

Property of
Robert E. Kendall

REPORT OF Leon M. Hall and Frederic W. Bishop

TO THE
COMSTOCK PUMPING ASSOCIATION
MAY 25, 1908

San Francisco, Cal., May 25, 1908.

TO the Comstock Pumping Association, San Francisco, Cal.

Gentlemen:—In accordance with the resolution of your organization, adopted by your board of directors on the 13th day of April, 1908, inspection has been made of the progress of the work on the Comstock Lode, Virginia City, Nev., since the day of the organization of your body to the present day. As is well known to your body the purpose of this inspection was to place in the hands of such of your members as might be unfamiliar with the most recent developments an authentic statement of true conditions, that you, and in particular the stockholders of the various corporations that have representation in your body, might be properly guided in your future attitude regarding the plans aiming toward the ultimate fruition of the purposes that brought these various corporations into association.

Outline of the Work.

That a better understanding may be had by you of the present encouraging condition of the mines of the Lode and of the vast amount of money, energy and engineering genius that have been expended in creating this condition, it would be advisable that, first, a brief outline be given of the conditions prevailing on the Lode at the time the drainage of the mines was resumed twenty years after the lower levels had been abandoned to Nature's forces, that have quadrupled problems which were even in the beginning of stupendous magnitude.

As is well understood by your organization, the square set system of timbering followed in the operation of the Comstock Mines (a system necessitated by the enormous extent of many of the ore bodies, and which, in but rare instances, included the refilling of abandoned workings) made, when decay through the lapse of years had attacked the forests of timber entombed in the mines, the crushing of the sets inevitable. This was followed by a bodily movement of the ground along and down the scaly selvage of the footwall; a movement so great that measurements taken at the old Con-Virginia shaft demonstrate that the throw to the east at the 1,500 level is at least sixteen feet. Standing at any point of vantage east of Virginia City and Gold Hill a great scar torn across the hills from end to end of the Lode can be seen, evidence from the depths of the collapse of hundreds of miles of excavations of the bonanza days.

As irresistible as an avalanche this crushing of the workings continued for a quarter of a century, and it was toward the unwatering and reclamation of this shattered wilderness of the depths that your organization turned its attention. During the period of idleness of the mines, such movements had taken place as to largely divest of value many of the most important surveys, and of necessity it was as explorers that your engineers faced the task before them.

Hottest Mines in the World.

Notoriously among the hottest mines in the world, with connecting drifts caved, shafts destroyed or greatly damaged, the Sutro tunnel (the drainage key of the Lode) in a deplorable condition, ventilation at a standstill and confronted on the north end by the added hazard involved in the possible escape of carbonic acid gas from the bulk-headed fires in the Con-Virginia stopes, the problem that confronted your association was unquestionably among the gravest of modern mining history, and that it has been met so well and so economically, as this report will later seek to show, entitles those entrusted with its solution to the greatest credit.

Attention in the beginning of this report has been called to those conditions that prevailed when you began work to emphasize a conclusion that will be discussed more fully later—a conclusion that those most interested must ultimately be in accord with and which, briefly expressed, is this: The day has passed when any mine on the Lode may be considered an individual unit and operated without regard to conditions prevailing on the rest of the Lode; abandoned workings and those the future will demand as essential to the economical working of ores uncovered have merged the Comstock into one, and, while it is advisable that each company operating on the Lode shall retain its corporate individuality, co-operation in mining operation is essential and is most strongly urged as marking the straightest line toward the successful achievement of your purposes.

Mines Were Flooded.

When your association undertook the work it now has in hand the water was over the sills in the south lateral of the Sutro tunnel. On the north end the flood had reached to within twenty-five feet of the Sutro tunnel, or 1,750 level of the Con-Virginia. Of high temperature, chemically laden vapor from this water permeated the timbers of all open workings, wrought their destruction and the works collapsed. Of necessity your

body, after failure to secure the necessary improvements at the hands of the Tunnel Company, assumed the burden of the Sutro tunnel repairs, after securing a contract providing for the return to your association out of the royalties provided in the original contract between the Tunnel Company and the Comstock corporations of \$125,000 of the sum required to complete these repairs.

The Sutro Tunnel.

Mindful of the fact that the plans outlined by your association for the drainage of the Lode accepted, of necessity, the Sutro tunnel as the key to the situation, attention first will be given to this great adit, to your relations to it and to the causes that led you to assume the burden of its repairs.

Ground was first broken for the Sutro tunnel on October 16, 1869, and it was practically completed for its connection with the 1,640 level of the Savage incline on July 3, 1878. Its purpose was to drain the Comstock mines and to furnish a cheap means for transporting the ore and waste rock. When the tunnel was begun the mines were already 1,000 feet in depth; by the time it was finished many of them had reached a depth of 3,000 feet. Two lateral branches were also driven. The one to the north was 4,415 feet in length and afforded facilities for draining the north end; the south lateral, 8,700 feet in length, together with its branches to the Crown Point incline and Alta shaft gave a ready outlet for the water from the Gold Hill mines.

Retimbering.

After the final completion of the tunnel many years were spent in retimbering and repair work. A tightly covered wooden drain box was placed in the tunnel for its entire length, and, at the time of the suspension of work in the deeper levels, it was in perfect repair and capable of many times the service then required of it. The maintenance of the tunnel was accomplished largely from royalties derived from the bullion producing mines, so, when the production of ore was curtailed, the tunnel was allowed by the management to drop into a state of absolute decay and uselessness, the only effort made being to keep the airway open.

