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data in the foregoing pages it is easy to calculate how large a body of ore must needs be found, in order to reimburse the purchasers from the profits of working, assuming for the future a yield per ton and a cost of operating equal to that of the past.

The third condition, the ore-producing capacity of the ground, after all that has been said, can only be taken at a venture.

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James D. Hague

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REPORT

ON THE

SOUTH AURORA MINE & MILL

AND

CHLORIDE FLAT.

BY

JAMES D. HAGUE.

JULY 12, 1871.

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12000

HAMILTON,

July 12th, 1871.

SIR,

I have the honour to transmit to you my Report on the South Aurora Mine and Mill and Chloride Flat.

I have endeavoured to comply with your request to make the Report exhaustive, and in doing so, have found it impossible to be brief, but a summary of important points concerning the Mine will be found on pages 36 to 40.

My thanks are due to F. A. Benjamin, Esq., General Manager, and to his assistants Dr. Goodfellow and Mr. Robinson, for aid in accomplishing the object of my errand and for much hospitable attention.

Very respectfully yours,

JAMES D. HAGUE.

CHAS. CADOGAN, Esq., *Secretary*,

SOUTH AURORA SILVER MINING COMPANY, LIMITED,
54, OLD BROAD STREET, LONDON.

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Part First.

THE

WHITE PINE MINING DISTRICT.

The South Aurora Mine is located at the south end of the crest of Treasure Hill, in the White Pine Mining District, White Pine County, Nevada.

For the better understanding of the matters to be treated in detail in this Report, a few general ideas of this district are given in the following paragraphs:—

The White Pine Mining district is in the eastern portion, and not far from midway between the northern and southern boundaries of the State; Treasure Peak, about which the principal mining operations have thus far been in progress, being in latitude $39^{\circ} 14'$ north, and longitude $115^{\circ} 27'$ west from Greenwich.

The town of Hamilton, the business centre of the district, is about 120 miles south of the Central Pacific Railway. It is connected by wagon roads with the railway stations of Palisade and of Elko, the former being 573 miles and the latter 606 miles from San Francisco. Hamilton is accessible from Palisade by a line of coaches, running daily, and making the journey in about twenty-one hours. Postal and telegraphic facilities are abundant. The roads are tolerably good during the greater portion of the year. Freights from Palisade to Hamilton are from two to two-and-a-half cents per pound, or sometimes more, according to the season. From San Francisco to Palisade, two-and-a-half cents. The average cost of freight during the year from San Francisco to Hamilton is about \$100 per ton of 2,000

pounds. A line of railway is now being surveyed with the view of building a narrow-gauge road. It is said that a portion of the capital is already provided, and that the construction of the road will presently be commenced.

General Description of the Country.

The eastern portion of the State of Nevada, in which the White Pine District is situated, is nearly the centre of what is known as the Great Basin, a comparatively depressed region, measuring 700 to 800 miles from east to west, and lying between the Sierra Nevada mountains on the west and the Wahsatch Range (east of Salt Lake) on the east.

The face of the country within this Great Basin presents a broad plateau, having an average elevation of 4,000 feet above the sea. Its surface is broken by parallel ranges of mountains, rising to a height of 4,000 to 6,000 feet above the plain, and having a nearly north and south trend. The foot-hills of these ranges are from ten to thirty miles apart, leaving between them a broad expanse of valley. The streams of this region never reach the ocean, but descending from the mountains to the plain, disappear there by sinking into the soil or by evaporation; or, in some cases, flow into the great saline lakes for which the country is celebrated.

The air is dry and clear, the fall of rain or snow being comparatively light. The plains or valleys lying between the mountain ranges are, in the most depressed portion of the country, arid deserts without water or much vegetation; but the more elevated portions of the plateau-country are better favoured, possessing some grassy valleys and fertile lands. The mountains present great variety in form and character; some being bold, rocky, and barren, others

having gentle slopes, well-watered and grassy valleys, and a fair growth of timber. The region about the White Pine District is well favoured in these respects. The neighbouring mountains furnish abundant supplies of fuel; much of the surrounding country is well adapted to stock-grazing and some branches of agriculture, and although the immediate vicinity of the Mines is scantily supplied with water, there are excellent sources of it within reach and made available by water-works.

Description of the District.

The White Pine Mining District includes an area of twelve miles square, having Treasure Hill, about which the most important Mines are clustered, as a central point. This hill is an isolated ridge, about three or four miles long measured from the extremities of the base, and one-and-a-half or two miles wide. Its longer axis is nearly north and south, parallel to the general trend of the White Pine or Pogonip Mountain, from which it is separated by a narrow valley, and intermediate but lower, parallel ridge, on the western side, known as the Base Metal Range.

Treasure Hill lies east of the White Pine Mountain, and its eastern slope descends steeply, and, in some places, precipitously, to Applegarth Cañon, which separates the hill from the next eastern range, known as the Moke-Moke Hills. The north and south slopes of the hill are gentler than the eastern and western. The town of Hamilton lies near the foot of the north slope; and on the southern and south-western slopes are the towns of Eberhardt and Sherman. The Stanford Mill and the International Mill, the

latter belonging to the Eberhardt and Aurora Mining Company, are situated at Eberhardt City.

The highest point of Treasure Hill, known as Telegraph Peak, is 9,228 feet above sea-level. The peak of White Pine Mountain is 10,792 feet above sea-level; and the town of Hamilton about 8,000 feet.

Geological Features and Ore Deposits.

The surface of Treasure Hill is composed almost entirely of limestone strata, the only exceptions on the western slope being a few isolated caps or patches of calcareous shale and silicious limestone, which belong to the next overlying formations, as may be seen further east. The geological age of these beds is believed to be Devonian; though they are overlaid immediately by rocks of the carboniferous period.

The general strike or course of these beds of limestone is nearly north and south, and they dip in opposite directions on opposite sides of the hill. The thickness of these single beds or strata, where most apparent, is from two to five or six feet.

