenwich. Situated as it is in the interior of the continent and within 250 miles of the arctic circle, climatic conditions approximate those of the arctic regions. Winters are long and severe, but the summers are warm. From the middle of May to the early part of August there is practically no night.

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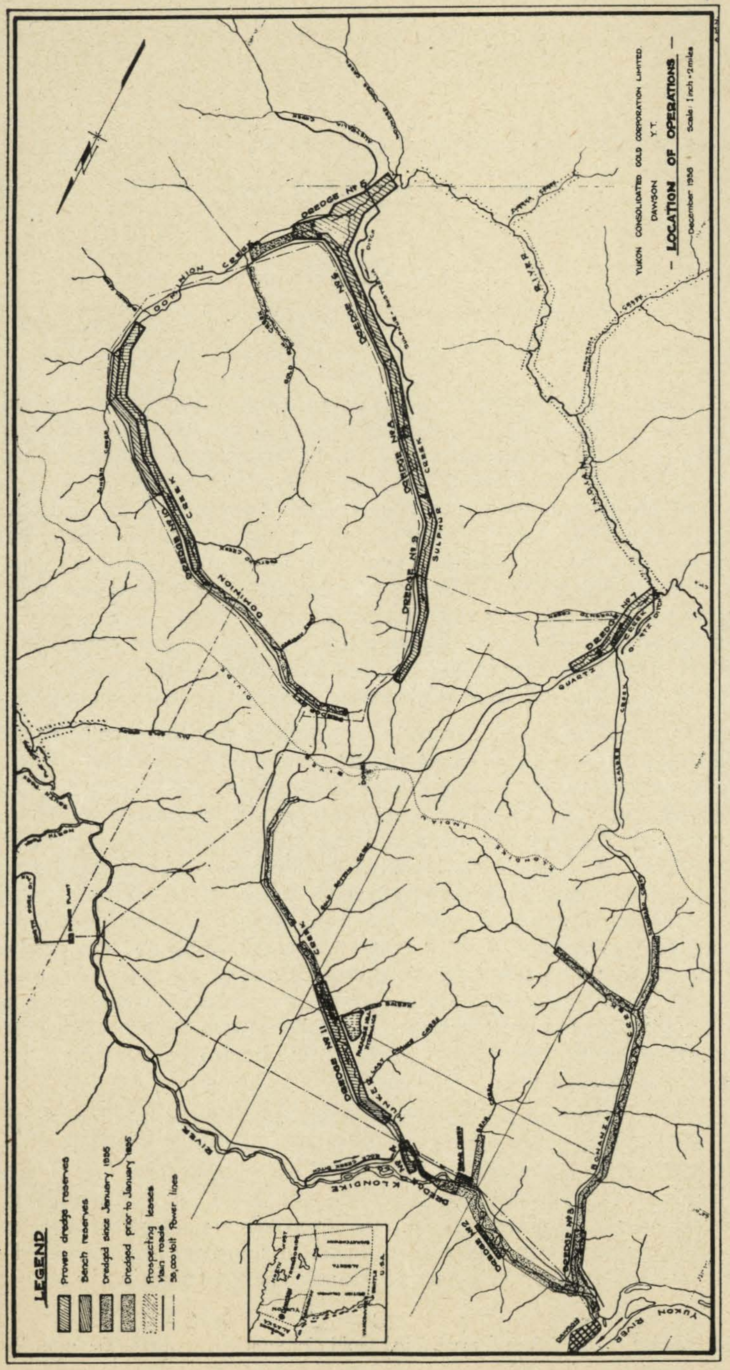


Map showing location of operations of the Yukon Consolidated Gold Corporation, Limited.

To reach Dawson by ordinary route one travels by steamer approximately 1,000 miles from Vancouver north to Skagway, thence by railway a further distance of 110 miles to Whitehorse, at the head of navigation on the Yukon river, and finally about 460 miles by steamer to Dawson. All ordinary freight comes in by this route.

The river usually opens at Dawson between May 1st and May 15th and generally closes over again some time in November. The first boat reaches Dawson late in May or early in June and the last boat leaves by October 10th, as navigation after that date is made risky by low water and cold weather.

The ordinary route of access to the interior is supplemented by an efficient year-round airplane service between Skagway, Whitehorse, and Dawson for mail, passengers, and some light freight. During the winter months, an overland service is maintained between Whitehorse and Dawson for mail and freight by truck and tractor.

Freight rates between Vancouver and Dawson, by the ordinary route, range from a minimum of $55 per ton on mining machinery to over $135 per ton. To this must be added the cost of local transportation to destination, which, in the past, averaged fifty cents per ton-mile but has been considerably reduced as road conditions have been improved. The main haulage roads are maintained largely by the Territorial Government, but the Company also does considerable road work and co-operates with the Government to get the best results from the money and equipment available. Local freighting is by truck and tractor, with teams used around the various dredges and thawing and stripping plants.

There have been three main reasons for the development of the Alaskan and Yukon dredging industry in recent years and for the increased prosperity now being experienced in the North. These are:

(1) The development of a successful method of stripping off the layer of barren, frozen 'muck' which overlies the gold-bearing gravels, so that it is no longer necessary to thaw and dredge this muck in place.

(2) The development of the method of thawing frozen gravel by cold water, or water at natural temperatures, instead of, as in earlier days, by steam, with the resulting saving of from 25 to 40 cents per cubic yard.

(3) The increased price of gold.

The modern methods of handling frozen ground were developed in Alaska rather than in the Yukon, and the adoption of these methods has been of almost as much importance to the Yukon Consolidated as has the increased price of gold. Before these methods were brought into use, it cost between 35 and 40 cents per cubic yard to dredge ground which was over 50 per cent naturally thawed. Today, it costs between 16 and 20 cents per cubic yard to dredge ground which is practically 100 per cent frozen, and the unit value of the material dredged is enhanced by every cubic yard of barren muck removed. To illustrate the importance of stripping, the following examples are given. The assumed figures approximate average conditions in our dredging reserves.

Assume:	Depth of muck	20 feet
	Depth of gravel	6 "
	Depth of pay bedrock	4 "
	Value per sq. ft. of bedrock	25 cents

Example No. 1

15 feet of muck removed by stripping

Annual capacity of dredge	650,000 cu. yd.
Stripping cost	6 cents per cu. yd. stripped
Thawing cost	4 " " " thawed
Dredging cost	10 " " " dredged

Working Cost Per Sq. Ft. of Bedrock:

Stripping 15 cu. ft. of muck at	6 cents per cu. yd.	3.3 cents
Thawing 15 cu. ft. of muck and gravel at	4 " " "	2.2 "
Dredging 15 cu. ft. of muck and gravel at	10 " " "	5.5 "
Total		11.0 cents

Working cost per cu. yd. dredged	19.8 cents
Value per cu. yd. dredged	45.0 "
Profit per cu. yd. dredged	25.2 cents
Sq. ft. of bedrock worked over per season	1,170,000
Production for season	$292,500
Working cost per season	$128,700
Leaving a working profit of	$163,800

Example No. 2

No stripping done

Annual capacity of dredge	650,000 cu. yd.
Thawing cost	5.5 cents per cu. yd. thawed
Dredging cost	10.0 " " " dredged

Cubic yards dredged equal to 90% of cubic yards thawed

Working Cost Per Sq. Ft. of Bedrock:

Thawing 30 cu. ft. at 5.5 cents per cu. yd.	6.1 cents
Dredging 27 cu. ft. at 10.0 " " "	10.0 "
Total	16.1 cents

Working cost per cu. yd. dredged	16.1 cents
Value per cu. yd. dredged	25.0 "
Profit per cu. yd. dredged	8.9 cents
Sq. ft. of bedrock worked over per season	650,000
Production per season	$162,500
Working cost per season	$104,650
Leaving a working profit of	$ 57,850

These examples show an increase in working profit, produced by the stripping operations, of $105,950 per season.

The above calculations are based on the assumption that thawing under the conditions of example No. 2 will be sufficiently thorough to enable the dredge to get as much yardage in a season as it would under conditions in example No. 1. As the thawing of muck is rather difficult, this is not easy to do. As a general practice, therefore, as much stripping is done as time and grade conditions will permit.

The Company's proved gravel reserves stand, at the present time, at approximately 92,000,000 cubic yards, containing $41,000,000 in gold. This yardage has been proved, during the past four years, by detailed drilling under expert supervision. The estimated working profit on these proved reserves amounts to $21,750,000. The Company controls substantial areas of ground which have not yet been prospected.

The technique of placer drilling in frozen ground, with Keystone drills, has been developed in Alaska during the past fifteen years to a point of high accuracy. Frozen ground simplifies many drilling problems. Properly handled, it reduces sloughing to a minimum and enables very accurate measurements to be made of the volume of material extracted from the hole. Ground which is entirely frozen is drilled without casing. The volume removed is accurately determined by adding measured quantities of water and determining the rise in the hole by tape and float. The arrangement and spacing of the holes is varied to suit conditions, but the bulk of the reserves were estimated from drilling done on cross-section lines 500 feet apart with holes spaced from 50 feet to 300 feet apart on the lines, depending on the width of the pay-streak.

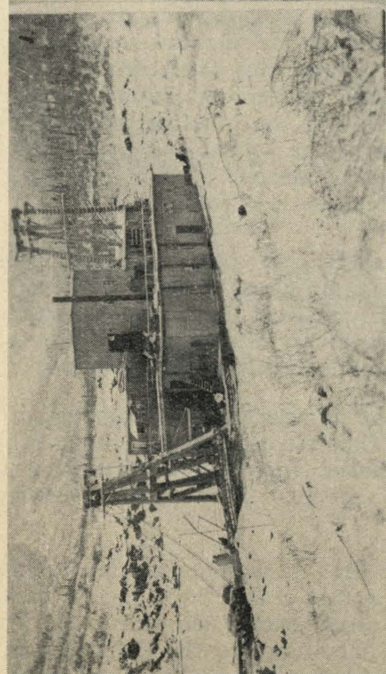
At Dawson, when a new area is to be prospected, scout drilling is first done with the holes so located they will fit into any closer drilling which may be done at a later time. The drilled cross-sections are studied for depths of muck, gravel, and pay bedrock, and calculations are made of the 'amount of muck', 'dredging section' (gravel plus pay bedrock), and the gold content. These calculations are made on a triangulation basis by connecting up the holes of one cross-section to the holes of the next cross-section in a series of triangles and figuring the volume and gold content of each triangle by weighting the holes at the apices.