Such were the conditions when the Comstock Pumping Association took charge of the C. & C. shaft and began its labor of unwatering the lower levels. Among the first duties of the association, therefore, was the partial rehabilitation of the old tunnel, and this

was accomplished at the expense of over \$7,000 by cleaning the ditch, catching up a bad place here and there as required, and in the construction of a two-foot drain box in the north lateral from the C. & C. shaft to its junction with the main tunnel.

After pumping was resumed the tunnel was forced to carry large volumes of warm water, and, as the covers had been removed from the greater portion of the old drain boxes, the process of decay became more rapid and it was a serious question as to whether or not the tunnel could be held open. It certainly could not through the expenditure of the entire tunnel income, so the Comstock Pumping Association was once more compelled to step into the breach.

About this time the Forman Shaft Works burned and upon the caving of this shaft the south lateral was entirely closed. Following this disaster the Union shaft burned and the north lateral beyond the Ophir became useless. Many months elapsed and thousands of dollars were spent before either branch was again serviceable.

Condition of Sutro Tunnel.

During the summer of 1903 a meeting of the officers of the various mining companies, together with those of the Tunnel Company was held in Virginia City, at which an engineering staff was appointed to make a thorough investigation of the condition of the Sutro tunnel and its branches and to report upon the same directly to the Pumping Association. After many weeks spent in examining every post, cap and piece of lagging, the engineers made an exhaustive report to the Pumping Association upon existing conditions. No better description of the condition of the tunnel at that time can be given than is contained in the report then filed by the engineers, excerpts from which are here given:

"The general condition of the Sutro tunnel and the north lateral branch thereof at the time of our examination was bad. Our examination extended over a period of several weeks immediately following the warm weather, and the property presented a worse appearance than usual because of the excessive heat in the tunnel and the inability of the tunnel management to make repairs and do necessary cleaning under these circumstances. Since making the examination the tunnel has been cleared of all rubbish and the several bad places noted at this time caught up. This work, however, was in the nature of temporary repairs and should be followed by work of a more thorough, permanent character.

"The section of the tunnel between the Combination shaft connecting drift on the west and shaft No. 2 on the east is in a very poor state of preservation and required immediate attention and extensive repair. The air in this portion was found to be greatly vitiated and this, to some degree, accounts for the general decayed condition of the timber, lagging and water boxes. The air and general condition of the north lateral and of the main tunnel from shaft No. 2 easterly to the mouth thereof is much better than the part just before mentioned.

A Word of Warning.

"Heretofore, in making needed repairs to the tunnel, the policy of the management has been to do the work cheaply and to 'patch up' without making renewals, so that the conditions are gradually growing worse until it will eventually be impossible to keep the tunnel open without considerable difficulty if this method is longer pursued. Instead of removing and renewing the decayed and broken sets auxiliaries of small sized timber have been placed under and between the main tunnel sets. These have served their purpose, namely, 'to keep the tunnel open with the least possible expense,' but at best it is only a temporary expedient and the time has come when, in justice to the Tunnel Company and to the Comstock Mining Companies, it is impossible to do more in this direction. Therefore, all of the decayed and broken sets should be replaced with sound timber. The water boxes and track are also in a bad state and need considerable attention even before any extensive work can be advantageously carried on in the tunnel. It goes without saying that this entire property should be put in first-class condition and so maintained."

In January, 1904, at the time of the first inspection, your engineers filed with your association recommendations as to the policy that should be followed to place the tunnel in a safe condition and also filed an estimate of the cost of this work. It was their opinion that the tunnel could be repaired, the track and sidings put in condition and a 30-inch stave pipe laid from the 1,200 station to the 17,000, and a 24-inch pipe from this point to the Ward shaft connection, for the sum of \$125,000. It is to be regretted that these recommendations were not followed immediately but that two years were allowed to elapse before your association relieved the Tunnel Company of the problem. During these two years conditions in the tunnel became graver and such work as was done by the Tunnel Company was not of a permanent character. Cottonwood auxiliary sets were used in many instances and, in fact, decayed sets were boxed in, giving an outward impression of permanency. As to this expediency no comment is necessary, except, possibly, the assertion that when used underground cottonwood timber becomes, in time, not an aid but a menace. It is an ally to decay; it preserves its form until it surrenders to collapse and accompanying expense.

Details of Timbers.

Included in this report and evidencing, in a measure, the fidelity to detail that directed your engineers, reference should be made to their examination of the Sutro tunnel timbers. Each set was examined and recapitulation demonstrated that of 2,426 sets in the Main tunnel, 1,314 8-foot posts, 1119 14-foot posts and 723 caps were in bad condition and, also, that of the remaining sets about a quarter were in such condition that renewal would be advisable. Your engineers recommended that suggested improvements be made immediately. That these suggestions were followed, at least to a degree warranted by the then financial conditions of your association, is best evidenced by the report under date of March 11, 1908, of your consulting engineer and superintendent, which in its analysis, finds that improvements are fully up to anticipations.