The structure of the hill shows that it forms an anticlinal fold in the beds; the axis of which, having a nearly north and south course, strikes along the eastern side of the hill, and about 500 feet below the summit. The strata on the western slope of the hill dip to the westward, generally at a gentle angle of from 6 to 10 degrees; while on the eastern side, and east of the axis of folding just referred to, the beds dip to the east. The surface slopes of the hill are steeper than the inclination of the beds, so that the edges of the latter crop out, forming occasional

bluffs or escarpments. The eastern slope of the hill, just below the summit or crest-line, forms a precipitous wall about 400 feet high, showing the broken edges of the westerly-dipping strata.

The general course of the limestone beds has been already described as nearly north and south; but they have been fractured in some places by transverse fissures or breaks, which in some instances have caused the displacement of the rock. The most important of these fractures is one that crosses the south end of the hill, a few hundred feet below the summit. It is in the line of this fissure that the celebrated Eberhardt deposit occurred. Numerous seams or breaks in the rock, similar in character to that of the Eberhardt fissure, but less in extent, traverse the hill in an east and west direction, sometimes causing a movement of the beds and interrupting their continuity. A seam of this description occurs in the South Aurora Mine, presenting a vertical fissure, filled with spar and limestone; transverse to the general course of the beds, breaking them off, and probably causing a little displacement in an east and west direction, though, as far as can be seen, not very great. This seam will be described in more detail further on.

That these transverse spar-seams in the limestone beds have had much to do with determining the position of ore-bodies in the strata, appears to be a well-established fact from the experience of the leading Mines on the hill, and a study of their ore-deposits. The famous Eberhardt ore-body occurred, as just stated, in the line of such a fracture; the Autumn Chamber of the South Aurora Mine is bounded on the north by an east and west seam, or break, which slightly displaces the bedded limestones;

further north, in the North Aurora, similar seams occur, one of which, at the extreme north end, has caused a displacement or faulting of the strata, and traverses the immense ore-body now being worked in the Ward Beecher. On the adjoining "Flats," lying west of the Aurora and Ward Beecher Mines, numerous east and west spar-seams or transverse fissures traverse the bedded limestones; and, so far as my observation extends, the deposits of ore have generally been determined somewhat by, or, at least, closely related to, these seams. When ore fails, such seams are usually followed by the miners as guides in the search for new deposits.

Ore Deposits.

The ore of Treasure Hill occurs in chambers or pockets of variable forms and dimensions, and the distribution of these deposits over the area of the hill and in the various limestone strata, although perhaps better understood than at first, is very irregular, and in accordance with no clearly defined law.

The great series of ore-deposits appears, however, to lie along a north and south course, coinciding nearly with the trend of the hill, and chiefly, so far as yet developed, a little west of the crest-line. The deposits of the Eberhardt, the two Auroras, the Ward Beecher, and Hidden Treasure, all lie in this general course, and, as just indicated, the richest points appear to be where this north and south line is traversed by the east and west seams. On the upper portion of the hill, in the North and South Auroras and the Ward Beecher, there is also a north and south spar-vein, of large size, which cuts the westerly dipping strata.

This vein has a course generally a little west of north, and dips to the eastward at an angle of 35 degrees. Where this vein cuts the limestone beds it presents a smooth surface, well-defined and regular in course and dip. So far as the experience of the Mines just named shows, this vein appears to be the western limit of the ore-bodies which they have worked. The pay-rock in these Mines has all been east of this vein or floor; at one or two points the ore has rested upon the floor, but has not gone below it. Where broken into, the limestone of this vein is said to have been hard, massive and barren. There are, however, large deposits of ore west of this vein, as in the "Icebergs," and on the "Flats," but these deposits, so far as I know, occur where the limestone strata of the hill, after having been cut through by the spar-vein, have again resumed their regular courses and dip.

The ore-deposits of the hill vary exceedingly in form and size. The Eberhardt deposit was between 100 and 200 feet in horizontal dimensions, and about 50 feet deep. Some of the chambers of the South Aurora have been immense, and that of the Ward Beecher, now being worked, is said to measure 270 feet in length, 80 feet in width, and over 60 feet in depth, with the bottom still unknown, and yielding ore, according to report, worth \$100 per ton, without assortment. I did not verify these measurements, but the excavation is already very large; nor am I able to ascertain precisely the value of the ore.

In general, the deposits are smaller than the above-mentioned, frequently forming narrow seams or channels, and pockets of variable dimensions, and most capriciously distributed, sometimes confined to a single bed of lime-

stone, or following a cleft or joint in the strata; at other times expanding, as we have just seen, so as to penetrate several contiguous beds of limestone. The outlines of the deposits are also very irregular, and even where bounded on one side by a spar-seam, as in the Autumn Chamber of the South Aurora, in the other direction the ore-bearing rock merges into and mingles with the barren rock without any visible line of demarcation.

It will be seen from the foregoing that the ore of the district occurs in pockets or chambers and not in regular or fissure veins. There is nothing in the district which, as it now appears to me, could be called an ore-bearing fissure vein in the generally-accepted sense of the term. Nevertheless in their mode of origin these deposits may have much in common with those of regular veins; for the breaks and fissures that traverse the region may have been channels through which ascended from below the vapours or solutions, or other agents that have deposited or caused the formation of the quartz and metal-bearing mineral, in manner similar to that by which it is believed that fissures have been filled; with the difference in this case that the operation of these influences have extended laterally into certain beds of limestone, the composition or character of which rendered them especially subject to such action.

The continuance in depth of the deposits is still a matter of conjecture, and must remain so until settled by actual developments. The present depth of the autumn chamber is about 110 feet below the surface, with ore still in the bottom. Shafts in various parts of the hill have been sunk to depths varying from 100 to nearly 200 feet, some of which, sunk on the transverse seams before referred to, are

said to have found small quantities of ore yielding from \$50 to \$116 per ton, while others, sunk through the bedded limestones, remote from the transverse seams, found nothing; but whether the great ore-bodies descend to considerable depths below their present level, remains to be proved.

The ore-bearing material of these deposits is a highly silicified limestone; frequently brecciated, the small fragments being cemented together with quartz, spar, and ore. Crystals of free quartz and calcspar, especially the latter, are of frequent occurrence. The silicious limestone, quartz, and spar, appear to be impregnated with the finely distributed silver mineral, but the richest occurrences of the latter are in the fillings of little clefts and joints of the rock, in which are found thin sheets of the chloride of silver. In the rich deposits that were first worked the occurrence of this mineral was truly marvellous. Large masses were found near the surface, and one lot of ore of twenty-two tons, selected from the Eberhardt, rich in chloride, yielded in the stamp mill over \$96,000.