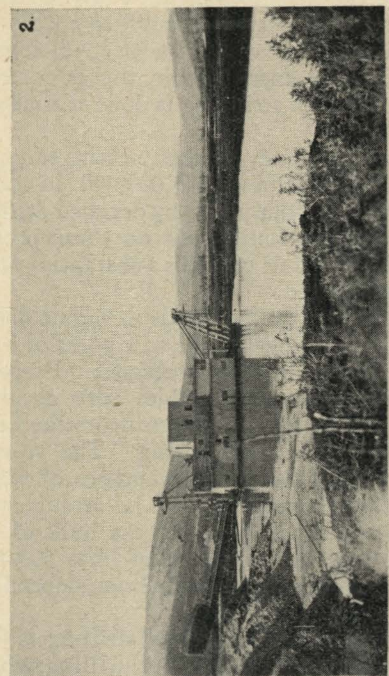
Gold-bearing gravels consist of three kinds, as follows:

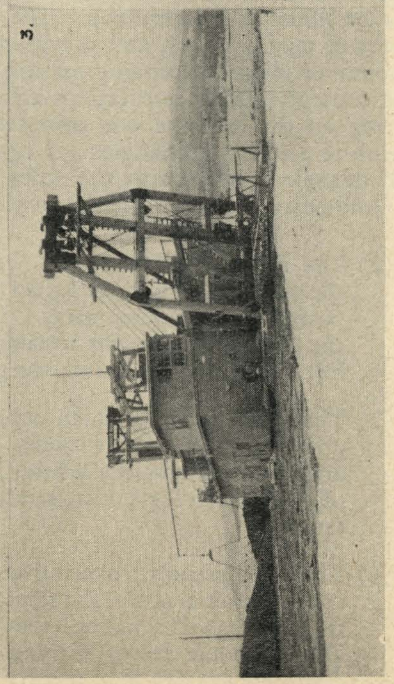
(1) The *Hill* or *'White Channel'* gravels, occupying the ancient beds of the streams. They are called White Channel because they are composed of nearly pure quartz. They lie from 200 feet to 300 feet above the beds of the present streams and vary in thickness up to over 200 feet. As a general thing, the gold is mostly at or near bedrock.

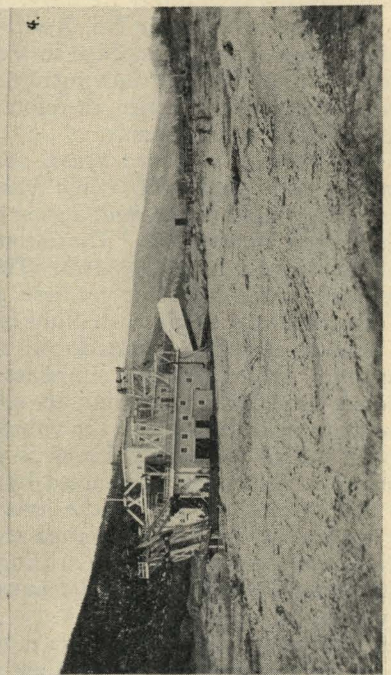
(2) The *Bench* gravels, which occupy terraces left by streams in cutting down to their present levels. They are composed of quartz pebbles and boulders from the White Channel gravels, mixed with fragments of the underlying schist, sand, and silt. They are of minor importance.

(3) The *Creek* gravels, covering the beds of the present streams. Their composition is about the same as that of the Bench gravels. Except in the Klondike valley, they rarely exceed ten feet in thickness. These gravels are of the first importance to the Company, as all dredging activity is in them.









Of the 92,000,000 cubic yards making up the Company's present proved reserves, approximately 5,000,000 cubic yards represent *Hill* gravels on Hunker creek, which will be worked by hydraulicking; 3,000,000 cubic yards represent *Bench* gravels on Dominion creek, which will be worked by drag-line methods; and the balance are *Creek* gravels suitable for dredging.

The ground at present being dredged by the Company falls into two general classes.

(1) Ground already worked by the early miners and mining companies.

(2) Virgin ground which was either too low grade or too difficult to work by earlier methods.

Approximately one-third of the Company's proved dredging reserves are in virgin ground. Of the ten dredges operating in 1939, four (Nos. 2, 5, 6, and 8) will be working on ground which is virgin or nearly so. The others will be on ground which has already been worked at least once by other methods.

During the 1938 season, the Company operated nine dredges. Three of these have buckets of 16 cu. ft. capacity, four have 7 cu. ft. buckets, and two have 5 cu. ft. buckets. A tenth dredge, having 7 cu. ft. buckets, was under construction and is scheduled to start by the middle of May this year. An eleventh dredge, with 7 cu. ft. buckets, will be constructed during 1939 and is expected to start digging by the middle of September. This will complete the dredge construction programme according to present plans.

Dredge No. 1 completed the mining of its area on upper Dominion creek during 1938 and was then dismantled. This dredge was first built and started operating in 1905. It was moved to different locations on two occasions, but operated at least a part of each season during that period. The usable parts of its machinery will be incorporated in the eleventh dredge, thus leaving a total of ten dredges operating.

Dredges Nos. 2, 3. and 4 were built in 1911 and 1912. All of the others have either been rebuilt since 1935 or are entirely new. The hulls are of wood. On the rebuilt dredges, both hulls and superstructures were entirely renewed and the nachinery completely reconditioned with replacements where required.

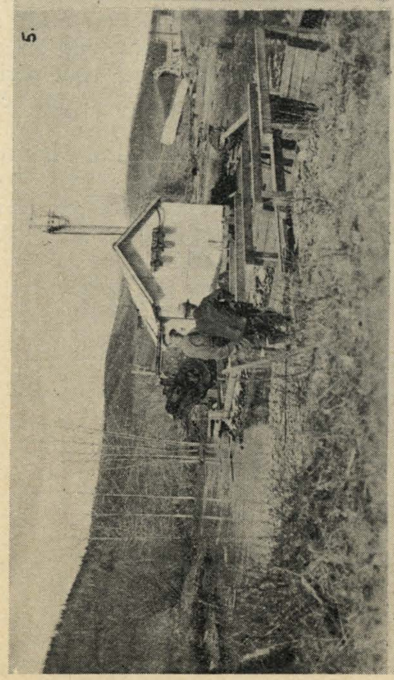
CAPTIONS FOR PHOTOGRAPHS 1 TO 4 ON PAGE OPPOSITE:

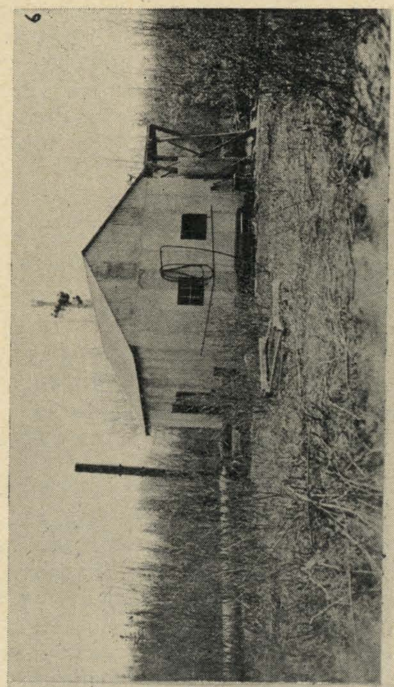
1.—Dredge No. 1 on 8 above Upper Discovery, Dominion creek.
This is a 7 cu. ft. dredge of Marion steam-shovel design. Built and commissioned in 1905 and worked part, at least, of every summer until dismantled in fall of 1938. Believed at that time to be oldest operating dredge in existence.

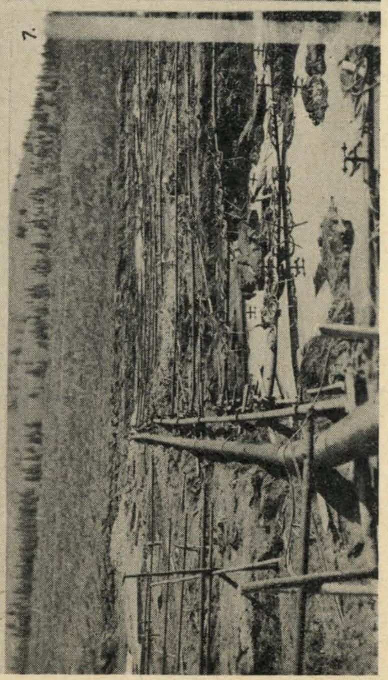
2.—Dredge No. 6 on Granville Flats near mouth of Sulphur creek.
Capacity 7 cu. ft. Started digging in 1936. Will turn up Sulphur creek.

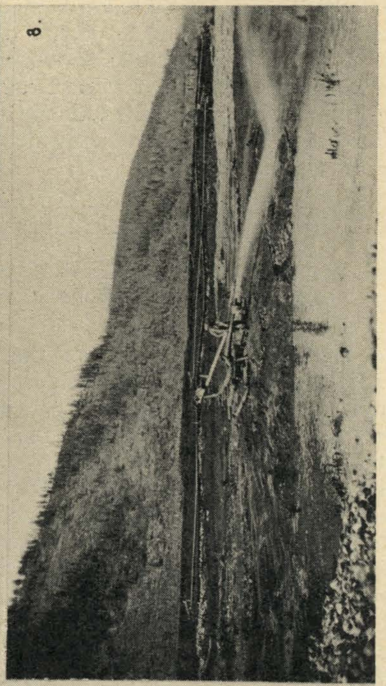
3.—Dredge No. 6, November 8th, 1938.

4.—Dredge No. 10 on 11 below Lower Discovery, Dominion creek.
Electrically driven, 7 cu. ft., wood-hull Yuba dredge. Started digging May 8th, 1939. A similar dredge, No. 8, was built on 48 below Discovery, Sulphur creek and started digging May 28th, 1938.









Dredges Nos. 2 and 3 are operating on ground which is outside of proved reserves, and dredge No. 4 will complete the mining of its ground in 1940. Thus, the Company will have a fleet of seven dredges which are new or completely rebuilt and each having a life of twenty years or more.

Dredges Nos. 2 and 3 operate on areas which are naturally thawed, but all the other dredge areas are virtually 100 per cent frozen and require artificial thawing.

The following tabulation shows the size, make, location, and average annual capacity of the various dredges:

Dredge No.	Bucket Capacity	Name of Original Manufacturer	Location	Distance From Dawson	Present Average Annual Capacity
2	16 cu. ft.	Marion	Klondike river	6 miles	2,000,000 cu. yd.
3	16 "	Marion	Lower Bonanza	3 "	2,500,000 "
4	16 "	Marion	Mouth of Hunker	11 "	1,800,000 "
5	7 "	Marion	Lower Dominion	52 "	650,000 "
6	7 "	Bucyrus	Lower Sulphur	52 "	650,000 "
7	5 "	Bucyrus	Quartz creek	30 "	450,000 "
8	7 "	Yuba	Middle Sulphur	44 "	650,000 "
9 (*a*)	5 "	Bucyrus	Upper Sulphur	40 "	450,000 "
10 (*b*)	7 "	Yuba	Middle Dominion	36 "	650,000 "
11 (*c*)	7 "	Yuba	Middle Hunker	15 "	650,000 "
	Total Annual Capacity				10,450,000 cu. yd.

(*a*) Started digging September 15th, 1938.
(*b*) Scheduled to start May 15th, 1939.
(*c*) Scheduled to start September 15th, 1939.

Operations are carried on with electric power supplied by a Company-owned 15,000 h.p. hydro-electric plant situated on the Klondike river about

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CAPTIONS FOR PHOTOGRAPHS 5 TO 8 ON PAGE OPPOSITE:

5.—Circulating pumping plant for Upper Sulphur thawing.
Three 10-in. centrifugal pumps, each driven by 150 h.p. synchronous motor. Water coming to pumps first passes through travelling water-screens, seen alongside the portable pump-houses. Dredge No. 9, 5 cu. ft., which started digging Sept. 15th, 1938, in background.

6.—Indian River pump-station, 1939.
This station pumps water from Indian river into a high-level ditch which carries it up Quartz creek for use in stripping operations there. Station has two 10-in. centrifugal pumps working in series, each driven by 150 h.p. synchronous motor. Capacity 3,500 U.S. gals. per min. against working head of 214 feet. Black standpipe in left-centre is sealed on the end. It fills with air and this takes up the shock of water hammer in event of a sudden shut-down.