In his report, which carried the work to the present date, your engineer says: "During the past year two men have been employed continuously upon repairs in the north lateral and, with the exception of about fifty feet near the Union south line, it is in excellent condition. It was found that the old water box placed there at the time pumping operations were resumed had rotted and was in very bad condition. This being the case, we have replaced the same with the 24-inch

stave pipe which was intended for the second line in the main tunnel. Excellent progress is being made, the crew having built about 120 feet a day. Great difficulty was encountered in taking out the old water box owing to its heavy condition and the limited space in which to work. The new pipe is laid on the six-inch by eight-inch track sills on the west side of the tunnel and allows much greater facilities for repair work and leaves an unrestricted airway.

"The South Lateral has been opened for its entire length and a good supply of air is going through from the Alta shaft to the Combination. This air has perceptibly cooled the South Lateral between the Ward and Julia connections. In opening that portion south of the Ward, several very bad caves were encountered and it took considerable time and patience to drive through them. This portion of the tunnel is now in a fairly safe condition, so that we can go ahead with the permanent repairs without fear of a collapse. Quite a number of new sets were put in just south of the Ward drift and the Ward shaft connection put into condition to be used as a generating station for the electric locomotive and this portion is now in first-class condition.

In the Ward Drift.

"We have had to ease the Ward connecting drift and are now at work retimbering portions of it for the fourth time. Power for operating the 20-horsepower motor to be used in driving the generator for charging batteries on the proposed electric locomotive, will be taken from the regular Ward shaft mine cable and will be metered separately so that the Tunnel Company can make proper returns to the Comstock Pumping Association. A careful examination of the stave pipe placed in the South Lateral two years ago shows the same to be in excellent condition and it is carrying the hot water without an apparent leak.

"During the past six months, we have made the only real progress in repairs to the main tunnel, inasmuch as we have been enabled to retimber many of the very bad places. The process of decay has been so very rapid that, with our limited monthly allowance, we, at times, could do little more than keep pace with it. However, the old timber is so rotten up that whatever is accomplished from now on will make a creditable showing.

"The 30-inch stave pipe has been laid from the mouth of the tunnel to about the 5,000 station and the track has been rebuilt to about the 6,500 station. The ditch to the 6,900 has been cleaned and is now ready for another section of pipe and all of the material dipped and ready for use. In addition to these improvements, the timbering has been completed to the 7,000, with the exception of about 40 posts near the 5,500. A new switch has been constructed just at the end of the 30-inch pipe and the water tank, used for the Sutro water supply, has been reconstructed. This is all permanent work and should not give trouble for many years. In addition to this work, four of the worst places in the main tunnel have been retimbered. These, by the way, were included in the original contract, dated February 12, 1904, and were not touched because of the heat and rapid deterioration at other points. Particularly notable among these places may be mentioned the 23 sets at the 11,000 which we have just completed.

"The track, as a whole, is in fairly good condition but will require repairs before it will be safe to operate the electric locomotive. Between the 8,000 and 16,000 there is some water on the track and this difficulty can not be entirely eradicated until all temporary center posts are removed.

"At the present time, permanent work is in progress at several of the lowest places, among which may be mentioned the 8,300 and 16,400 and retimbering at the Brunswick lode is also going on. This latter is probably the most dangerous point in the tunnel. Considerable work has been done in the Combination drift at its junction with the Main tunnel and besides catching up the shaft station, the airway has been opened so that through the shaft is now circulating double the amount of air."

Union.

"On the 2,900-foot level a joint Sierra Nevada east crosscut was started from the joint Sierra Nevada winze and extended 287 feet. When in a distance of 130 feet from the winze the drift passed through a vein of ore eleven feet wide on the bottom of the drift and six feet wide on the top, the assays averaging \$21 a ton. Work on this ore vein showed it to extend up twenty feet and south sixty-three feet in Union ground. A joint winze was afterwards started 141 feet east of this ore body. In sinking the above winze to the 3,100-foot level, narrow streaks of gold-bearing ore were passed through, selected samples assaying high. This company joined with the Sierra Nevada, Mexican and Ophir companies in sinking the Mexican winze to the 3,300-foot level, and all other work was temporarily suspended. In January, 1885, deep mining was discontinued. A study of the report discloses the fact that while depth was being attained by sinking winzes, the levels above, up to the 2,300, were not being prospected but were kept open for ventilation and drainage. There is no reference made in this report to the walls of the vein or lode on any of the lower levels. Development work or prospecting that is done without regard to the position of the walls of a vein or lode cannot be said to be conclusive or valuable.

Mexican.

"On the 2,700-foot level ore was found in a drift south from the joint Union winze ranging from twelve inches to three feet in width, giving fair assays. This ore was followed a distance of eighty feet. A winze was started down twelve feet east of the ore and sunk sixty feet, when water stopped the work. Ore was found in the winze at that depth. On the 3,100-foot level a main lateral drift was run to connect on through with the Union Consolidated for ventilation. From this drift an east and west crosscut was started 300 feet from the south line of the mine. The east crosscut was run 228 feet and stopped by a strong flow of water. The west crosscut was run 224 feet and a diamond drill hole was run ~~from the east crosscut, showing assays from~~ \$2 to \$6 a ton. This crosscut was dry. It was advised work should be continued in this crosscut when air connections were made. This work was not done. From the 3,100 level an east ~~winze~~ ^{crosscut} ~~was started~~ ^{was run} ~~to the 3,300-foot level, showing assays from~~ ^{the greatest} ~~extended~~ ^{extended} ~~the Comstock Lode, 3,308 feet.~~ This winze passed through quartz of value at a depth of 134 feet below the 3,100-foot level and porphyry and quartz thence to the bottom. It appears from this report that ore bodies were found on the 2,700, on the 3,100 and in the deep winze at a point 134 feet below the 3,100-foot level. The ore body on the 2,700-foot level was partly prospected. That on the 3,100-foot level was only touched by the diamond drill, and the ore body in the deep winze was not prospected. It further appears that while the work of attaining depth was in progress no prospecting in the levels above was done, the drifts being kept open for ventilation and drainage only.