The average value of the ores of the district will appear more clearly in the following paragraph:—

Development of the District.

The first discovery of silver-bearing lodes in this district was made in the autumn of 1865, on the west side of White Pine Mountain; and two years elapsed before the more important ore-bodies of Treasure Hill were brought to notice. The Eberhardt Mine was located in January, 1868. The fame of the discoveries made there attracted thousands of people, and in the summer of the same year prospecting

and mining were vigorously carried on. The ores found on the surface and first worked, contained some very rich lots. Besides the lot of twenty-two tons, already mentioned producing \$96,000, the Eberhardt worked,

2,300 tons,	yielding per ton of 2,000 pounds	\$300
600	" " " " "	200
744	" " " " "	148
1,200	" " " " "	102

In a Report made under the direction of the United States Government, I estimated the total production of the district, to January 1870, at \$3,500,000 coin value. Since that date the production has probably been, to July 1st, 1871, not less than \$1,800,000, making a total of \$5,300,000.

The average value per ton of milling-ore in 1869 appears to have been something over \$60; from January 1st, 1870, to March 3rd, 1871, the average has been, as nearly as can be ascertained, \$35 per ton.

Part Second.

THE MINE AND MILL.

The South Aurora Mine is located, as already described, on the south end of the crest of Treasure Hill. Its surface-claim, secured by United States Patent, covers 800 feet in length, measured in a north and south direction, along the course of the ore-bodies, by 300 feet in width. Joining this claim on the north is that of the North Aurora, the property at present of the Eberhardt and Aurora Consolidated; on the east rises the summit of the hill in which but little prospecting has been done; on the west is the South Iceberg claim and the so-called summit and Nevada, in which excellent bodies of ore have been found; and on the south the hill falls off steeply for several hundred feet, beyond which is situated the celebrated Eberhardt Mine.

Geological Features.

In the foregoing pages some general ideas of the geological features of Treasure Hill have been presented. A few details concerning these characteristics of the Mine will suffice here.

The country rock in which the ore-bodies of the Mine occur, is composed of the flatly-dipping limestone strata, each several feet in thickness, striking generally north and south, and inclined to the westward at an angle of 6 to 10°. These beds are cut through, first by a spar-vein, striking also north and south, or north a little west, but dipping in a direction opposite to that of the stratified beds, that is, to

the eastward, and at an angle of about 35° . In the section through C D, on the accompanying map, this vein is shown, described as a "slip," by which term it is known here. Its position along the surface is also dotted down on the ground plan of the two Auroras; not in accordance with any actual survey, but only hypothetically. This seam is also called the "spar wall," "the main spar vein," and by some the "foot wall." It runs along the hill underlying the ore-bodies of the two Auroras and the Ward Beecher Mines; and, so far as yet developed, is the western limit of ore in those Mines.

Further, the bedded limestones and the spar vein just described, are both cut through by other spar veins or seams that have an east and west course, and nearly vertical dip. These have been already mentioned in the foregoing pages. The principal seam of this kind in the South Aurora occurs just north of the Autumn Chamber. Its position is approximately indicated by a broken line on the map. It makes its appearance in the lower tunnel (see map of the Mine already forwarded) about eleven feet north of drift B, and for about eighty or ninety feet north of the point where the seam is first met in the tunnel, the rock is made up of unstratified limestone, full of seams of spar, and honey-combed or traversed in all directions by clefts and joints. On the north side of this disturbed ground occurs another well-defined and *open* fissure, or seam, marked on the main map as "cave," a north and south crack, wide enough for a man to climb about in, and in which men have both ascended and descended many feet above and below the tunnel-level. This cross-vein, sometimes described as a "dyke," has probably caused a little,

but not much, displacement of the bedded limestone in an east and west direction. Beyond the cave on the north, the regular bedded limestones again appear in place, though the spar vein which formed the footwall of the tunnel south of the "dyke" is missing, having probably been thrown to the eastward.

The important relation which this and other similar east and west seams, traversing the bedded limestones, appear, from the experience of the principal Mines, to have towards the ore-bodies, has already been referred to.

Ore Bodies and Mode of Working.

The position and extent of the known ore bodies of the South Aurora, as well as the mode of working the Mine, are shown so fully on the large map already forwarded, that I need hardly refer to them in detail except as may be necessary to show the present condition of the work.

It may be observed, however, that one of the principal ore-bodies has been found at the extreme north end of the Mine, that directly south of it occurs the "cave," and thence for eighty or ninety feet is the transverse vein or "dyke," in which nothing has been found. Immediately south of this is the Autumn Chamber, and it will be seen by reference to the plan, that the greatest east and west extent of ore has been along the line of this transverse seam. Thence, south, the ore-bodies extend nearly three hundred feet with almost unbroken continuity.

The character of the ore has been already described. The total yield of all ore extracted from the Mine and worked up to May 31st, 1871, has been over \$712,000, as I shall have occasion to show further on.

Much of the ore of the Mine was taken out from the surface openings. The present method, as shown by the map referred to, is by means of the lower tunnel. All the ore broken in the stopes above is thrown down to the track-level, and run out in wagons or cars, by tramways, to the assorting-floors. As it is not readily practicable to sort the ore in the Mine, the mixed mass of limestone and ore must be broken and extracted together, and assorted on the floors outside. For this purpose a large force of sorters is required. The poor rock is thrown away and the selected ore sent to the mill.

The lower tunnel also serves an important purpose in the prosecution of prospecting or exploring work in depth. Much of this, now in progress, is shown on the map. Other points, not noted on the map, because selected since the map was made, will be referred to in what follows.

Present Condition of the Mine.

ORE EXTRACTION.

The force engaged on the 9th of July, in mining and extracting ore, was twenty-two men. Of these, six were at work in the South Open Cut, near the point marked Winze C. The face of the body of ore being worked was about ten feet wide, bounded on both sides of its longer dimensions by small seams of spar, separating it from barren limestone. The ore is said to be of very fair quality after assorting. It is thought from the present indications that the body extends to the south-east, and gains in depth in that direction.