7.—Water-thawing plant on Upper Sulphur, ahead of dredge No. 9.
Water for this plant is circulated by centrifugal pumps.

8.—Stripping on 46 below Discovery on Hunker creek.
Formation at this point is peat moss, 4 to 26 feet in depth. It is difficult to strip, but almost impossible to thaw.

twenty-eight miles from Dawson and drawing water from the two main forks of the river. The original plant consisted of two 5,000 h.p. turbines driving 3,000 kv.a. generators. Water was taken from the North fork of the river through a six-mile ditch which gave an effective head of 220 feet at the plant. When the decision was made to expand operations, a third set, consisting of a 5,000 h.p. turbine driving a 4,690 kv.a. generator, was added to the plant and it was necessary to bring in additional water. This was secured by building a ditch 16 miles long with a capacity of 10,000 M.I. to bring water from the South fork of the river and dump it into the North fork above the old intake. The plant is operated all the year by freezing over the ditch in the winter and running the water under the ice. During the freezing-over period, which generally is less than a week's duration, power is erratic.

During the past three years, the first dredges have been able to start digging during the latter part of April, and there is generally sufficient power available by the 12th of May so that all can run. After November 1st, the power supply begins to decrease rapidly and it is this factor, coupled with cold weather, which causes the dredges to close down. The dredges on the smaller streams are the first to cease operations and those on the Klondike river the last. In the season of 1938, two of the dredges operated until December 24th. Throughout the remaining winter months, the plant delivers sufficient power to supply the city of Dawson and the Company camps and machine shop.

Operations

In the Dawson district, the gravels are comparatively shallow, seldom being more than ten feet deep, except in the valley of the Klondike river, where they reach a maximum depth of forty-five feet, and probably average about thirty feet. The gravels are overlain with a deposit of frozen muck ranging from ten to sixty-five feet in depth. The muck is barren, the bulk of the gold values being in the bottom gravels and top of bedrock. Generally speaking, taking up four feet of bedrock will get all the values, but where blocky or slabby bedrock is encountered, it is necessary to take up more, and in special cases as much as ten feet.

In all areas except in the stream-bed of the Klondike river, where the gravels are naturally thawed, working of a dredging area means first clearing off the brush, old buildings, and machinery, and then removing as much muck as available run-off grade will permit. This is followed by artificially thawing the remainder of the deposit, and finally by dredging. To keep the various operations clear of each other, and to allow them to proceed at greatest efficiency, we are endeavouring to get the stripping completed about two years in advance of thawing, and the thawing at least a year and a half ahead of dredging. Experience has shown that, when thawing is well done, the tendency is for the ground to improve rather than freeze back. The seasonal frost which accumulates during the winter is usually gone by the middle of June.

Stripping is done by hydraulicking, using water under pressure through a system of pipes leading to a series of No. 2 Giants placed so that all surrounding muck can be reached with a minimum shifting of Giants. To get the greatest efficiency out of the water, it is necessary to cover a fairly large area in a single operation so as to give the sun's rays time to thaw the surface.

For each stream of water used, several Giants are set up so that, by a process of rotation from one to another, sufficient time elapses after all thawed material has been removed from a given set-up before it is necessary to work it over a second time. We have found that eight to ten Giants is a suitable number for average conditions. All told, there are approximately one hundred and forty Giants set up at one time over all the stripping plants. Water duties at Dawson vary between eight and fifteen cubic yards of muck removed per M.I.D. (this unit being a flow of 1½ cubic feet per minute for 24 hours). Stripping is complicated by the presence of tailing piles on the surface, deep moss, and slide rock in the muck. For efficient work, pressures between 50 and 120 pounds per square inch are desirable. The style of pipe-line layout for connecting up the Giants is determined by the shape of the area to be stripped off, the slopes of the surface, and the presence of tailing piles. If tailing covers a large part of the surface, the first step is to make a set-up for disposal of the tailing, followed by a second set-up for muck removal. The distance between Giants is regulated by the pressure of the water and character of material to be handled. A rule-of-thumb method for stripping muck is to work away from each Giant a distance in feet equal to one and one-half times the pressure of the water in pounds per square inch. Naturally, this distance has to be applied with a knowledge of the work to be accomplished.

Water for stripping is derived either from ditches or from pumps taking water from the local streams. Pumps for this purpose have been standardized on one size and consist of high-efficiency ten-inch centrifugal pumps rated at 3,000 U.S. gallons per minute against a 150-foot head. Each is driven by a 150 h.p. 2,300-volt synchronous motor. The capacity of these pumps is just right for a 3½-inch nozzle. Each pumping unit, with its starting equipment, is housed in a portable building 18 ft. long by 10 ft. wide, built on four steel-shod skids which are double ended so the building can be moved in either direction. The building has a 3-inch floor nailed directly to the skids and a 2 in. by 4 in. frame-work covered with corrugated iron. There are fourteen of these units in service. Actual stripping is carried on from about May 10th to September 30th. Preparatory work begins about April 10th with a small crew and continues to about October 20th.

Artificial thawing with water follows completion of stripping, and the more complete the job of stripping, the fewer the thawing problems. Thawing is accomplished by injecting water into the ground through pipes termed 'points', which are driven to bedrock as the water thaws the ground ahead of them. This system was started by Miles in Alaska and was perfected at Nome, Fairbanks, and Dawson for large-scale operations. The equipment now used at Dawson is mostly the same as that which was perfected at Nome and Fairbanks by the United States Smelting, Refining and Mining Company. The ground to be thawed is laid off in a series of blocks, or 'units', each containing about 600 points. Water is conducted through a 12-inch gate-valve into a flanged pipe ranging in size from 11 in. down to 8 in. and having 6-in. outlets spaced 27 ft. 7 in. apart, to which are bolted 6-in. gate-valves. The average unit has twelve such outlets. To these are attached the 'header pipes', which distribute water to the points. Header pipes are 6-in. and 4-in. slip-joint pipes which are 16 ft. long when driven and each has a 2-in. screwed outlet in the centre for the cross-heads, which consist of a 2-in. by 4-in. nipple leading into a 1-in. by 1-in. by 2-in. tee. From each side of the tee is a 1-in. by 4-in. nipple, a 1-in. cock, and a 1-in.

Chicago Pneumatic hose coupling, thus giving a lead to two points at each cross-head. Connection to the points is by 1-in. hose 16 ft. long. Points consist of ¾-in. and ½-in. extra-heavy pipe. The former has a special chisel-bit on the end and is used where there is considerable driving to be done. This bit has high-carbon steel on the cutting edge and mild steel on the end which is welded to the pipe. The latter has no tip and is used when driving is a secondary, and ease of cleaning plugged points the primary, consideration. The use of the ¾-in. points is predominant. Points are in 10-ft. sections, coupled together by hydraulic recessed couplings. The pipe layout is designed for points spaced on the corners of equilateral triangles having 16-ft. sides, but can be used for closer spacing by putting in cross-heads having four or six outlets. This is done by screwing the standard 2-outlet cross-heads into a 2-in. tee or a 2-in. cross as the case may be. Points are driven to bedrock by men called 'point drivers'. The points are driven by means of a driving weight which is slotted to fit around the point and is held in place by a ⅜-in. round-steel bar fitted through holes in the weight and which also acts as a handle. This driving weight is brought into contact with an anvil in the shape of a heavy swing-bolt clamp tightened on the point. A wooden handle bolted to the back of the clamp acts as a means of twisting the points. Both weight and clamp are drop-forgings of special manufacture. After the points are on bedrock, they are taken over by men called 'point doctors', who keep them alive until the thawing period is over. At Dawson, the duty of the water varies between five and ten cubic yards thawed per M.I.D. of water. Point driving rates range from two to fifteen feet per man-hour. The thawing season extends from about May 10th to September 25th. Preparatory work begins about April 15th and extends to about October 20th. Due to scarcity of supply, water for thawing has to be re-circulated. Settling basins are built to settle out the mud, and water is pumped from these basins to the thawing field, from whence it flows back to the basin. All water passing to the pumps must first pass through mechanical screens to remove floating trash. These screens have baskets which are covered with seven-mesh wire galvanized after weaving.

Pumps for circulating thawing water have been standardized on a 12-inch unit rated at 6,000 U.S. gallons per minute against a 100-foot head and driven by a 200 h.p. 2,300-volt synchronous motor. The pumps have a flat performance curve, so that they can be operated at lower heads with corresponding increase in quantity of water delivered without great loss of efficiency. Each unit is housed in a portable house of the same dimensions and construction as used for the stripping pumps. There are eleven such units in service.

The process of thawing consists of injecting water into the ground through pipes or 'points' which are driven to bedrock. The ground is thawed by absorbing heat from the water. As the ground thaws, it settles around the points and leaves a more or less open channel between the thawed and frozen masses, so that the water returning to the surface generally comes up along the frozen face. The presence of 'old works' complicates the operation, as they frequently furnish more open channels for the water and the flow from several points may come out at one place, thus leaving islands of frozen ground which must be located and thawed by driving additional points.

During the thawing season, careful records are kept of the temperature of the water and quantity going into the ground, to get a measure of the

work being done. When it is indicated that a given block should be thawed, testing is done by driving steel bars into the ground midway between the points, and the manner in which these bars enter the ground is an indication of its condition.

Dredging of the ground follows completion of thawing. Dredging conditions in the Yukon are comparatively easy when the ground is well thawed, but as that is a condition which is not always easy or practicable to reach, the dredges are often called upon to dig a certain amount of frozen ground. The season is relatively short and major repairs are made in the shut-down period so far as possible. Preparatory work begins about April 1st and the crews are generally laid off within two weeks of the time they close down in the fall. All dredges are of the continuous-bucket type and are electrically driven.

The Company operates a large, well equipped repair shop at its main camp located at Bear creek on the Klondike river, about eight miles from Dawson, where it also maintains a large stock of repair parts and general warehouse supplies.

In conclusion, the following figures, giving the results of the 1938 operations, may be of interest as illustrating the size of the Company's activities:

OPERATING DATA, 1938

Overburden stripped off		2,818,000 cu. yd.
Ground thawed		4,141,000 "
Ground dredged		8,551,000 "
Power used		28,073,000 k.w.h.
33,000-volt power line	94.3 miles	
2,300-volt power line	29.0 "	
Total		123.3 miles
Additional 2,300 volt on 33,000-volt lines		8.4 miles
Production		$2,131,000

MEN EMPLOYED IN 1938

End of January	90	End of July	675
End of February	90	End of August	630
End of March	215	End of September	540
End of April	420	End of October	360
End of May	610	End of November	165
End of June	660	End of December	90

At the end of 1938, the Company's nine dredges, stripping and thawing equipment, power plant, camps, buildings, and ditches represent an investment at cost of $6,500,000.

The following is a list of the dredges operated by the company:

Dredge No.	Size of Bucket Cu. Ft.	Average Daily Capacity Cu. Yds.	Manufacturer
1	7	4,700	Marion
2	16	12,000	Marion
3	16	12,000	Marion
4	16	12,000	Marion
5	7	4,700	Bucyrus
6	7	4,700	Bucyrus
7	5½	3,000	Bucyrus
8	7	4,700	Yuba
9	5½	3,000	Bucyrus
10	7	4,700	Marion
11	7	4,700	Marion
12	2½	1,300	Johnson

Dredge No. 1

Originally built on the Klondike river in 1905 at the mouth of Bear creek. Later it was rebuilt on upper Hunker creek and finally was rebuilt on upper Dominion creek where it ended its life there in 1938.