Ophir.

"From 1882 to 1885, the 1,900, 2,000, 2,300 and 2,500-foot levels were kept open for the purpose of ventilation and drainage, and the winze and drifts on the 2,700 and 2,900 levels were also for ventilation and drainage, looking toward the opening of deeper levels. In 1883 a winze was sunk jointly with the Mexican Company from the 2,900 to the 3,100-foot levels, and the main south drift on the 2,900 level was completed to the California Company's south line. In June, 1884, the Board of Trustees assumed one-quarter of the expense of sinking the Mexican winze from the 3,200 to the 3,300 level."

A fact worthy of note in connection with this report, and verifying the conclusion of the superintendents that "no level on the Lode has been so thoroughly prospected that there is not a chance of finding ore in it," is that no mention is made of indications of the ore bodies that were struck in the 1,750 level of the Con-Virginia in June of 1898 and followed into Ophir ground and from which millions have been taken. And this ore body has

not yet been exhausted, but the most sanguine hopes are based on the theory that it will make stronger with depth and extend into Mexican ground.

Con. California and Virginia.

"During the years 1882, 1883 and 1884 work was carried on in the 2,500, 2,700 and 2,900 levels. The work at that time in the upper levels was confined to keeping ventilation drifts open. This work demonstrated that the Comstock Lode in the lower levels continued to show great strength of formation and the cutting of seams of quartz giving low assays in the various drifts on the 2,500, 2,700 and 2,900 levels shows that it is mineralized, with a possibility of finding ore deposits of value when the lower levels are fully opened." (The discovery of valuable ore in the Con-Virginia since this report was written was referred to in the resume of the statement in reference to Ophir.)

Best & Belcher.

"Samples taken from a drift on the 2,300-foot level gave fair assays. At a point on this level 2,118 feet in from the shaft a west drift was run to crosscut the vein, where it was found to be 250 feet wide, the course being northeast and southwest, which is considered of great importance. In sinking the joint winze from the 2,300-foot station numerous streaks of quartz were encountered, and for the purpose of prospecting the country lying northeast, a drift was run 116 feet, passing through a very favorable formation. A very extensive ledge was also discovered on the 2,500-foot level, which assayed over \$4 a ton. In September, 1886, work below the Suto Tunnel level was altogether suspended, as the pumps then in use were unable to cope with the water. Further explorations of these discoveries at greater depth is recommended.

Savage.

"From the 2,000 level to the 2,600 level the Savage ground has not been prospected north of the main incline and but very little from the incline to the south line. From the 2,600 level to the 3,100 level, inclusive, the ground is practically untouched and the work that has been performed for the purpose of reaching this ground invariably developed water in large quantities and ~~at~~ ^{of} ground that ~~streaks~~ ^{streaks} ~~and~~ ^{is} regarded as favorable to the existence of ore.

Chollar.

"The effort on the various levels from the 2,600 to the 3,200 level seems to have been to prospect the south end of the mine, where the formation was reported to have radically changed for the better. Except in one or two places the work was hampered by heavy flows of hot water, of which all stood in dread, and in consequence of which a large part of the prospecting was done with diamond drill. Emphasis seems to have been placed on the statement that the formation in the south end of the mine showed marked improvement. No evidence can be found of the prospecting of the north end of the mine under ore seams exposed on the 2,600 level in the west crosscuts from the lateral drift. From the 1,700 level, where a connection was made from the old Chollar incline with the Combination shaft, to the 2,400 level is a space of untouched and unprospected ground.

Potosi.

"The Potosi ground has been very little prospected from the 2,600 down—one might say it is practically virgin ground. The 2,600 level was slighted, no doubt from the fear of water. It seems to have been the aim and desire of the management to reach a point in the mine under where it is stated a marked change in the formation for the better was disclosed. Large blocks of ground remain unprospected from the 2,400 level down, and from that level up are several hundred feet of entirely virgin ground.

Crown Point.

"On the 2,000 and 2,300 levels large quantities of quartz were uncovered, which is believed to be of the same character as that subsequently extracted from the levels above—'gold' ore. At that time assays of \$8 and \$10 a ton attracted no

attention. It cannot be determined at this time whether or not the grade of this quartz would warrant its mining and milling, but with the cheaper means of milling now in use it is deemed that it is quite possible that such would be the case. The lower levels were never thoroughly prospected, but the formation continued at the greatest depth strong and solid and with as perfect definition as anywhere in the mine. Should the prospect that was found in the Belcher on the 2,760 level prove to be of value similar developments could be expected in Crown Point ground, for the two mines have apparently occupied jointly the same mineral-bearing zone in the past, and have exposed on other levels, both in bonanza and higher levels, analogous chimneys of pay ore, having, in all respects, identical characteristics.