In the Great Open Cut, further north, eight men are at work, four in following some small seams of ore, near the

surface, and four in working on a face of ore at a lower level, eight or ten feet wide, and apparently extending to the eastward.

The remainder, eight men, are at work in the extreme Northern Chamber, not far below the surface, likewise following seams of ore of fair quality.

The daily number of tons of milling ore, extracted and remaining after assorting, is estimated by the under-ground foreman at about twenty tons per day; but as the ore, after selection, is thrown upon the ore-heap and not weighed until hauled to the stamp-mill, it is not possible to say exactly what the present daily product of ore is.

The relation of dressed ore to rock extracted from the Mine previous to assortment, is estimated at one in six, but the data for estimating this are not very clear.

It will be seen from the foregoing, that the present show of ore in the Mine is not large. In fact, since encountering the transverse seam that proved to be the northern limit of the Autumn Chamber, and which suddenly cut off, at least, for a time, the principal source of supply, the production of the Mine has decreased somewhat. In the year 1870, there were mined, as nearly as can now be ascertained, about 11,000 or 12,000 tons; while in 1871, to May 31st, 2,772½ tons had been crushed, and adding about 1,600 tons now estimated as on hand, ready for crushing, we have 4,372, or say 4,400 tons as the present product of the Mine for the first six months of the present year.

Prospecting.

This decrease in the supply of ore has given great importance to the prospecting or exploring work now in

progress. There are at present engaged in this department of the work, about 24 men.

At the south end of the Mine, about 20 feet from the mouth of the Lower Tunnel, a drift is being run eastward from the tunnel, with the view of cutting the ore-body of the open cut immediately overhead, and which appears to be dipping to the south-east. In this work there are four men.

Further north, the drift C, is being carried south-eastward in search of ore-bodies, possibly lying in that direction; employing four men. This drift has advanced about 50 feet beyond the point shown on the map.

On the right hand side of drift B, about 55 feet from where that drift diverges from the tunnel, a prospecting shaft is being sunk. This shaft is for the purpose of seeking the continuation in depth of the Autumn Chamber. The shaft starts from the level of the tunnel; is now down about 37 feet in limestone; but as the ore in the bottom of Autumn Chamber, at tunnel level, is said to be good, it is probable that by getting beneath it, an additional supply may be found there. In this four men are employed.

Another exploring drift is about to be started above the level of drift B, searching along the line of the transverse now to the eastward.

The drift A has been formed in the direction indicated on the map to the boundary-line and little beyond. Work now suspended.

From the Autumn Chamber, four men are also employed driving south, following some indications of ore remaining of that great deposit.

At the point where the North Tunnel diverges from its

north-easterly course (see map) a new drift is started in a south-easterly direction to cut through the "Dyke" towards the Autumn Chamber. Four men are employed here; and a drift will probably be commenced on this level to cut through the ground lying east of the great North Chamber.

Besides the above, four men are engaged in driving a new tunnel, just started from the surface, 68 feet below the level of the present bottom-tunnel, and about 120 feet further east, and having a parallel or nearly north and south course.

The disposition of these prospecting drifts is such that the ground east of the tunnel should be pretty well explored. I have suggested to Mr. Benjamin and Dr. Goodfellow the possible advantage of paying special attention to the ground in the vicinity of the great transverse seam, both on the south side near the Autumn Chamber, and on the north in the region east of the North Chamber.

I have also suggested some exploration of the ground west of the main north and south spar vein. It is true that the principal course of ore-bodies is east of it, and this vein is generally regarded as the western limit of ore in these Mines. The ground lying immediately west of it is therefore but little explored; but the Mines of the "Iceberg" claims, adjoining the Auroras on the west, have been very productive, and it is quite possible that undiscovered bodies lie between these and the spar vein.

The great difficulty in prospecting is that the deposits are distributed so capriciously, so little in accordance with any law or system, that the miner has but few guides to lead him to the object of his search. Almost all the great discoveries here have been purely accidental. One of the

best bodies of the North Aurora, now being worked, lies within two feet of an exploring tunnel which passed by without disclosing its presence. The Ward Beecher discovery is described as a fortunate accident; and some of the largest and best bodies have been found by following seams or branches of ore of small size and little promise. The whole experience of the Mines on Treasure Hill shows that while the prospector must watch all indications with the closest scrutiny, following the spar seams or feeders of ore where they appear to guide him, yet the element of chance is, after all, the most important. Thus months may elapse before any great discoveries are made in the South Aurora; while on the other hand a fortunate strike may be made before this Report reaches its destination. That large and rich deposits of ore still remain to be found seems to me by no means improbable.

It follows from this that, under prudent management, prospecting work will never be neglected. The possession of the most promising body of ore should not be permitted to interrupt explorations for the future; and under the most fortunate circumstances a portion of the force and of the profits of the Mine should always be reserved and devoted to keeping the search for new ore-bodies constantly in advance.

Costs of Mining.

The total force employed at the Mine averages about eighty men, full time. On the 7th July the classification of the force was as follows:—

Mining ore, 22; Sorting ore, 14; Shovellers, 7;
Prospecting, 24; Carmen, 2; Carpenter and smiths, 5;
besides the overseers.

The price of labour is from \$3 to \$3 50c. per day. Contractors expect to make at least as much. Tunnelling costs from \$12 to \$15 per foot.

Scarcely any timber is used under ground. There is, of course, no water; and all the ore is run out from the tunnel without hoisting.

The cost of mining, *per ton of ore*, from month to month is not readily ascertained from the books at the Mine, because the accounts have not hitherto been classified with reference to such a purpose. The monthly disbursements do not furnish precisely the desired information, because the actual payments for labour and materials during any given month may be greater or less than can be fairly applied to the ore production of that month.

The safest approximation that I can make to the probable cost is to divide the total expenditure at the Mine from the beginning by the total production of ore, making due allowance for such items as cannot fairly be counted a mining expense, such as, for instance, litigation. The statement of expenditure is as follows:—

Labour Account from Dec. 12, 1868, to June 1, 1871	...	\$202,446.54
Materials	...	30,618.62
Ore Tax	...	11,590.13
Expense Account	...	5,215.44
Office Account	...	2,786.57
Wood, coal, and water	...	6,009.63
Stationery	...	86.75
Lumber	...	9,651.25
Interest and Exchange	...	5,401.81
Salary, Account	...	14,600.00
Litigation	...	20,877.79
Purchase-money on sundry claims	...	2,507.50
City Taxes	...	29.25
Total		\$311,821.28

Of this sum besides, besides \$23,385.29 spent in litigation and purchase-money, there were some other outlays, such as building office, road-making, and other contingent expenses, amounting probably to not less than \$32,000 in all.