Dredge No. 2

Built on the Klondike river in 1911 and operated there until closed down in 1939 because of lack of profitable ground to work.

Dredge No. 3

Built on the Klondike river below the mouth of Bonanza creek in 1912. She operated on the Klondike river and in the lower part of Bonanza creek until 1952 when she was shut down for lack of any more profitable ground to work.

Dredge No. 4

Built on the Klondike river below the mouth of Bonanza creek in 1912. She operated on the Klondike river and finally ended her life in 1940 after completing the mining of a high-grade area at the mouth of Hunker creek. Her machinery and equipment was removed and reconditioned and placed in the hull of a new No. 4 on Bonanza creek where it operated re-handling Yukon Gold Company dredge tailings from 1941 until being shut down in 1959 due to reduced values to be recovered from the tailings.

Dredge No. 5

This dredge operated in the area of Lower Dominion creek between the mouths of Gold Run Creek and Sulphur Creek. During the war she was shut down due to lack of operating labor and it was during this time that she was struck by lightning and destroyed by fire.

Dredge No. 6

Built on Lower Dominion creek near the mouth of Sulphur creek in 1936. Her original plan of operation called for her to mine out the lower part of Sulphur creek but, after No. 5 was destroyed, she was turned around and brought back to Dominion creek through an area of marginal ground values and took over the mining of No. 5's area. She is still operating there.

Dredge No. 7

Built on Quartz creek in 1935 and operated there until she came to the end of her area at the mouth of the creek in ~~in~~ 1950

Dredge No. 8

Built in 1937 in the middle Sulphur creek area ~~in 1937~~. When No. 6 dredge was taken out of Sulphur creek NO. 8 area was extended to cover the ground remaing in the No. 6 area. The operation is continuing at this time.

Dredge No. 9

Built on upper Sulphur creek in 1937-8. She is still operating there.

Dredge No. 10

Built in the Middle Dominion creek area in 1938-9. She is still working downstream in that area.

Dredge No. 11

Built in the Middle Hunker creek area at the mouth of Hester creek in 1938-9 using machinery from Dredge No. 1. For two years she operated profitably in Yukon Gold Company's dredge tailings while other ground was being prepared for her. She is now operating near the mouth of Hunker creek and will eventually end her life at the mouth of Last Chance creek or in that creek.

Dredge No. 12

This was a dredge that had operated in Alaska about 75 miles from Dawson. She was a steel pontoon type. She was dismantled, hauled to Dawson where her machinery and equipment was recoditioned. She was then reconstructed on a Dominion Bench near the mouth of Jensen creek. She completed the mining of that area and, after a short period of idleness, ~~she~~ was hauled overland during the winter months to a new Bench area where she resumed operating in 1963.

Hydro-electric Power Plant

All dredges were electrically operated with power supplied by the company's hydro-elctric plant situated on the Klondike river. As originally constructed this had two 5,000 horsepower units supplied by water taken from the North Fork of the Klondike river. This was delivered to the plant through a 6-mile canal which gave a head of about 220 feet. When plans were made to extend the company's operations more power was required and another 5,000 horsepower unit was added. As the North Fork river had periods when its water supply was well below the required amount, a 16-mile canal of 10,000 M.I. capacity was constructed to bring water from the South Fork ~~river~~ of the Klondike river and deliver it to the North Fork above the intake of the original canal. At the same time the capacity of the original ditch was increased to take care of the greater water supply. This was done by the use of a dragline shovel operating along the upper bank of the canal. The canal is now 50 feet wide on the water line and carries an average depth of water of six feet. and has a capacity of 30,000 M.I.

Power is delivered to the dredges, to Bear Creek (the main operating headquarters) and to the City of Dawson over 33,000 volt lines. Secondary lines are 2,300 volts. (2300)

In the Fall of the year, when cold weather comes, power is erratic during the freeze-up. This condition continues until the canals and the rivers freeze over after which time no further trouble is experienced from slush ice. As the ice in the canal gets thicker the water delivered gradually falls off but the output of the plant seldom gets below 2,500 K.W. which is sufficient for all winter uses. A short, sharp freeze and an early snow fall give the ideal conditions for the freeze-up.

The shut-off gates at the intakes of the canals are housed over and kept warm with electric heat so that the gates can always be operated as required.

Operations

Stripping

In the Dawson district, in the smaller streams, the gravels are ~~over~~ overlain with a deposit of barren, frozen muck ranging from ten feet to sixty five feet in depth. This is a very difficult and expensive material to thaw and dredge, It can be removed by hydraulic stripping at a lower cost than that of thawing and dredging and every yard of muck removed increases the unit value of each yard dredged and enables more bedrock to be worked over in a season.

Working of a dredging area on the creeks means clearing the surface of brush, trees, old buildings and machinery and then removing as much of the muck as available run-off grade will permit. When operations were first started in 1934 the clearing of brush and trees was carried on by hand work under contract but as tractors came into use this work was shifted to bull-dozers,

Water supply for stripping is derived from ditches or from pumps taking water from the local streams. Pumps for this purpose were standardized on a high-efficiency ten inch centrifugal pump rated at 3,000 U.S. gallons per minute against a 150-foot head. Each unit is driven by a 150 H.P. 2,300 volt synchronous motor. The capacity of these is just right to supply a 3½ inch nozzle. The pump casings were made heavy enough to stand double pressure so that two pumps could be operated in series if higher pressure was required and the pump set-ups were made so that operation could be switched from parallel to series as required. Each pumping unit and its starting equipment is housed in a portable house 18 feet long by 10 feet wide built on four steel-shod skids which are double ended so that the building can be shifted in either direction. The building has a 3-inch floor nailed directly to the skids and a 2-inch by 4-inch framework covered with corrugated iron. There are fourteen of these units.

Stripping is accomplished by hydraulicking using water under pressure through a system of pipes leading to s series of No. 2 Giants placed so that all surrounding muck can be reached with a minimum shifting of Giants. To get the best efficiency out of the water it is necessary to cover a large area in a single operation so as to give the sun's rays time to thaw the surface. For each stream of water used from eight to ten Giants are set up so that, by a process of rotation from one to another, sufficient time elapses after all thawed material has been removed from a given set-up before it is necessary to work it over a second time. At the peak of operations there were approximately one hundred and forty Giants set up at one time over all the stripping plants. Water duties at Dawson vary from eight cubic yards to fifteen yards per M.I.D. depending on the character of the material to be removed. (The M.I.D. is a unit with a flow of 1½ cubic feet per minute for 24 hours.) Stripping is complicated by the presence of 'Old Works' tailings on the surface, deep moss and slide rock in the muck. For efficient work pressures between 50 and 120 pounds per square inch are desirable. The style of pipe-line lay-out for placing the Giants and for delivery of water to them is determined by the shape of the area to be worked, the slope of the surface and the presence ~~and amount~~ of tailings on the surface. Originally, the first set-up of the giants was for the purpose of disposing of the tailings but, after bull-dozers became available, this work was done mechanically. The distance between Giants is regulated by the water pressure and the character of the material to be handled. A rule-of-thumb method for placing Giants for muck stripping is to work away from each Giant a distance in feet equal to one and one-half times the pressure of the water in pounds per square inch.

11 A.

Sulphur-Australia Ditch 11A

This ditch was constructed to supply water for Sulphur creek which has a very small supply of its own. Fortunately, Australia Creek was near and had a much more satisfactory water run-off. This creek was dammed off at a point about six miles from its mouth and the water was led into a 1500 M.I. capacity ditch which was constructed to carry the water to a point on Dominion creek, near the mouth of Sulphur Creek, where it was carried across the valley of Dominion creek in a pipe line salvaged from the operations of the Yukon Gold Company. A surge tank was built at the end of the pipe line and from this the water was led in to two centrifugal pumps, each driven by 800 H.P. motors and these elevated the water some 300 feet to another 1500 M.I. Capacity ditch which delivered it up Sulphur creek. This ditch was eleven miles long. At the end of this ditch another pump station was constructed to elevate a smaller part of the water another some 300 feet to supply upper Sulphur Creek operations.

It is interesting to note how surge suppression was managed at the two stations. At the main pump station each pump was equipped with a heavy fly wheel to keep the pumps revolving for a few seconds after any sudden power failure. In addition each pump outlet was supplied with a gate valve and a swing-check valve. The swing check valve was equipped with a dashpot arrangement which would prevent that valve from closing too quickly. The flywheels gave a sufficient time interval to allow for this closing. The gate valve was supplied to enable starting of the pumps against a closed valve and to regulate the water supply to the pumps when the head was less than full supply.

At the smaller station on Sulphur creek surge was handled by erecting an air cylinder on the pipe line beyond the gate valve and swing-check valves. On the smaller station this worked very well.

Thawing

Thawing with water at natural temperatures follows completion of stripping and the more complete the job of stripping the fewer are the thawing problems. Thawing is accomplished by injecting water into the ground through pipes termed 'points' which are driven by hand to bedrock as the water thaws the ground ahead of them. This system was started by Miles in Alaska and was perfected at Nome, Fairbanks and Dawson.for large scale operations. The equipment now used at Dawson is mostly the same as that which was perfected at Nome and Fairbanks by the United States Smelting Refining and Mining Company.

Originally the ground to be thawed was laid off in a series of blocks, or units, each containing about 600 points but, with the wider spacing of points, this was increased in size. Now, with the wider spacing of the 'header pipes' enough equipment is laid to cover a full season's area without shifting of equipment.

Water is conducted through a 12-inch gate valve into a flanged pipe ranging in size from 11 inches down to 8 inches and having 6 inch outlets spaced at proper distances to suit the location of the 'header pipes'. These outlets have 6 inch gate valves attached and to these are attached the 'header pipes' which distribute the water to the points. 'Header pipes' are 6 inch and 4 inch slip joint pipes which are 16 feet long when driven. Each piece of 'header pipe' has a 2-inch screwed outlet in the center for the 'cross-heads' which consist of a 2-inch by 4-inch nipple leading into a 1-inch by 1-inch by 2-inch tee. From each side of the tee is a 1-inch by 4-inch nipple, a 1-inch cock and a 1-inch Chicago Pneumatic hose coupling, thus giving a lead to two points at each 'cross-head'. Connection to the points when they are spaced 16 feet apart is by 1-in hose 16 feet long which hose has a Chicago Pneumatic hose coupling on one end and a 3/4-in gooseneck on the other end. When point spacing is greater than 16-ft the length of the hose is made longer to fit.

Points consist of 3/4-in and ½-in extra-heavy pipe. The former has a special chisel-bit on the end and is used where there is considerable driving to be done. The bit is a combination of steel which is drop-forged so there is high-carbon steel on the cutting edge and mild steel on the end which is welded to the pipe. The ½-in pipe has no tip and is used where driving is a secondary consideration and ease of cleaning plugged pipes is primary. The use of 3/4-in points is predominant. Points are in 10-ft lengths and are coupled together with hydraulic recessed couplings. If additional outlets are required at the 'cross-heads' this can be accomplished by screwing the standard 2-outlet 'cross-head' into a 2-in tee or a 2-in cross as the case may be.

Poimts are driven to bedrock by men, called 'point drivers', by means of a driving weight which is slotted to fit around the point and is held in place by a 3/8-in round-steel bar fitted through holes in the weight. This also acts as a handle. The driving weight is brought into contact with an anvil in the shape of a heavy swing-bolt clamp tightened on the point. A wooden handle, bolted to the back of the clamp, acts as the means of twisting the point. Twisting of the point is essential to keep it going strait when being driven. Both weight and clamp are drop-forgings of special manufacture.