Belcher.

"On the ore streak found on the 2,760 level, 300 feet south of the incline shaft and 120 feet east of the main south lateral drift, a south drift was run a distance of 106 feet, passing through a mixture of quartz and porphyry that yielded some very good assays. From the south end of this drift a crosscut was run a distance of fifty feet through porphyry and streaks of quartz. From the end of this crosscut a diamond drill was driven east a distance of ninety-six feet, passing through porphyry and quartz yielding low assays. A strong flow of water compelled them to stop. A north drift was run on the ore a distance of thirty-six feet, passing through bunches of good ore. A winze was sunk on the vein to a depth of seventy-five feet, passing through porphyry and quartz. No further work was done on this level south of the incline shaft. The Belcher mine from the 1,650 to the 3,000 level has not been prospected in a thorough manner, and from the very favorable showing on the 2,760 level it would seem that, with more thorough prospecting, it is not unreasonable to suppose a large and valuable ore body might be encountered.

Seg. Belcher and Mides.

"From the 2,360 level down no work of any importance has been done on this property."

Justice.

"Not deep enough to be affected by the water problem, but as indications point to a downward continuation of the ore bodies, recommendation was made by the superintendent that this corporation join the Pumping Association.

Alta.

"In July, 1877, the first crosscut was started from the shaft at a depth of 1,050 feet and run west a distance of 238 feet, where a body of fine ore was discovered. Then the work of sinking was vigorously resumed and continued to the 1,150 level, where a station was opened, a drift run to the vein and some ore extracted, with little exploratory work done. The 1,250 level was next opened and a drift run north on a vein a distance of 700 feet. Little work was done to the south of the shaft. Some ore was found on this level of a low grade, but which could be profitably worked now.

"The shaft cut the vein between 1,260 and 1,300 feet, where ore of apparently milling value was found, but in the haste to get down no samples for assay were taken. The 1,350 station was cut on the east side of the shaft, a crosscut made through the vein and the little work done on this level uncovered some bunches of very rich ore—mostly gold.

"The east crosscut here shows a body of quartz liberally mineralized. The 1,450 level was opened, a crosscut run east to the hanging wall and a drift run north on the vein a distance of 600 feet. Promising indications were found all along this drift and, although it did not show rich anywhere, the grade of the ore was uniformly from \$10 to \$15 a ton.

"The 1,550 level was next opened and a drift run in the vein to the north line of the Lady Washington ground, a distance of 1,769 feet. The greater portion of this drift was through barren ground, but the vein was only partly explored.

"Ore of variable grades was found in about 400 feet of Alta; and in Lady Washington these crosscuts disclosed very good

prospects for ore in paying quantities. At a point in this drift 440 feet north of the shaft a station was excavated, from which a three-compartment incline winze was started and continued down to the 2,350 level, vertical depth. Stations were opened first at the 1,750 level and drifts run north and south a distance of 400 feet.

"The south drift on this level was not extended beyond ninety or one hundred feet. Next was the 1,850, which, like the other levels, was not exhaustively prospected, but good indications were found everywhere. Then the 1,950 was opened and a drift driven to the south line, a distance of 790 feet. In this drift, near the center of Alta ground, a body of galena ore was encountered which assayed 70 per cent lead, six ounces silver and \$10 gold per ton. The drift continued in this ore about eighty feet, and a crosscut at this point showed a width of twenty-four feet of good concentrating ore. The average value of this twenty-four feet was about \$30 per ton gold and silver and about 15 or 20 per cent lead.

"The 2,050 level was next opened, where a considerable amount of work was done, but finding more water than the donkey pumps could handle, the diamond drill was extensively used in exploring the vein, and for prudential reasons four holes were bored in the vein, two of which gave indications of value and a flow of water that submerged the pumps, so the winze was abandoned and the main shaft sunk from the 1,550 to the 2,150 level—100 feet below the bottom of the winze.

"On the 2,150 level an east drift was driven a distance of 1,230 feet and the diamond drill employed a further distance of about 200 feet, streaks of ore six or eight inches wide being cut which assayed from \$75 to \$142 a ton. A peculiar formation was encountered in sinking the main shaft. At the depth of 2,080 feet the apex of a ledge was struck running north and south and widening so rapidly that it had the appearance of pitching two ways. It continued in the shaft to the bottom, where, on opening east and west, it was found to have a width of nearly 200 feet, pitching east on the east side and west on the west side, with a strong capping of black slate. It is a calcite vein, strongly impregnated with chalcopryite, and will assay from \$4 to \$4 a ton gold and silver.

Caledonia.

"There is a large block of ground to prospect south and west of the shaft from the 1,200 level down. Most of the prospecting work on these levels has been done east and north of the shaft. All quartz found in the workings below the tunnel level was of low assay value."

Power.