The amount of ore taken out and crushed, of which any record exists, was, to May 31st, 1871, 19,128 tons, and allowing for 800 or 900 tons then on hand, it may be placed at 20,000 tons.

The total expense of the above work, divided by this amount, would be, per ton	...	\$15.59
And, allowing for extraordinary expenses above referred to, say	... ..	1.59

We have as mining cost, per ton	...	\$14.00
---------------------------------	-----	---------

The cost of labour and materials is so much less at present than in the earlier portion of the period included in this statement, that the sum above given may somewhat exceed the present mining cost. Mr. Benjamin believes that \$12 per ton will cover the mining expense. The total disbursements at the Mine for 1870, divided by the number of tons mined (11,000 as nearly as I can get at it) gives us the cost for that year—\$12 31c. per ton.

The cost per ton, however, will vary according to the relative amount of ore-extraction and dead work. When the Mine has large ore-bodies and is producing freely, the cost, per ton, will be comparatively light; when the supply of ore is short and the relative expense of prospecting increased, the cost per ton of ore produced will be augmented.

The disbursements from January 1st, 1871 to June 1st,

1871, amounting to \$58,799 31c., divided by estimated quantity of ore mined, say 4,400 tons, gives as cost of mining per ton \$13 86c. In the long run I think from \$13 to \$14 per ton would prove a safe estimate. This will be again referred to after speaking of the Milling cost.

The Mill.

The Mill belonging to the Company is situated on the south-eastern slope of Treasure Hill, about a mile and a half from the Mine in a straight line, but four and a half miles by way of the road. The ore has hitherto been hauled in wagons to the Mill, at a cost, in the summer of \$2 50c. per ton, and in winter at rates varying from \$3 to \$4 50. The new wire tramway of the Eberhardt and Aurora Company passes the Mine and Mill of the South Aurora, and it is proposed to employ this means of transportation; but at present date the arrangement of the loading and discharging stations is not complete, and it is not possible to say with what degree of economy this road can be made available.

The Mill is one of the best in the State, and is, so far as I know, unsurpassed by any for the excellent character of its machinery and the arrangement of all its working parts. It contains a rock breaker (Varney and Rix), a drying-floor (10 by 48 feet), 30 stamps weighing 750 pounds each, 16 amalgamating-pans (4ft. 6in. diameter and 2ft. 6in. deep), 8 separators or settlers, for the settling and separation of the amalgam (8 feet in diameter), and 4 agitators. There are 4 retorts for distilling the amalgam; and 2 furnaces for melting bullion. The driving power is a steam-engine,

20in. diameter of cylinder by 36in. stroke; to which steam is supplied by three boilers, each 16 feet long, 52 inches in diameter, with 51 three inch tubes; consuming six cords of wood per day. The capacity of the Mill is from 50 to 60 tons daily.

The arrangement of the Mill is such that the ore passes from one department of the work to the next succeeding with the least expenditure of power. The wagons bringing the ore dump it, after weighing, upon a platform several feet below that on which the wagons stand, so that there is space sufficient for a large accumulation. Thence the rock is passed through the breaker and is delivered upon the drying-floor, which consists of flues covered by cast-iron plates. When dry enough for crushing, the ore is thrown into self-feeding hoppers, which supply it to the stamps without the aid of hand labour. The stamps make over ninety blows per minute, dropping about seven or eight inches, playing in mortars (five stamps each) that are furnished with wire-cloth screens of forty meshes to the linear inch. When reduced to this degree, the dry powder or pulp is discharged into compartments enclosing the mortars. During the crushing, samples of the pulp, issuing from the mortars are taken every half-hour; and the accumulated samples of twelve hours work are mixed and assayed, the result represents the average value of the ore crushed during the twelve hours. The pulp is taken from the batteries to the pans in cars, and in these it is weighed again. The actual value of the charge to be amalgamated is thus ascertained, and the yield to be required can be calculated. The pans each hold a charge of 2,500 pounds, and require eight hours for grinding and amalgamation. A

little salt is used in this process, and a little cyanide of potassium is employed to quicken the mercury. The mercury put into each pan during the amalgamation is about 250 pounds. At the end of the eight hours the charge is drawn off into the separators, where, by addition of water and the gentle movement of the stirring apparatus during eight hours more, the fluid amalgam settles to the bottom, and, being discharged through a syphon, is strained through canvas filters, regaining the surplus quicksilver to be returned to the pans and obtaining the amalgam for distillation.

The remaining pulp or tailings, after this separation, is sampled and assayed; and its value being deducted from the value of the ore supplied, shows very nearly the yield to be demanded in bullion. The pulp discharged from the settlers passes through the agitators, where a little escaping quicksilver and amalgam is recovered.

The strained amalgam is then cleaned, weighed and retorted. The bullion obtained is about one-sixth of the amalgam; and the quicksilver recovered is ready for repeated use. The bullion is melted, assayed and stamped. Its fineness is from $\frac{220}{1000}$ to $\frac{228}{1000}$.

The percentage obtained of the original value of the ore has averaged during the past year about 85 per cent., as may be seen from a statement of operations given further on.

Cost of Milling.

The number of men employed in the mill averages about 31. These are classified about as follows:—

In the breaking, drying, and feeding department	(4 each shift)	8
In the pan-room	(5 " ")	10

In the engine-room	(2 each shift)	4
Watchman, smith, carpenter, weigher		4
Wood-passer, tailings-man, hostler... ..		3
Assayer, superintendent		2
Total		31

Wages are about \$4 per day for Mill hands; more to certain classes of labour. The pay-roll for May, including the salary of the General Manager, was \$5,441 99c. The consumption of fuel is about ten cords per day, for steam and other purposes. Its cost has been \$6 per cord; but will be in future \$6 50c. The supply of fuel for the district is abundant for some time. Water, supplied by the White Pine Water Company, costs \$1000 per month. Quicksilver costs 65c. per pound; the loss per ton is usually about $1\frac{1}{2}$ pounds per ton of ore treated, though it sometimes exceeds or falls short of that average. In May, the loss was 2877 $\frac{1}{2}$ pounds, amounting to \$2,676.08. The total consumption of supplies in May, as per statement forwarded with monthly accounts, was \$7207.18.