After the points have reached bedrock they are taken over by men, called 'point doctors', who keep them operating until thawing of the ground is completed.

At Dawson the duty of the water varies between Five and ten cubic yards thawed per M.I.D. of water. Point driving rates range from two to fifteen feet per man-hour. The thawing season extends from about May 10th to September 25th. Preparatory work begins about April 15th. After the thawing season is over work continues to about October 20th on the dismantling of the equipment and the preparation of the pump site for the following season.

Due to scarcity of supply, water for thawing has to be re-circulated. Settling basins are built to settle out the mud, and water from these basins is pumped to the thawing field, from whence it flows back to the settling basin. All water passing to the pumps must first pass through mechanical screens for removal of floating trash. These screens have baskets which are covered with 7-mesh wire screen galvanized after weaving.

Pumps for circulating thawing water were standardized on a 12-in centrifugal unit rated at 6,000 U.S. gallons per minute against a 100-foot head and driven by a 200 H.P. 2,300 volt synchronous motor. These pumps have a flat performance curve so that they can be operated at a lower head with a corresponding increase in quantity of water delivered without a great loss of efficiency. Each unit, with its starting equipment is housed in a portable house of the same dimensions and construction as used for the stripping pumps. There are eleven of these units.

The process of water thawing consists of injecting water, at natural temperatures, into the ground through the 'points'. The ground is thawed by absorbing heat from the water. As the ground thaws it settles around the 'point' and leaves a more or less open channel between the thawed mass and the frozen ground so that the water returning to the surface generally comes up along the frozen face. The presence of

'Old Works' complicates the operation as they frequently leave more open channels for the water and the flow of several 'points' may come out at one place thus leaving islands of frozen ground which must be located and thawed by driving additional 'points'.

In the early days of 'cold water' thawing careful records were kept of the temperature of the water and the quantity going into the ground to get a measure of the work being done. When it was indicated that a block of ground should be thawed it was tested by driving steel bars into the ground midway between the 'points' and the manner in which these bars entered the ground gave an indication of its condition. After a few years of operation sufficient knowledge had been gained so that the expense of keeping these records was no longer justified and they were abandoned.

It is interesting to note that, under present climatic conditions, ground once well thawed improves rather than having any tendency to freeze back. Naturally, the surface freezes during the winter to a depth of four to six feet but this frost is usually gone by early June. Early snow-falls help to keep this freezing to a minimum.

Dredging

Dredging of the ground follows completion of the thawing. Dredging in the Yukon is relatively good when the ground is well thawed, but as that is a condition which is not always easy or practicable to attain, the dredges are often called upon to dig a certain amount of frozen ground.

The dredging season is relatively short and major repairs are made in the shut-down period so far as possible. Preparatory work begins about April 1st, the dredges start operating about May 1st, continue to the early part of November and the crews are generally laid off within two weeks of the time dredging is closed down.

14 P.

Bull-dozing

Certain areas which are too small or two shallow or have very uneven bedrock are being mined by the 'Bulldozer' method. In this operation the start is made the same as for a dredging area. The surface is first cleared of old buildings, brush and trees and then the muck is stripped off by hydraulicking. Generally the gravel is shallow enough to thaw naturally after the muck is removed and no thawing is required if this condition holds true.

When the deposit is ready for the gold recovery a sluice box with angle iron riffles is set up with a wide dump box at its head into which a bull-dozer pushes the gravels. There is

INSERT ON PAGE 14

Hydraulick mining

Hydraulick mining of the Bench Gravels of Hunker Creek was carried out on Paradise Hill located on the Left Limit of Hester Creek at its junction with Hunker Creek. This deposit was ideally located for hydraulick mining except for the water supply. The only available source was Hunker Creek which, by its self,was inadequate. To remedy this condition it was decided to construct a settling basin and re-circulate the water. As Dredge No. 11 had already mined out the creek gravels below this area there was no interference with dredging operations.

A large dam of dredge tailings was built about a mile below the place where tailings from Paradise Hill were to be dumped into Hunker Creek. Below this dam another low dam was built to give a supply to a pump station. The company had on hand a 1200 H.P. centrifugal 4-stage pump capable of delivering 500 M.I. against a 600 foot head. This pump and its electrical equipment were re-conditioned and placed in service. A system for surge suppression, similar to that supplied to the Upper Sulphur pump station, was supplied here.

In operation the large tailing dam was tight enough to back up the water and make a settling basin but seeped enough water to supply the pump station below it without taking any dirty water direct. The re-circulation of water worked so well that, even in very dry periods, hydraulicking was carried on at full force.

The bedrock on Paradise Hill was extremely uneven sometimes varying as much as fifty feet in a distance of little more than 100 feet but generally had a good slope towards Hunker Creek so that no bedrock cuts were required. The bottom gravels were pushed to the head of the sluice boxes by bull-dozer and the cleaning of the bedrock was performed by the same method. As was done at the Bull-Dozer operations, the sluice boxes had angle-iron riffles over which perforated plates were placed in a step manner to presvent the riffles clogging with heavy concentrates.

Hydraulicking was commenced in 1952 and completed in 1960. There was no operation during 1959 while the tailings dam being re-built after it had been largely destroyed during a flood at the beginning of the season.

a suitable washing arrangement over this dump box so that the material is well washed before it enters the riffle area in the sluice. Boulders are generally removed from the dump box before they can enter the sluice. It has been found to be a good practice to place perforated plates over the riffles, in a stepped arrangement, to prevent the riffles from clogging with heavy concentrates and leave them free to hold the gold.

Where there is not sufficient grade below the sluice box to allow the tailings to run away from the box it is necessary to have the bull-dozer stack them as often as required.

Repair Facilities

The company operates a large, well equipped repair ~~Shop~~ shop at its main camp which is situated at Bear Creek on the Klondike river about eight miles from the City of Dawson. Here it also maintains a large stock of repair parts and general supplies.

Camps

Originally each operation had its own camp but in later years it was found to be more economical to maintain fewer camps and give the men transportation to and from the job.

Camps are now maintained at Bear Creek, Middle Dominion Creek, Granville and upper Sulphur Creek.

OPERATIONS OF THE YUKON CONSOLIDATED GOLD CORPORATION

By: W.H.S. McFarland.

The Yukon Consolidated Gold Corporation, Limited, is a Canadian company carrying on operations for the recovery of gold from the placer deposits of the Klondike goldfields in the Yukon Territory. Its properties lie in the valley of the Klondike River and its tributaries, Bonanza, Eldorado and Hunker Creeks and in the valley of Indian River and its tributaries, Dominion Creek, Sulphur Creek, Gold Run Creek, and Quartz Creek. These cover a belt approximately twenty miles wide by fifty miles long. At the end of 1938 they consisted of 1,650 placer mining claims and 9 leases or concessions. By the end of 1963 much of this area had been mined out so that the properties then consisted of 813 placer mining claims and 2 concessions.

These properties are not held in freehold but in the form of mining claims and mining leases granted by the Dominion Government under the provisions of the Yukon Placer Mining Act. Full size creek mining claims are 500 feet along the valley by 1,000 feet on each side of the base line or from the center of the valley if no base line has been surveyed. Full size Hill and Bench claims are 500 feet along the valley by 1,000 feet at right angles to this direction. All claims are held on the basis of an annual renewal fee of $10 for each claim plus representation work of an assessed value of $200 per claim per annum. Leases are held under the terms set out in the lease when it was granted which terms provide for certain fees to be paid and the amount of representation work to be performed each year.

For the purpose of such representation work claims may be grouped so that the work performed on one claim may be applied to other claims. It is only in this way that it becomes possible to hold enough ground for large scale operations over a period of years.

Dawson, the operating headquarters of the operations, is situated at the confluence of the Klondike and Yukon Rivers about 46 miles East of the Yukon-Alaska border at Latitude 64°05' North and Longitude 139°20' West of the Meridian of Greenwich. This is about 250 miles South of the Arctic Circle. Climatic conditions approximate those of the Arctic regions. Winters are long and severe but summers are warm. From the middle of May to the first part of August there is no night.

Originally, to reach Dawson, one travelled by steamer approximately 1,000 miles North from Vancouver, B.C., through the Inside Passage to Skagway, Alaska, at the head of the Lynn Canal, thence by railroad over the White Pass summit 110 miles to Whitehorse, at the head of navigation on the Yukon River, and finally about 460 miles by river steamer to Dawson. All ordinary freight had to come in by this route. As the river did not, usually, open at Dawson until some time between May 1st and May 15th and closed, as far as navigation was concerned, early in October the period of navigation was short. This route was, for many years, supplemented by an overland route in the winter time for delivery of mail and light freight. Originally this service used horse-drawn sleighs but was later converted to tractor and truck service. Later there was airplane service between Skagway, Whitehorse and Dawson and, as airplanes became more efficient, between Vancouver, B.C., and these places. Later an all-weather road was constructed by the Dominion Government between Whitehorse and Mayo, on the Stewart River, for delivery of the lead-silver concentrates from the Mayo district mines. Ferries carried the traffic over the Yukon, Pelly and Stewart Rivers. This road was finally extended to Dawson. In the last few years all ferries were replaced by modern steel bridges. Now all freight comes in over this road and there is no more river traffic from Whitehorse.

Freight rates between Vancouver and Dawson vary between $55 and $135 per ton. To this must be added the cost of local transportation to destination which, in the past, averaged about 50¢ per ton-mile but, as road conditions were improved, has been considerably reduced and is now about half that amount.

For many years the main haulage roads in the Klondike District were largely maintained by the Territorial Government with the mining company doing a considerable amount of road work in addition. In the last few years the maintenance of these roads has been the responsibility of the mining company aided by grants from the Territorial Government.

There were three main reasons for the development of the Yukon dredging industry in recent years. These were

(1) The development of a successful method for stripping of the frozen muck which overlies the gold-bearing gravels.

(2) The development of a method for thawing the frozen gravels with water at natural temperatures instead of, as in the early days, by steam.

(3) The increased price of gold.

In the early days of the Yukon dredging industry, when thawing by steam was practiced and both muck and gravel were thawed and dredged, it cost between 35¢ and 40¢ per cubic yard to dredge ground which was over 50% naturally thawed. With the introduction of the new methods for stripping and thawing these costs were reduced to from 16¢ to 20¢ per cubic yard dredged in ground which was practically 100% frozen and the unit value of each cubic yard dredged was increased by every cubic yard of barren muck removed.

Muck is a very difficult material to thaw so that the removal of as much of this as possible greatly reduced the cost of thawing the remaining material. To illustrate the importance of removing the barren muck prior to dredging the following examples are given using assumed figures which approximated average conditions in the dredging reserves and cost figures which approximated those at the time when operations were being expanded.