As heretofore stated, the first pumping operations under the Risdon contract were carried on by means of a hydraulic elevator with water furnished by the Virginia & Gold Hill Water Company at the rate of \$20 a miner's inch a month. The supply of water from this source is limited to less than 300 miner's inches, so that it was evident that another source of cheap power must be found, and investigations along this line led to the consummation of a five-year contract with the Truckee River General Electric Company. This company, under a contract dated August 31, 1899, agreed, upon receiving a bonus of \$100,000, to erect a hydro-electric plant on the Truckee River and to run a double circuit into Virginia City. The rate for power was \$7 a horsepower a month on a two-minute peak load basis, with the understanding that when 1,000 horsepower was used 20 per cent of the monthly bill was to be rebated. This plant was in readiness and the power turned on the Gould & Curry mill on October 20, 1900, and it was applied to pumping operations at the C. & C. shaft on March 28, 1903. Since the advent of electricity all of the principal plants have been modernized and, with the exception of three steam hoists, have all been thoroughly equipped with electric machinery as well as with electric lights.

Following this, the C. & C. shaft, the Ward shaft and the Overman, which maintain their steam hoists, each installed an oil-burning plant for operating the same, and this change cut the expense of hoisting practically in two. It has been demonstrated that oil at the contract price of \$1.55 a barrel is equivalent to wood at \$4 a cord, or less than one-half of the former cost.

Upon the expiration of the above mentioned electric contract a second agreement was entered into on October 17, 1904, whereby the mining companies were to receive power on a meter basis, the rates varying from \$6 to \$4.50 a horsepower a month, according to the amount used. Upon a guarantee of \$2,500 a month the electric company agreed to erect an additional plant and to continue the rebate on the \$100,000 for a period of three years. Under this contract the Gold Hill companies are privileged to withdraw after a period of five years. At the present time the consumption of power is about 1,500 horsepower, and the meter rate is \$5 a horsepower month. The rate for hoisting is \$5 on a meter basis, with a guaranteed minimum of \$2 a horsepower. For intermittent power used on motors operating less than twenty-four hours a day a minimum of \$3.60 a horsepower is guaranteed. It will be observed, therefore, that this contract is a very satisfactory one and is radically better than those existing in other mining sections of Nevada. Under this contract it has been demonstrated that the actual power for hoisting will be as low as 3 cents a ton when the hoists are operated at or near their full capacity.

As is set forth in Mr. W. R. Eckart's report, the cost for power for pumping under the old regime was \$34.13 a horsepower, or \$58,120 a month. At the present time it averages about as follows:

C. & C. shaft, electric power.....	\$2,150.00
C. & C. shaft, water power.....	2,200.00
Ward shaft, electric power.....	1,400.00
Total, monthly.....	\$5,750.00

For raising about 3,500 gallons a minute of mine water, on an average of 800 feet, this is less than one-tenth the former cost a month for a similar service. The electric company now has developed on the Truckee River about 5,000 horsepower, with a capacity for 2,500 or 3,000 horsepower circuits into Virginia City, and a sub-station is equipped for the distribution of about 3,500 horsepower. Power for future developments and the enlargement of existing installations is, therefore, practically assured from this source and particularly so because the mining companies, under agreement, have the first call of this power.

Conclusions.

The foregoing report on the present condition of the mines and of the probability of future discoveries along the Comstock Lode is based upon a personal inspection of the mines and of the Sutro Tunnel. As to the work under your engineers and the actual mining work that has been carried on no conclusion can be reached other than that, in view of the almost superhuman difficulties met and overcome, the best has been done that could be done. There have been, there are and there will be critics of this work, but investigation discloses the fact that a majority of the critics are either unfamiliar with the principles of mining, or, at least, as necessity compels the application of these principles on the Comstock Lode, or are men seeking financial advantage through the uncertain medium of criticism. While some errors have been committed, none, however, have been serious in their effect upon the object ultimately to be attained, and it is much easier to see how these errors could have been avoided than it was to anticipate and avoid them while your plans were in the formative stage.

An effort has been made throughout this report to make clear the progress that has been made along the lines of the plans laid out for the unwatering and develop-

ment of the Comstock Lode to its greatest depths, and a reiteration of the plan of your engineer reduced to simplified form is here made, with the recommendation that it be followed in its entirety at the earliest possible day.

The Union shaft should be sunk, or reopened, to the water level attained through the use of the C. & C. pumps, in order that such connections for ventilation and drainage may be made from time to time as necessity demands and which will permit of exploration on all of the lower levels. The Ophir shaft should be maintained and the airways put in the best possible condition. The C. & C. shaft should be unwatered to the bottom (2,650 level) and a new system of pumps installed at this point. This attained, the shaft may then be sunk to the 3,000 level and the present system of Riedlers, on the 2,150, lowered into position at the bottom. Working and prospecting to a still greater depth, if desired, could then be continued.

The Ward shaft should be sunk to the 3,150 level, and, as is the present intention, one of the units of the pumping plant now on the ground placed in position at the 3,100 level. Connection with the Combination shaft, for the purposes of drainage and ventilation, should be made on the 2,400 and later on the 3,100 level. Connection from the Ward shaft with Gold Hill should be made on the 2,150 level to relieve the pressure from the south, even if the better plan of placing a plant at the Alta shaft be followed, and, ultimately, connection with Gold Hill made on the lowest level. These connections are imperative because of the fact that work in no one shaft on the Comstock can be carried on successfully without an air connection with some other. The 1,400 level of the Crown Point, from the Overman side, should be connected with the Crown Point branch of the south lateral of the Sutro Tunnel and the water now flowing down the Belcher and Yellow Jacket inclines, unquestionably burdening the pumps now operating on the north end, picked up and carried out through the Tunnel.