The accounts at the Mill have not until lately been kept in such a way as to show the costs per ton from month to month, nor can the sum total of all costs since the commencement be very closely arrived at. Of late, however, the accounts are being carefully kept and properly classified. A statement for the month of May was forwarded to London, and I am assured that the costs for that month will fully represent the average for the future.

These costs were:

For Supplies	\$7,207.18
„ Labour	5,441.99
„ Expense	1,343.43
Total	\$13,992.55

The amount crushed, including over 501 tons from the Chloride Flat, being 1567 $\frac{1200}{2000}$ tons.

The cost per ton, was	\$8.93
To this is to be added hauling, at present	2.50
Making	\$11.43

or, in round figures, \$11.50.

It should be observed that in this statement is included the salary of the General Manager (Mr. Benjamin), and perhaps some other expenses not strictly belonging to milling.

If the cost of mining be placed at	\$13.50
And hauling and milling together, at	11.50
We have for cost of mining and milling, per ton	\$25.00

This, under existing circumstances and with a fair relation between ore extraction and dead-work, I think may be a safe estimate. The cost may considerably exceed or fall a little short of that, according as the production of ore and the rate of supply to the Mill be diminished or increased.

The difference between this sum and the cost apparent from some of the statements forwarded from the office here, is to be accounted for by the fact that these statements hitherto have shown the *cash expenditures* during a given period rather than the *expenses*; not taking into consideration the consumption of supplies on hand and previously paid for. Thus, in the account for May, the expenses, or rather the disbursements, are stated at \$23,520 60c.; but this statement takes no account of the cost of supplies used at the mill during the month.

The following statement shows the record of milling operations since the beginning to the end of May, 1871:—

It exhibits the number of tons of ore worked, the assay value of the same, the actual yield in bullion, the yield per ton, the per centage of value obtained, and the value of the tailings:—

Date.	Tons of Ore Worked.		Assay Va. per Ton.	Actual Yield in Bullion.		Yield per Ton.	Per cent. obtd.	Assay value of Tailings per Ton.
	Tons.	Pnds.		Dols.	Cts.			
1869.								
Oct. 20 to Nov. 12..	445	0298	54 86	15,811	52	35 52	64½	15·87
Nov. 13 to Dec. 5 ..	451	1750	44 37½	18,911	92	41 41	77½	11·48
Ditto ditto ..	4	1662	909 90	46,384	81	62 40	83·9	11·38
Dec. 6 to Dec. 30 ..	743	0650	73 96½	50,725	59	80·8		9·70
1870.								
Jan. 1 to Feb. 10 ..	1580	0300	39 69½	27,373	60	75·6		10·45
Feb. 13 to March 18 Stopped for water.	1037	1565	34 89	76,378	27	80·6		11·58
April 16 to May 22..	1411		67 16½	57,630	05	77·5		10·60
May 25 to July 1 ..	1422	0100	52 29½	112,863	68	85·6		8·75½
July 5 to Sept. 14 .. Stopped for repairs.	2889	0150	45 39	126,781	08	85·5		7·41½
Oct. 6 to Dec. 31 ..	3914	1000	37 84	56,202	47	32 99	84·8	7·34
1871.								
Jan. 16 to Feb. 19 ..	1706	1541	38 81	22,289	55	20 91	85	
May 1 to May 31 ..	93	1350	42 02	610,852	54	36 64		
Ditto ditto ..	*972	0185	22 92					
	16672	0291						

* Not including 501.142½ tons, worked for Chloride Flat, assaying \$32.08 per ton, and yielding 13.683.35, or 27.25 per ton.

Total Product.

To obtain the total product of the South Aurora Mine there must be added to the total footing of the foregoing statement the following lots of ore worked in other Mills:—

400 tons (quality estimated)	...	yielding	\$40,643·99
708 „ assay value 43·35	...	„ 75%	23,018·85
336 „ „ „ 37·21	...	„ 75%	9,376·92
1012 „ „ „ 37·03	...	„ 75%	28,180·77
2456 „		Totals	101,220·53
16,072 „ Increasing these by the Co.'s Mill product			610,854·54
19,128 tons.		We have	\$712,073·07

General Deductions.

From the foregoing the following averages are deduced:—			
Average yield per ton of all ore produced ...	...	...	\$37·22
Ditto ditto	Worked in Company's Mill		36·64
Ditto ditto	in 1870 (12,254 tons)		36·82
Ditto ditto	in first run of 1871 (1,706 tons)		32·99
Ditto ditto	in May, 1871 (1,065 tons)		20·91

The low yield of the last run has already been explained by Mr. Benjamin. The ore was very poorly assorted, chiefly owing to the weather and the exposure of the men in the open air. The ore at Mine and Mill now ready for crushing, estimated at 1,600 tons, is believed to be worth \$40 per ton assay. The pulp assays of Sunday and Monday, July 9th and 10th, were \$33·77 and \$36·12; and it is thought the general average will be considerably higher. The quality of the ore depends largely on the sorters, and I see nothing in the last run to indicate a permanent decrease in the yield per ton, the quantity of ore, of course, depending on the future developments in the Mine.

If the average yield of all ore produced from the Mine in the past be assumed as the probable yield of the future, say \$37.22 per ton; and if we accept as the probable cost of operations the figures given in the foregoing, say \$25.00 per ton; we shall have, after deducting other outlays not yet included, such as the shipment of bullion, expenses in England, &c., a very fair per centage of profit on the value of the ore.