Assume:	depth of muck	20 feet
	depth of gravel	6 feet
	depth of pay bedrock	4 feet
	value per square foot of bedrock	25 cents

Example No. 1

15 feet of muck removed by stripping

Annual capacity of dredge		650,000 cubic yards
Stripping cost		6 cents per cu. yd.
Thawing cost		4 cents per cu. yd.
Dredging cost		10 cents per cu. yd.
Working cost per sq. ft. of bedrock		
Stripping 15 cu. ft. of muck @ 6¢ per cu. yd.	3.3¢	
Thawing 15 cu. ft. of D.S. @ 4¢ per cu. yd.	2.2¢	
Dredging 15 cu. ft. of D.S. @ 10¢ per cu. yd.	5.5¢	
Total	11.0¢	
Working cost per cu. yd. dredged	19.8¢	
Value per cu. yd. dredged	45.0¢	
Profit per cu. yd. dredged — Total	25.2¢	
Sq. Ft. of bedrock worked over per season		1,170,000
Production per season		$292,500
Working cost per season		128,700
Working profit per season — Total		$163,800

Example No. 2

No stripping done

Cubic yards dredged equal to 90% of Cu. yds. thawed

Annual capacity of dredge		650,000 cubic yards
Thawing cost		5.5 cents per cu. yd.
Dredging cost		10.0 cents per cu. yd.
Working cost per sq. ft. of bedrock		
Thawing 30 cu. ft. @ 5.5¢ per cu. yd.	6.1¢	
Dredging 27 cu. ft. @ 10.0¢ per cu. yd.	10.0¢	
Total	16.1¢	
Working cost per cu. yd. dredged	16.1¢	
Value per cu. yd. dredged	25.0¢	
Profit per cu. yd. dredged — Total	8.9¢	
Sq. ft. of bedrock worked over per season		650,000
Production per season		$162,500
Working cost per season		104,650
Working profit per season — Total		$ 57,850

These examples show an increase of working profit produced by stripping of $105,950 per season. These figures were conservative because the thawing of muck is difficult and not often accomplished at 100% efficiency thus increasing the cost of dredging and decreasing the capacity of the dredge.

Over the years, with increasing costs of labor and supplies, the costs of stripping, thawing and dredging have necessarily advanced. Beyond endeavouring to increase the efficiency of the work not much has been changed in the stripping and dredging operations but in the thawing operation the advance in costs has been checked to a certain extent by changing the spacing of the points. Experience has demonstrated that in some areas the original spacing of points on 16-foot triangles could be increased to as much as 24 feet thus reducing the number of distributing pipes to be laid and greatly decreasing the number of points to be driven. Also, with the wider spacing of points, enough equipment could be placed before actual thawing was commenced to cover an entire season's operation and no equipment needed to be shifted during the season. With ground conditions varying a great deal in different areas the wider spacing could not be universally adopted but the distributing pipes were laid out for this spacing and any extra points required were given water from hoses leading from multiple cross-heads in the header pipes. At the end of 1963 stripping, thawing and dredging costs then averaged as follows:

Stripping per cubic yard	10.8¢
Thawing per cubic yard in stripped areas	7.2¢
Thawing per cubic yard where the formation is largely muck	11.1¢
Dredging per cubic yard	20.1¢

Applying these figures to the conditions shown in Example No. 1 gives the following results:

Example No. 1

15 feet of muck removed	
Working cost per sq. ft. of bedrock	
Stripping 15 cu. ft. of muck @ 10.8¢ per cu. yd.	6.0¢
Thawing 15 cu. ft. of muck, gravel and bedrock @ 7.2¢ per cu. yd.	4.0¢
Dredging 15 cu. ft. @ 20.1¢ per cu. yd.	11.2¢
Total	21.2¢
Working cost per cubic yard dredged	38.2¢
Value per cubic yard dredged	45.0¢
Profit per cubic yard dredged	6.8¢
Sq. Ft. of bedrock worked over per season	1,170,000
Production per season	$ 292,500
Working cost per season	248,300
Working profit per season	$ 44,200

Example No. 2

No stripping done	
Thawing cost per cubic yard	11.1¢
Dredging cost per cubic yard	20.1¢
Cu. Yds.dredged equal to 90% of cu. yds. thawed	
Working costs per sq. ft. of bedrock	
Thawing 30 cu. ft. @ 11.1¢	12.3¢
Dredging 27 cu. ft. @ 20.1¢	20.1¢
Total	32.4¢
Working costs per cu. yd. dredged	32.4¢
Value per cu. yd. dredged	25.0¢
Working profit or (loss) per cu. yd. dredged	(7.4¢)
Sq. Ft. of bedrock worked over per season	650,000
Production per season	$ 162,500
Working cost per season	210,600
Working Profit or (Loss) per season.	($ 48,100)

These examples show that even with the increase of cost the stripping off of the barren muck is very advantageous.

In 1934 much of the company's holdings had not been tested for gold values. The Lease on the Klondike River had been proved, by actual dredging with large dredges, to contain sufficient gold values to warrant dredging where the gravels were naturally thawed. On the smaller streams, which had been worked over by hand methods in the early days of the district, it had been demonstrated by the operations of the Yukon Gold Company and the New Northwest Corporation that any ground which had been successfully hand-mined would warrant dredging but the actual values remaining in the 'Old Works' and the extent and value of any workable ground adjacent to the 'Old Works' could only be estimated.

A 4-year campaign of prospect drilling was initiated under expert supervision to provide reliable figures for estimating yardage and value in each dredging area and it was on the basis of these figures that equipment was ordered.

The technique of placer drilling in frozen ground with Keystone drills had been developed in Alaska to a point of high accuracy. Frozen ground simplifies many drilling problems. No casing is required and, properly handled, it reduces sloughing to a minimum and enables accurate measurements to be made of the volume of the material extracted from the hole by adding measured quantities of water and determining the rise in the hole by tape and float.

The arrangement and spacing of the drill holes varies according to conditions but the bulk of the company's reserves were estimated from drilling done on cross-section lines 500 feet apart. Depending on the width of the paystreak, holes on the cross-section lines were spaced from 50 feet to 300 feet apart. At Dawson, when a new area is to be tested, scout drilling is first done with the holes so located that they will fit into any closer drilling which may be done at a later time.

The drilled cross-section lines are studied for depths of muck, dredging section (gravel plus pay bedrock) and gold content. These calculations are made by connecting up the holes of one cross-section line to the holes of the next cross-section line in a series of triangles and figuring the volume and gold content of each triangle by weighting the holes at the apices.

By the end of 1937 the drilling campaign had established proved gravel reserves of 96,360,000 cubic yards containing $42,154,600 (gold @ $35) with an estimated profit, after allowing for necessary capital expenditure, of $22,780,000.

Gold-bearing gravels of the Klondike District are of three kinds.

(1) The Hill or 'White Channel' gravels occupying the ancient stream beds. They are called 'White Channel' gravels because of the large content of nearly pure quartz. They lie from 200 feet to over 300 feet above the present stream beds and vary in thickness to over 200 feet. Their gold values are mostly near bedrock. These gravels were drift-mined by the early day miners and later worked by hydraulicking by the Yukon Gold Company.

(2) The Bench Gravels which occupy terraces left by the streams in cutting down to their present levels. They are composed of

quartz pebbles and boulders mixed with fragments of the underlying schist, sand and silt. In quantity they are of minor importance but, on Dominion creek, some of them have proved to be very highly profitable when worked by bull-dozers pushing the gravels into sluice boxes for the gold recovery.

(3) The Creek Gravels covering the beds of the present streams. Their composition is about the same as that of the Bench Gravels. These gravels were of the first importance as they were to contain all of the dredging activities except in the one case of Dredge No. 12 which was a very small dredge (2-1/2 cu. ft. bucket capacity) purchased to mine certain Bench Gravels on Dominion creek.

Of the 96,360,000 cubic yards of Gravel Reserves proved by the drilling campaign approximately 5,000,000 cubic yards represented 'Hill Gravels' on Hunker creek which were worked by hydraulicking and 3,000,000 cubic yards represented Bench Gravels on Dominion creek which are now being worked by bull-dozer and sluice box and by Dredge No. 12.

The ground which has been and is now being worked by the company falls into two general classes.

(1) Ground worked over by the early day miners and early day mining companies ('Old Works').

(2) Virgin ground which was too low grade to work by earlier methods.

Approximately one-third of the company's proved Reserves were in virgin ground and the balance in 'Old Works'.

The following is a list of the dredges operated by the company:

Dredge No.	Size of Bucket Cu. Ft.	Average Daily Capacity Cu. Yds.	Manufacturer
1	7	4,700	Marion
2	16	12,000	Marion
3	16	12,000	Marion
4	16	12,000	Marion
5	7	4,700	Bucyrus
6	7	4,700	Bucyrus
7	5-1/2	3,000	Bucyrus
8	7	4,700	Yuba
9	5-1/2	3,000	Bucyrus
10	7	4,700	Marion
11	7	4,700	Marion
12	2-1/2	1,300	Johnson

Dredge No. 1

Originally built on the Klondike river in 1905 at the mouth of Bear creek. Later it was rebuilt on upper Hunker creek and finally was rebuilt on upper Dominion creek where it ended its life there in 1938.

Dredge No. 2

Built on the Klondike river in 1911 and operated there until closed down in 1939 because of lack of profitable ground to work.

Dredge No. 3

Built on the Klondike river below the mouth of Bonanza creek in 1912. She operated on the Klondike river and in the lower part of Bonanza creek until 1952 when she was shut down for lack of any more profitable ground to work.

Dredge No. 4

Built on the Klondike river below the mouth of Bonanza creek in 1912. She operated on the Klondike river and finally ended her life in 1940 after completing the mining of a high-grade area at the mouth of Hunker creek. Her machinery and equipment was removed and reconditioned and placed in the hull of a new No. 4 on Bonanza creek where it operated re-handling Yukon Gold Company dredge tailings from 1941 until being shut down in 1959 due to reduced values to be recovered from the tailings.

Dredge No. 5

This dredge operated in the area of Lower Dominion creek between the mouths of Gold Run creek and Sulphur creek. During the war she was shut down due to lack of operating labor and it was during this time that she was struck by lightning and destroyed by fire.

Dredge No. 6

Built on Lower Dominion creek near the mouth of Sulphur creek in 1936. Her original plan of operation called for her to mine out the lower part of Sulphur creek but, after No. 5 was destroyed, she was turned around and brought back to Dominion creek through an area of marginal ground values and took over the mining of No. 5's area. She is still operating there.

Dredge No. 7

Built on Quartz creek in 1935 and operated there until she came to the end of her area at the mouth of the creek in 1950.

Dredge No. 8

Built in 1937 in the middle Sulphur creek area. When No. 6 dredge was taken out of Sulphur Creek No. 8 area was extended to cover the ground remaining in the No. 6 area. The operation is continuing at this time.

Dredge No. 9

Built on upper Sulphur Creek in 1937-8. She is still operating there.

Dredge No. 10

Built in the Middle Dominion Creek area in 1938-9. She is still working downstream in that area.

Dredge No. 11

Built in the Middle Hunker Creek area at the mouth of Hester Creek in 1938-9 using machinery from Dredge No. 1. For two years she operated profitably in Yukon Gold Company's dredge tailings while other ground was being prepared for her. She is now operating near the mouth of Hunker Creek and will eventually end her life at the mouth of Last Chance Creek or in that creek.

Dredge No. 12

This was a dredge that had operated in Alaska about 75 miles from Dawson. She was a steel pontoon type. She was dismantled, hauled to Dawson where her machinery and equipmentwere reconditioned. She was then reconstructed on a Dominion Bench near the mouth of Jensen Creek. She completed the mining of that area and, after a short period of idleness, was hauled overland during the winter months to a new Bench area where she resumed operating in 1963.