The wooden stave pipe line in the Sutro Tunnel, and too much importance cannot be attached to this recommendation, should be rushed to completion. When this work is done the maintenance of the tunnel will be assured and the expense of re-lining, with concrete, which can be well prepared from the waste rock being transported from the mines. This, in effect, would eventually produce a concrete pipe, easily repaired, and which would last indefinitely.

The south lateral of the Sutro Tunnel should be repaired so soon as finances will permit, inasmuch as the present condition of this lateral precludes the possibility of drainage of the south end of the Lode through the Alta shaft, which, heretofore, in this report is strongly urged.

As fast as the water recedes, the Combination shaft must be repaired, ultimately to the bottom, or 3,250-foot level. Ventilation along the entire Lode should be revised and proper fans installed. The necessity for revision of the present system is due to the fact that, in many cases, the modern workings have reached such an extent that the air, heretofore ample, becomes greatly vitiated during its extended course through the mines until a greater flow of air has become a positive necessity.

However, progress along the entire Lode is making toward success. The time is not far away when greater depth than yet attained on the Comstock will be in the line of possibility, and it is with the desire that this report may further this object and expedite your purpose that it is submitted. Respectfully,

LEON M. HALL,
Consulting Engineer.
FREDERIC W. BISHOP,
Associate Engineer.

In September, 1903, the engineers reported that it was imperative that the entire tunnel should be cleared of debris before the actual work of repairs was begun. Acting upon this suggestion, your association voted \$1,294.80 for the purpose and the required work was done by the Tunnel Company.

Contract With Tunnel Company.

On February 12, 1904, a preliminary contract with the Tunnel Company was entered into whereby the Tunnel Company was to retimber and repair certain specified points at an expense not to exceed \$18,200, it being understood and agreed that this sum and the former amount should be rebated to the mining companies from any royalties that might thereafter be due the Tunnel Company. Work was begun under this agreement but the tunnel became oppressively hot with accompanying slacking effect, with the result that caves were of frequent occurrence, thus blocking any attempt to do the work specified in the agreement. However, the entire sum appropriated was used by the Tunnel Company, indiscriminately, in catching up dangerous places and maintaining the tunnel as an open airway.

On April 15, 1905, more than eighteen months after the engineers' report was filed, another agreement was entered into whereby the Pumping Association was to take absolute charge of the repair work for five years and to spend at least \$125,000 in the repair and maintenance of the tunnel and its two lateral branches. This agreement also included the repair of the track and the construction of a steam-tight drain throughout the tunnel.

Before commencing work under this agreement, another careful survey was made and the tunnel was found to be in a deplorable state, it having, during the year following the previous examination, decayed so rapidly that it was a matter of much concern whether or not the tunnel would absolutely close. On a trip through the tunnel, it was necessary to climb over five caves, one of which was over twenty feet in height, between the 8,000 and the 18,000 stations. The temperature this day, at the Combination shaft connection was 105 degrees Fahrenheit, so that the difficulties under which your association began may well be imagined by those familiar with such work.

Previous to this a connection had been made between the Ward shaft and the South Lateral, which, after an immense cave at its junction with the main tunnel had been removed, greatly facilitated the work of repairs. The Ward Shaft Association immediately undertook to maintain the South Lateral and in so doing spent over \$7,000 without any returns from the Tunnel Company. This should be a matter for future adjustment. The portion south of the Ward connection remained closed until after work was begun under the last mentioned agreement, but this is now open for air connection only.

Result of Two Years' Labor.

The first two years' labor, under this agreement, was devoted almost entirely to catching up dangerous places, repairing track, cleaning ditches, reopening the Mint shaft, maintaining the South Lateral and to reopening the airways leading to the Alta and Union shafts, so that while an immense amount of work was done and much good accomplished, it did not, to the unfamiliar, casual observer, make much of a showing. It was not, therefore, until the last year that much apparent progress was chronicled and it may be said now, for the first time, that the tunnel is in a fairly safe condition. Under your direction a crumbled adit has been turned back to its intended uses.

As to the present management of the tunnel repairs, no comment but that which is commendatory can be made. Those employed in the tunnel—in its repair and maintenance—are men of industry and experience and through their labor the tunnel is making toward that point which must, ultimately, meet with your approval.

Expenditures.

Comments on questions of this character are unnecessary, as comments are best based on financial standards and, with this logic as standard, the following

recapitulation of the expenditures by your association in bringing the tunnel to its present state of repair is given, it being kept in mind that the tunnel, crumbled as heretofore described, and originally costing more than \$5,000,000, in its completion, has been recovered for a little over a quarter of a million dollars:

Cash	\$ 70.98	
San Francisco Office..		\$221,000.00
Salary	8,750.00	
Main Tunnel	139,336.86	
North Lateral	25,515.32	
South Lateral	40,776.03	
Team Expense	46.10	
Tunnel Office	3.50	
Office Expense	521.36	
Exchange	1,105.00	
Electrical installation	702.19	
Freight	4,165.56	
Interest	7.10	
	\$221,000.00	\$221,000.00

Material for pipe under above contract	22,277.93
Advance during Oct. and Nov., 1903....	1,294.80
Advance under contract of Feb. 12, 1904	18,200.00
	\$262,772.73

Advance by Ward Shaft Ass'n. about 7,000.00

These figures contain all expenditures with the exception of a small outlay in the San Francisco office, the exact amount of which is unobtainable owing to the destruction of the books in the conflagration of 1906.