If this be placed at \$10 per ton, the profits on a year's run, like that of 1870, when about 12,000 tons were worked in the Company's Mill, would be

\$120,000.00

Or, if the Mill be steadily supplied and worked without interruption, say 1,500 tons per month, or 18,000 tons per annum, the net profit might be, with present Milling capacity

\$180,000.00

The realisation of these results depends almost entirely on the Mine. The Mill is in excellent condition. The administration of affairs at both Mine and Mill appears well adapted to efficient working; and, saving the contingency of fire or other destruction of property, or of some unforeseen emergency, almost the only problematical element of the future is in the ore-producing capacity of the Mine itself. On this point I have already expressed my views; and nothing but actual development will answer the question definitely.

Brief Summary concerning the Mine.

There are at present about 75 or 80 men employed in the

Mine; of this force 22 are extracting ore and 24 are prospecting.

The daily ore-extraction amounts at present, according to the foreman, to about 20 tons per day.

The prospecting work is well distributed, in order to seek new bodies of ore east of those already worked, and both in higher and lower levels.

The prospect of finding new bodies of ore is favourable. The deposits are distributed so capriciously, and are so variable in form, size and mode of occurrence, that the miner has but few guides to follow. There are indications of ore in several portions of the Mine, and these are being pursued; but the probability of finding new ore-bodies rests chiefly, not on any significant appearance of the ground, but on the general principle that where actual development has shown so strong a course of ore, and where so much ground, within the supposed ore-bearing limits, remains unexplored, the discovery of new bodies may reasonably be expected. The best bodies of ore yet found have been discovered accidentally, and a fortunate strike in the South Aurora may reveal new sources of ore in unsuspected localities at any moment. Meantime, under existing circumstances, and at present rates of production, the profits of the Mine should be devoted to explorations.

The greatest depth yet reached in ore is about 110 feet, with indications of more below.

The total production of ore from the

Mine, already milled, is	...	...	19,128 tons.
And now on hand to be Milled	...	...	1,600 "
Making in all	...	...	20,728 "

The total yield of ore from the Company's Mill is	...	\$610,852.54
And including yield of other Mills, 19,128 tons in all	...	712,073.07
The average yield per ton of 19,128 tons, is	...	37.22
The average yield per ton of ore worked in 1870, was	...	36.82
The average yield per ton of ore worked in first run of 1871, was	...	32.99
The average yield per ton of ore worked in May, 1871, was	...	20.91

As already explained, the low yield of last run was due to careless assorting, and does not necessarily imply a decrease in the *yield per ton*, since that depends largely on the sorters; the quantity of tons, on the other hand, depending on the grade or value to which the ore is dressed.

The total expense at the Mine divided by tons produced to June 1st, 1871, is	...	\$15.59
\$311,821.28	...	
20,000	...	

This includes some extraordinary expenses, such as litigation, purchase-money of claims, &c., not less in all than \$32,000.

Deducting these, say, per ton	...	1.59
We have remaining	...	\$14.00

As costs of Mining from the outset.

The disbursements at Mine of 1870, divided by estimated ore product, gives as mining cost per ton	...	\$12.31
The disbursements of 1871, to June 1st, divided by estimated ore product, gives as cost per ton	...	13.36
The present Mining cost may be placed at not less than	...	13.50
Hauling to Mill (at present)	...	2.50
Milling	...	9.00
Making in all, costs of operation per ton of ore	...	\$25.00

If the average yield of the ore worked in the future remains as high as the average of all worked in the past, this cost leaves a handsome margin of profit. But this result depends on developments yet to be made in the Mine.

The Mine and Mill are well managed. The Mill is one of the best in the State; and all the appurtenances of the concern are in good working condition. The administration of affairs appears to be excellent. The Manager, F. A. Benjamin, Esq., is an experienced, able, and watchful Superintendent; and his Assistants, Dr. Goodfellow at the Mine, and Mr. Robinson at the Mill, also seem very well adapted to their respective offices.

Part Third.

CHLORIDE FLAT.

The portion of Chloride Flat proposed for purchase lies west of the northern end of the South Aurora Mine. The traced map, accompanying this Report, shows the outlines of the ground and its relations to the adjacent claims. The total area included in this tract offered for sale is seven-and-a-half acres, and it embraces much of what was the most productive portion of the flat, during the period of its development.

Some of the workings are indicated on the map, but without either precision or any attempt to show the full extent of the work done. Portions of the area referred to are almost literally honey-combed with shafts and pits of shallow depth, and below the surface is a labyrinth of tunnels, holes, and irregular gropings that have never been surveyed, and would be difficult to map. The map forwarded will, however, be sufficient for the purpose of showing the surface outlines, and their relation to the South Aurora. The two transverse sections, one taken through the South Aurora Autumn Chamber, and extending down through the "Iceberg," the other beginning at same level with the lower end of the first, but taken further north, through the Genesee Cut, will convey some idea of the relative level of the points referred to, and of the structure of the hill.

The area under consideration is bounded on the map by

a blue line, comprising a portion of the "Iceberg," Snowdrop, and Genesee claims.

So much has been already said of the general geological characteristics of the district, that but little remains necessary to add in this connection.

The "Flats," Pogonip, Chloride, and Bromide are gently inclined or almost level surfaces that lie near the summit of the hill, just west of the Auroras. They are distinguished from each other by bluffs or walls of limestone about twelve feet high; Pogonip lying the highest, Chloride next, and Bromide Flat still lower. The sections will show about the general slope of the hill from the Aurora down. Below the Genesee Cut the surface begins to fall off more steeply and is precipitous in places.

The surface consists of limestone strata that dip gently, at an angle of six to ten degrees, to the westward. These strata are not always well defined but are somewhat irregular in their bedding. They are cut through by numerous seams and joints that are filled with crystalline minerals, chiefly calcspar and quartz. The great transverse, or east and west, seams already referred to in detail, continue their course, and traverse the flats as they or the ore-bearing ground in the Auroras, Ward Beecher, and others.

So far as understood, the mode of formation, the origin and character of the ore, are quite similar to those already described in this Report. The ground is perhaps more broken, the ore-bodies more generally distributed in small pockets and not so much concentrated in large chambers. They are very irregular in their distribution, following the little clefts and joints and seams of spar, and forming a net-work of channels and chambers of constantly

varying dimensions and without any apparent law or order. Most of the ore that has been produced from the Flats has come from within 80 feet of the surface, though the ore now exposed in the Genesee Cut is more than 60 feet below the surface directly overhead.