<u>Hydro-electric Power Plant</u>

All dredges were electrically operated with power supplied by the company's hydro-electric plant situated on the Klondike river. As originally constructed this had two 5,000 horsepower Francis type, I.P. Morris turbine units supplied by water taken from the North Fork of the Klondike river. This was delivered to the plant through a 6-mile canal which gave a head of about 220 feet. When plans were made to extend the company's operations more power was required and another 5,000 horsepower I.P. Morris turbine unit was added. As the North Fork river had periods when its water supply was well below the required amount, a 16-mile canal of 10,000 M.I. capacity was constructed to bring water from the South Fork of the Klondike river and deliver it to the North Fork above the intake of the original canal. At the same time the capacity of the original ditch was increased to take care of the greater water supply. This was done by the use of a dragline shovel operating along the upper bank of the canal. The canal is now 50 feet wide on the water line and carries an average depth of water of six feet, and has a capacity of 30,000 M.I.

Power is delivered to the dredges, to Bear creek (the main operating headquarters) and to the City of Dawson over 33,000 volt lines. Secondary lines are 2,300 volts.

In the fall of the year, when cold weather comes, power is erratic during the freeze-up. This condition continues until the canals and the rivers freeze over after which time no further trouble is experienced from slush ice. As the ice in the canal gets thicker the water delivered gradually falls off but the output of the plant seldom gets below 2,500 K.W. which is sufficient for all winter uses. A short, sharp freeze and an early snow fall give the ideal conditions for the freeze-up.

The shut-off gates at the intakes of the canals are housed over and kept warm with electric heat so that the gates can always be operated as required.

Operations

Stripping

In the Dawson district, in the smaller streams, the gravels are overlain with a deposit of barren, frozen muck ranging from ten feet to sixty five feet in depth. This is a very difficult and expensive material to thaw and dredge. It can be removed by hydraulic stripping at a lower cost than that of thawing and dredging and every yard of muck removed increases the unit value of each yard dredged and enables more bedrock to be worked over in a season.

Working of a dredging area on the creeks means clearing the surface of brush, trees, old buildings and machinery and then removing as much of the muck as available run-off grade will permit. When operations were first started in 1934 the clearing of brush and trees was carried on by hand work under contract but as tractors came into use this work was shifted to bull-dozers.

Water supply for stripping is derived from ditches or from pumps taking water from the local streams. Pumps for this purpose were standardized on a high efficiency ten-inch centrifugal pump rated at 3,000 U.S. gallons per minute against a 150-foot head. Each unit is driven by a 150 H.P. 2,300 volt synchronous motor. The capacity of these is just right to supply a 3-1/2 inch nozzle. The pump casings were made heavy enough to stand double pressure so that two pumps could be operated in series if higher pressure was required and the pump set-ups were made so that operation could be switched from parallel to series as required. Each pumping unit and its starting equipment is housed in a portable house 18 feet long by 10 feet wide built on four steel-shod skids which are double ended so that the building can be shifted in either direction. The building has a 3-inch floor nailed directly to the skids and a 2-inch by 4-inch framework covered with corrugated iron. There are fourteen of these units.

Stripping is accomplished by hydraulicking using water under pressure through a system of pipes leading to a series of No. 2 Giants placed so that all surrounding muck can be reached with a minimum shifting of Giants. To get the best efficiency out of the water it is necessary to cover a large area in a single operation so as to give the sun's rays time to thaw the surface. For each stream of water used from eight to ten Giants are set up so that, by a process of rotation from one to another, sufficient time elapses after all thawed material has been removed from a given set-up before it is necessary to work it over a second time. At the peak of operations there were approximately one hundred and forty Giants set up at one time over all the stripping plants. Water duties at Dawson vary from eight cubic yards to fifteen yards per M.I.D. depending on the character of the material to be removed. (The M.I.D. is a unit with a flow of 1-1/2 cubic feet per minute for 24 hours.) Stripping is complicated by the presence of 'Old Works' tailings on the surface, deep moss and slide rock in the muck. For efficient work pressures between 50 and 120 pounds per square inch are desirable. The style of pipe-line lay-out for placing the Giants and for delivery of water to them is determined by the shape of the area to be worked, the slope of the surface and the presence of tailings on the surface. Originally, the first set-up of the giants was for the purpose of disposing of the tailings but, after bull-dozers became available, this work was done mechanically. The distance between Giants is regulated by the water pressure and the character of the material to be handled. A rule-of-thumb method for placing Giants for muck stripping is to work away from each Giant a distance in feet equal to one and one-half times the pressure of water in pounds per square inch.

Sulphur-Australia Ditch

This ditch was constructed to supply water for Sulphur creek which has a very small supply of its own. Fortunately, Australia creek was near and had a much more satisfactory water run-off. This creek was dammed off at a point about six miles from its mouth and the water was led into a 1500 M.I. capacity ditch which was constructed to carry the water to a point on Dominion creek, near the mouth of Sulphur creek, where it was carried across the valley of Dominion creek in a pipe-line salvaged from the operations of the Yukon Gold Company. A surge tank was built at the end of the pipe-line and from this the water was led in to two centrifugal pumps, each driven by 800 H.P. motors and these elevated the water some 300 feet to another 1500 M.I. capacity ditch which delivered it up Sulphur creek. This ditch was eleven miles long. At the end of this ditch another pump station was constructed to elevate a smaller part of the water another some 300 feet to supply upper Sulphur creek operations.

It is interesting to note how surge suppression was managed at the two stations. At the main pump station each pump was equipped with a heavy fly wheel to keep the pumps revolving for a few seconds after any sudden power failure. In addition each pump outlet was supplied with a gate valve and a swing-check valve. The swing check valve was equipped with a dashpot arrangement which would prevent that valve from closing too quickly.

The flywheels gave a sufficient time interval to allow for this closing. The gate valve was supplied to enable starting of the pumps against a closed valve and to regulate the water supply to the pumps when the head was less than full supply.

At the smaller station on Sulphur creek surge was handled by erecting an air cylinder on the pipe-line beyond the gate valve and swing check valves. On the smaller station this worked very well.

Thawing

Thawing with water at natural temperatures follows completion of stripping and the more complete the job of stripping the fewer are the thawing problems. Thawing is accomplished by injecting water into the ground through pipes termed 'points' which are driven by hand to bedrock as the water thaws the ground ahead of them. This system was started by Miles in Alaska and was perfected at Nome, Fairbanks and Dawson for large scale operations. The equipment now used at Dawson is mostly the same as that which was perfected at Nome and Fairbanks by the United States Smelting Refining and Mining Company.

Originally the ground to be thawed was laid off in a series of blocks, or units, each containing about 600 points but, with the wider spacing of points, this was increased in size. Now, with the wider spacing of the 'header pipes' enough equipment is laid to cover a full season's area without shifting of equipment.

Water is conducted through a 12-inch gate valve into a flanged pipe ranging in size from 11 inches down to 8 inches and having 6-inch outlets spaced at proper distances to suit the location of the 'header pipes'. These outlets have 6 inch gate valves attached and to these are attached the 'header pipes' which distribute the water to the points. 'Header pipes' are 6 inch and 4 inch slip joint pipes which are 16 feet long when driven. Each piece of 'header pipe' has a 2-inch screwed outlet in the center for the 'cross-heads' which consist of a 2-inch by 4-inch nipple leading into a 1-inch by 1-inch by 2-inch tee. From each side of the tee is a 1-inch by 4-inch nipple, a 1-inch cock and a 1-inch Chicago Pneumatic hose coupling, thus giving a lead to two points at each 'cross-head'. Connection to the points when they are spaced 16 feet apart is by 1-inch hose 16 feet long which hose has a Chicago Pneumatic hose coupling on one end and a 3/4-inch gooseneck on the other end. When point spacing is greater than 16-ft. the length of the hose is made longer to fit.

Points consist of 3/4-inch and 1/2-inch extra-heavy pipe. The former has a special chisel-bit on the end and is used where there is considerable driving to be done. The bit is a combination of steel which is drop-forged so there is high-carbon steel on the cutting edge and mild steel on the end which is welded to the pipe. The 1/2-inch pipe has no tip and is used where driving is a secondary consideration and ease of cleaning plugged pipes is primary. The use of 3/4-inch points is predominant. Points are in 10-ft. lengths and are coupled together with hydraulic recessed couplings. If additional outlets are required at the 'cross-heads' this can be accomplished by screwing the standard 2-outlet 'cross-head' into a 2-inch tee or a 2-inch cross as the case may be.

Points are driven to bedrock by men, called 'point drivers', by means of a driving weight which is slotted to fit around the point and is held in place by a 3/8-inch round-steel bar fitted through holes in the weight. This also acts as a handle. The driving weight is brought into contact with an anvil in the shape of a heavy swing-bolt clamp tightened on the point. A wooden handle, bolted to the back of the clamp, acts as the means of twisting the point. Twisting of the point is essential to keep it going straight when being driven. Both weight and clamp are drop-forgings of special manufacture.

After the points have reached bedrock they are taken over by men, called 'point-doctors', who keep them operating until thawing of the ground is completed.

At Dawson the duty of the water varies between five and ten cubic yards thawed per M.I.D. of water. Point driving rates range from two to fifteen feet per man-hour. The thawing season extends from about May 10th to September 25th. Preparatory work begins about April 15th. After the thawing season is over work continues to about October 20th on the dismantling of the equipment and the preparation of the pump site for the following season.

Due to scarcity of supply, water for thawing has to be re-circulated. Settling basins are built to settle out the mud, and water from these basins is pumped to the thawing field, from whence it flows back to the settling basin. All water passing to the pumps must first pass through mechanical screens for removal of floating trash. These screens have baskets which are covered with 7-mesh wire screen galvanized after weaving.

Pumps for circulating thawing water were standardized on a 12-inch centrifugal unit rated at 6,000 U.S. gallons per minute against a 100-foot head and driven by a 200 H.P. 2,300 volt synchronous motor. These pumps have a flat performance curve so that they can be operated at a lower head with a corresponding increase in quantity of water delivered without a great loss of efficiency. Each unit, with its starting equipment, is housed in a portable house of the same dimensions and construction as used for the stripping pumps. There are eleven of these units.

The process of water thawing consists of injecting water, at natural temperatures, into the ground through the 'points'. The ground is thawed by absorbing heat from the water. As the ground thaws it settles around the 'point' and leaves a more or less open channel between the thawed mass and the frozen ground so that the water returning to the surface generally comes up along the frozen face. The presence of 'Old Works' complicates the operation as they frequently leave more open channels for the water and the flow of several 'points' may come out at one place thus leaving islands of frozen ground which must be located and thawed by driving additional 'points'.

In the early days of 'cold water' thawing careful records were kept of the temperature of the water and the quantity going into the ground to get a measure of the work being done. When it was indicated that a block of ground should be thawed it was tested by driving steel bars into the ground midway between the'points' and the manner in which these bars entered the ground gave an indication of its condition. After a few years of operation sufficient knowledge had been gained so that the expense of keeping these records was no longer justified and they were abandoned.

It is interesting to note that, under present climatic conditions, ground once well thawed improves rather than having any tendency to freeze back.

Naturally, the surface freezes during the winter to a depth of four to six feet but this frost is usually gone by early June. Early snow-falls help to keep this freezing to a minimum.

Dredging

Dredging of the ground follows completion of the thawing. Dredging in the Yukon is relatively good when the ground is well thawed, but as that is a condition which is not always easy or practicable to attain, the dredges are often called upon to dig a certain amount of frozen ground.