On the transverse seams, one of which crosses the Flat near the bluff dividing Chloride from Bromide, one or two shafts have been sunk. One of these is 112 feet deep, and found ore at the bottom. Some of this ore has been worked, yielding from \$50 to \$116 per ton. It appears to be mixed, however, with base metals, and has not been much worked, partly, it is said, from want of capital.

On the Genesee, where this transverse seam crosses the claim, near the cut, a shaft was sunk by the old Chloride Flat Company, following the seam downwards 100 feet. The shaft is said to have shown a clean fracture of the limestone beds, and to carry ore throughout its depth, but not in very large quantities. The shaft was inaccessible, and this statement was given me nearly two years ago by the mining captain who did the work.

Other shafts sunk in the bedded limestones, away from the transverse veins, discovered no ore. One went down 140 feet through stratified rocks without seeing a trace of ore.

From these statements it appears that the ore produced came chiefly, practically altogether, from near the surface; and they indicate that the great transverse seams have the same relation to the rocks on the Flats, that they appear to have higher up the hill, and that sufficient ore has been found in depth in the neighbourhood of these seams, to warrant a properly-directed search for more.

In the early development of White Pine, the Flats were probably as actively worked as any part of the district. Chloride Flat, particularly, was covered by parties of men who, requiring no capital and finding the ore close at hand, located hundreds of claims, sunk their pits and extracted large quantities of rich ore. As the laws under which the claims were located were devised and intended to apply to regular veins, the difficulty of applying them to such irregular deposits caused many conflicts of interest. Soon after, however, the Consolidated Chloride Flat Company was formed and acquired by original location, compromise and purchase, the title to most of the ground now embraced within the limits of the proposed purchase.

This Company was formed in California when the White Pine excitement was at its height, and capital was furnished and expended with utter recklessness. Mills were constructed costing over \$200,000; and the sums paid for the purchase of mining claims amount, it is said, to several hundred thousand dollars, perhaps half-a-million.

The operations of that Company furnish the most complete and trustworthy data concerning the yield of the ore and the cost of treatment.

A summary of the statement of their work from May, 1869, to February, 1870, shows that they milled 8,646 tons of ore, varying in actual yield from \$28 10c. to \$107 80c. per ton, and averaging \$43 46c. The total product was \$375,769.58.

The total costs of mining and milling were \$254,884.73, giving an average cost per ton, of \$29.48, which leaves a margin of \$13.98 per ton, between the yield of the ore and the cost of producing and milling it. The mining

cost alone was \$14.88, and the milling cost was \$14 60c., including hauling, which was \$4.50 per ton.

The total product of the ground known as Chloride Flat is variously estimated; by many it is placed at over a million of dollars. I think it is quite safe to assume that it was twice the product of the Consolidated Company, or \$750,000.

When the reaction that followed the White Pine excitement produced its effect in San Francisco, the affairs of the Consolidated Company were very much depressed, and although their accounts show a fair profit in mining and milling, yet their outlays for Mills and for mining claims had been so large, that they became embarrassed and ended in bankruptcy. The ground was purchased for a comparatively small sum by the present owners, who are now engaged in securing it by United States Patent. Pending this operation, Mr. Benjamin, the Manager, is doing but little to prospect the ground, as any important development would be likely to give rise to adverse claimants. There is, therefore, but little work in progress there at the present time.

The only point at which operations are in active progress is in the Genesee Cut, where an open excavation has been carried on in an east and west direction, following a seam of ore that appears now to be gaining somewhat in depth; and an incline is being sunk on it as represented in the section. This body of ore lies in the neighbourhood of the transverse seam on which the shafts before referred to were sunk. The seam is north of the cut; on the south the limestones are bedded, but show joints and clefts of spar that apparently form the limit of the ore. This varies in

places from two or three to ten feet wide; in some parts the excavation is thirty feet wide, and is said to have carried ore across the whole width. It is impossible to form any trustworthy judgment as to the continuation of this ore-body. It may fail suddenly or may lead to a large and rich deposit.

The character of the ore is similar to that of the South Aurora. In May there were 501 $\frac{1025}{1000}$ tons worked from this source, at the Mill of the South Aurora Company, yielding \$13,688 35c., or \$27 25c. per ton. Ore is still being extracted, and it is thought a better yield will be obtained from present appearances.

The costs of mining on the Flat would probably be about the same as in the South Aurora, so that if the costs of mining and milling be stated at \$25, the margin of profit on this experimental lot would be small. But if ore-bodies remain to be found on the Flats, it is reasonable, judging from the past, to expect a higher yield from them than that just given. I think the records of past production show as high an average yield per ton of ore from the Flat as from the South Aurora.

Enough has been said of the character of these deposits to show how impracticable it is to form a reliable opinion as to the ore-producing capacity of the Flats. The appearance of the ground shows no satisfying indication. Nothing but actual development will show where the deposits are, or how long they will last when found.

The record of the past furnishes the most favourable evidence, and perhaps the best indication of the possibilities of the future. There has been a great production, and there remains a considerable area still undeveloped, present-

ing, apparently, the same conditions as the ground that has been so productive, to say nothing of the possibility of finding ore at yet lower levels than hitherto.

Any venture in such ground is a pure hazard; and the amount of risk involved, as compared with the chances of success, is an important element in the question. If the title can be clearly secured, and the property purchased for a moderate sum, the chance of finding a large body of ore might be a sufficient inducement for the investment.

It should, perhaps, be observed that this inducement is greater for the South Aurora than for other parties. The proposed area lies adjacent to their present property, and could be worked in connection with it. It covers the most desirable portion of the Flat; and if an ore-producing capacity be assumed in it, the acquisition of additional and adjacent mining ground at a reasonable price is desirable, because in Mines of such uncertain and fluctuating character as these, a given portion may, alternately, be rich and poor; and the larger the territory, the better the chances of having one part productive, while other parts are being explored. The Company, moreover, own a Mill capable of working large quantities of ore; and the economy of working is the greater, the more uninterrupted the supply. These considerations are too important to be passed by without mention.

The main questions in the matter of purchase are: the security of title; the price to be paid; and the ore-producing capacity of the ground.

The first, I understand from Mr. Benjamin, will be definitely settled within a few weeks by United States Patents. Of the second I am not informed, but from the