The dredging season is relatively short and major repairs are made in the shut-down period so far as possible. Preparatory work begins about April 1st, the dredges start operating about May 1st, continue to the early part of November and the crews are generally laid off within two weeks of the time dredging is closed down.

Hydraulic Mining

Hydraulic Mining of the Bench Gravels of Hunker Creek was carried out on Paradise Hill located on the Left Limit of Hester Creek at its junction with Hunker Creek. This deposit was ideally located for hydraulic mining except for the water supply. The only available source was Hunker Creek which, by itself, was inadequate. To remedy this condition it was decided to construct a settling basin and re-circulate the water. As Dredge No. 11 had already mined out the creek gravels below this area there was no interference with dredging operations.

A large dam of dredge tailings was built about a mile below the place where tailings from Paradise Hill were to be dumped into Hunker creek. Below this dam another low dam was built to give a supply to a pump station. The company had on hand a 1200 H.P. centrifugal 4-stage pump capable of delivering 500 M.I. against a 600 foot head. This pump and its electrical equipment were re-conditioned and placed in service. A system for surge suppression, similar to that supplied to the Upper Sulphur pump station, was supplied here.

In operation the large tailing dam was tight enough to back up the water and make a settling basin but seeped enough water to supply the pump station below it without its taking any dirty water direct. The re-circulation of water worked so well that, even in very dry periods, hydraulicking was carried on at full force.

The bedrock on Paradise Hill was extremely uneven sometimes varying as much as fifty feet in a distance of little more than 100 feet but generally had a good slope towards Hunker creek so that no bedrock cuts were required. The bottom gravels were pushed to the head of the sluice boxes by bull-dozer and the cleaning of the bedrock was performed by the same method. As was done at the Bull-Dozer operations, the sluice boxes had angle-iron riffles over which perforated plates were placed in a step manner to prevent the riffles clogging with heavy concentrates.

Hydraulicking was commenced in 1952 and completed in 1960. There was no operation during 1959 while the tailings dam was being re-built after it had been largely destroyed during a flood at the beginning of the season.

Bull-Dozing

Certain areas which are too small or too shallow or have very uneven bedrock are being mined by the "Bull-dozer" method. In this operation the start is made the same as for a dredging area. The surface is first cleared of old buildings, brush and trees and then the muck is stripped off by hydraulicking. Generally the gravel is shallow enough to thaw naturally after the muck is removed and no thawing is required if this condition holds true.

When the deposit is ready for the gold recovery a sluice box with angle iron riffles is set up with a wide dump box at its head into which a bull-dozer pushes the gravels. There is a suitable washing arrangement over this dump box so that the material is well washed before it enters the riffle area in the sluice. Boulders are generally removed from the dump box before they can enter the sluice. It has been found to be a good practice to place perforated plates over the riffles, in a stepped arrangement, to prevent the riffles from clogging with heavy concentrates and leave them free to hold the gold.

Where there is not sufficient grade below the sluice box to allow the tailings to run away from the box it is necessary to have the bull-dozer stack them as often as required.

Repair Facilities

The Company operates a large, well equipped repair shop at its main camp which is situated at Bear creek on the Klondike river about eight miles from the City of Dawson. Here it also maintains a large stock of repair parts and general supplies.

Camps

Originally each operation had its own camp but in later years it was found to be more economical to maintain fewer camps and give the men transportation to and from the job.

Camps are now maintained at Bear Creek, Middle Dominion Creek, Granville, Upper Sulphur Creek and the Power Plant.

Attached to this paper is a schedule which summarizes, by years, the work performed in ground preparation and its dredging. This is shown as follows:

(1) The cubic yards of overburden removed by stripping and the cost thereof.

(2) The cubic yards of dredging section thawed and the cost thereof.

(3) The cubic yards mined by the dredges and the cost thereof.

(4) The recovery from the ground by the dredges and the percentage of value recovered compared with estimate of value made on the basis of the prospect drilling in prospected areas,, and from other information where prospect drilling results were not available.

There is also a schedule summarising by years the results of the hydraulicking operation on Paradise Hill and the bulldozing operation on the Dominion Benches.

PARADISE HILL - NO. 13 - HYDRAULICKING

OPERATING DATA

Year	Duty of Water	Cubic Yards Mined	Cost		Production - Au @ $35		
			Total	¢ Per Cu. Yd.	Total	¢ Per Cu. Yd.	% of Estimate
1952	7.24	111,651	38,100.65	34.12	16,847.31	15.09	54.9
1953	-	127,445	52,523.41	41.21	106,013.75	83.18	277.3
1954	4.80	186,026	102,078.94	54.87	73,685.76	39.61	133.9
1955	4.81	164,587	111,295.45	67.62	175,010.38	106.33	191.0
1956	4.11	177,208	102,070.92	57.60	76,591.25	43.22	80.4
1957	8.27	371,570	105,519.68	28.40	111,738.40	30.07	87.8
1958	7.25	325,936	86,393.09	26.50	115,960.69	35.60	118.6
1960	4.26	169,370	116,045.00	68.50	92,229.00	54.50	136.1
Totals		1,633,793	714,027.14	43.70	768,076.54	47.01	173.1

DOMINION BENCHES NOS. 14, 15, 16

BULLDOZING OPERATING DATA

Year	Cubic Yards Mined	Cost		Production - Au @ $35		
		Total	¢ Per Cu. Yd.	Total	¢ Per Cu. Yd.	% of Estimate
1958	153,987	105,729.36	68.7	104,968.19	68.1	38.2
1959	120,650	101,633.85	84.2	70,011.41	58.0	80.7
1960	138,763	150,845.00	108.7	79,734.00	57.5	65.7
1961	257,192	161,690.00	62.9	351,254.00	136.6	106.1
1962	205,537	153,497.00	74.7	212,827.00	103.5	89.2
1963	264,890	169,126.00	63.8	231,106.00	87.2	112.0
Totals	1,141,019	842,521.21	73.8	1,049,900.60	92.0	78.0

STRIPPING - THAWING - DREDGING

OPERATING DATA

Year	Cubic Yards of Muck Stripped	Stripping Cost		Cubic Yards of D.S. Thawed	Thawing Cost		Cubic Yards Dredged (All Dredges)	Total Dredging Costs (including stripping and thawing write-offs)		Production (All Dredges)		
		Total	¢ Per Cu.Yd.		Total	¢ Per Cu.Yd.		Total	¢ Per Cu. Yd.	Total	¢ Per Cu.Yd.	% of Estimate
1935	416,438	62,615.37	15.04	958,824	88,237.00	9.20	5,222,144	555,590.13	10.64	908,339.04	17.39	106.0*
1936	1,290,220	128,122.76	9.93	2,046.748	106,775.09	5.21	7,957,108	876,448.80	11.02	1,456,423.77	18.31	107.0*
1937	1,871,624	170,898.78	9.13	3,844,638	188,068.27	4.89	7,443,785	842,001.56	11.31	1,887,723.05	17.30	115.2
1938	2,818,268	201,621.47	7.15	4,140,821	263,864.38	6.37	8,550,652	1,174,081.59	13.73	2,127,103.43	24.88	111.9
1939	3,762,824	187,864.74	4.99	4,112,845	242,081.70	5.89	10,090,182	1,285,322.08	12.74	2,734,778.15	27.10	110.3
1940	4,298,047	229,530.61	5.34	6,174,169	290,149.53	4.70	10,480,799	1,197,409.28	11.43	2,617,227.40	24.97	102.3
1941	2,692,219	197,829.53	7.35	7,108,325	311,739.38	4.39	8,205,270	1,163,342.10	14.17	2,333,681.40	28.43	108.6
1942	2,501,681	174,284.51	6.97	4,529,117	202,647.88	4.47	10,401,131	1,478,142.29	14.21	2,831,292.56	27.22	112.0
1943	360,621	31,861.00	8.84	486,021	12,016.39	2.47	7,006,055	823,723.09	11.76	1,329,354.64	18.98	98.1
1944	1,016,994	84,565.21	8.40	-	-	-	4,348,874	596,932.78	13.73	616,288.73	14.17	105.5
1945	1,038,110	96,923.82	9.33	477,056	38,032.08	7.97	2,682,743	584,758.71	21.79	915,962.91	34.14	136.9
1946	2,138,654	204,385.39	9.54	2,868,542	185,256.27	6.46	5,614,700	983,737.76	17.52	1,362,697.63	24.27	101.3
1947	2,290,715	295,613,45	12.91	5,048,008	340,268.99	6.74	6,692,528	1,167,938.49	17.45	1,326,906.80	19.82	133.7
1948	3,144,020	261,167,02	8.31	4,415,705	324,632.71	7.35	7,146,666	1,355,269.92	18.97	1,652,795.72	23.13	110.3
1949	2,487,131	219,609.69	8.83	3,850,978	222,212.84	5.77	8,556,300	1,456,644.02	17.02	2,171,909.31	25.38	85.3
1950	2,037,891	223,906.13	10.99	4,155,557	247,855.45	5.96	6,835,964	1,466,837.93	21.46	2,540,841.38	37.17	142.8
1951	1,736,120	201,632.75	11.61	4,946,601	232,678.51	4.70	5,878,422	1,305,260.72	22.20	1,932.525.93	32.87	131.7
1952	1,982,404	254,837.97	12.85	4,249,900	209,754.89	4.94	5,863,491	1,431,740.20	24.42	1,900,880.41	32.42	112.8
1953	1,937,568	243,005.47	12.54	4,562,819	237,211.29	5.20	4,340,557	1,256,678.00	28.95	1,416,883.07	32.64	104.5
1954	1,728,937	263,910.68	15.26	3,042,778	163,316.03	5.37	5,115,815	1,307,680.10	25.56	1,780,387.84	34.80	104.5
1955	2,238,528	248,054.85	11.08	3,171,720	162,946,76	5.14	5,319,022	1,295,861.35	24.36	1,524,058.08	28.63	99.8
1956	1,438,987	207,428.01	14.41	2,241,394	116,017.38	5.18	4,960,352	1,240,631.14	25.01	1,604,861.99	32.35	119.1
1957	1,242,555	164,384.59	13.23	2,376,147	128,162.90	5.39	6,283,046	1,426,830.62	22.71	1,822,579.94	29.01	101.1
1958	1,042,469	129,643.62	12.40	3,546,725	170,681.54	4.81	6,130,347	1,414,845.32	23.10	1,671,801.57	27.30	93.2
1959	1,296,134	155,735.57	12.01	2,149,194	138,748.16	6.46	5,914,587	1,541,870.28	26.10	1,724,037.04	29.20	87.9
1960	1,020,689	122,660.00	12.01	3,456,012	234,659.00	6.79	4,517,964	1,443,021.00	31.90	1,993,864.00	44.10	125.3
1961	1,214,439	108,013.00	8.89	2,545,886	221,281.00	8.69	4,041,022	1,267,591.00	31.30	1,554,118.00	38.40	114.1
1962	1,015,621	108,645.00	10.70	3,876,533	280,484.00	7.20	4,477,386	1,247,670.00	27.90	1,299,684.00	29.10	129.8
1963	1,431,141	148,338.00	10.36	2,656,277	226,264.00	8.52	4,478,831	1,409,049.00	31.50	1,275,247.00	28.50	87.2
Totals	53,491,049	5,127,088.99	9.58	97,039,340	5,586,043.42	5.76	184,555,743	34,596,909.26	18.75	50,314,254.79	27.26	110.0

* Percentage of actual value recovered over estimated recovery is approximate in 1935 and 1936.