Comstock Pumping Association.

Greatest in their benefit to the entire Lode and demonstrating the feasibility of the plans of your engineers to drain the flooded levels of the mines are the operations now being carried on by your association through the C. & C. shaft. These operations were begun sixteen years after a flood that was encountered on the 2810 level of the Exchequer caused the abandonment of all work in the South End below the Sutro tunnel level. This flood was struck on February 13, 1883, and several years later work on the deeper levels in the North End mines was also suspended on account of the great expense attached thereto, together with the fear of an occurrence such as closed the Gold Hill mines. The Combination shaft was abandoned in 1886 and this suspension was death to deep mining until, after a lapse of eight years, the Gold Hill Pumping Association, comprising thirteen companies, was formed in February, 1890, and an attempt made to unwater the Gold Hill mines through the Crown Point incline by the use of air-driven Dow pumps. A connection was made between the Sutro tunnel and the Crown Point incline, and after an expenditure of about \$640,000, the attempt was abandoned without accomplishing its purpose.

Early in 1898 the agitation for a return to the lower levels was again revived and this resulted in the forming of the Comstock Pumping Association for the ostensible purpose of draining the entire Lode to its greatest depth. The work of this association has been attended with success in unwatering the North End and the natural sequence was the establishment, in August, 1903, of the Ward Shaft Association for the drainage, exploration and development of the middle group of mines.

The Comstock Pumping Association is composed of twenty-four companies of the Comstock Lode, extending from the Utah on the north to the Alta on the south. Each company is directly interested in the future development of the Comstock because all are located upon the same great fissure vein and the prosperity of any one has an immediate bearing upon the standing of the others.

Governing Board.

The governing board consists of the presidents of each of the companies and the management of the work is under the direction of a superintendent. It was first thought advisable to set aside \$100,000 for equipping the C. & C. shaft with a plant of sufficient capacity to lower the water 500 feet. This expense was

borne jointly by all of the companies and a contract was let to the Risdon Iron Works of San Francisco for \$30,000, under which they were to lower the water 500 feet to the 2150-foot level. They used up the \$30,000 without accomplishing the purpose, so that your association was compelled to assume the task and, after overcoming many difficulties, the 2150 level was unwatered.

As the water receded, prospecting was resumed with the result that ore in paying quantities was almost immediately discovered on the 1750-foot level in Con-Virginia ground. This lent new strength to the situation and in 1902 the **Con-Virginia Company** stepped in to the breach and, at a cost of about \$100,000, purchased and installed a magnificent Riedler pumping plant on the 2150 level of the C. & C. shaft. Your association assumed charge of this plant upon its completion.

This plant is composed of three 6 11-16-inch by 24-inch double acting Riedler pumps driven by means of three 200-horsepower Westinghouse motors. This installation is capable of raising 4,500 gallons a minute 500 feet or to the Sutro tunnel. These pumps were arranged to take water from a 30,000-gallon tank just below the 2150 and the hydraulic elevators were lowered and rearranged so as to discharge into this tank. With this arrangement the water was lowered to a point about 20 feet below the 2,450 level (the 2,300 of Ophir) where it is now being held stationary. A five-step centrifugal pump with necessary motor, column, etc., was purchased some months ago for installation on the 2,450 for the purpose of handling the water from this level in order to relieve the hydraulic elevator when it is desirable to still further lower the level of the water.

Hydraulic System.

All the necessary column and material for extending the hydraulic system to the 2,650 level has been purchased and is on the ground preparatory to unwatering the shaft to the very bottom. The drainage of this shaft was a very difficult piece of work because of the immense amount of old material that it was necessary to clear away before the shaft was serviceable. The stations were badly caved and in all drifts there was an immense amount of debris that had to be removed. Many months were required to perfectly drain all of the old workings of the North End to the level of the 2,450 station. This difficulty was due to the fact that hundreds of miles of abandoned workings had caved and in many instances had formed great subterranean reservoirs. The drainage of these reservoirs necessitated the exercise of great caution lest the retaining caves give way and release their waters in a resistless torrent and flood the pumps, with consequent enormous loss. But, as this work has been so successfully accomplished, the time is at hand for the drainage of the mines to the 2,650, and we hereby heartily recommend the immediate drainage of this shaft to the bottom and the installation of such machinery as may be necessary to keep the mines free of water and permit of the exploration of every inch of ground to this level.

Through the agency of the one installation at the C. & C. shaft, the water has been lowered to a greater or less degree over the entire length of the Lode. The Sierra Nevada, Union, Mexican, Ophir, Con-Virginia and Best and Belcher properties have been drained to the 2,450 level and it is now possible to do work in all of these mines to this depth. In fact, through this means alone was it possible to uncover the ore now being extracted from the Ophir and the extension of the 2,000 level from the Union shaft was begun soon after this level was drained.

The water in the Combination shaft has been lowered about 200 feet and is still receding. The water in the Overman shaft has also been lowered about 60 feet, thus showing beneficial results over the entire area. All companies paid toward the general expense until the North End mines, those directly benefited, were on a better basis financially, when the Gold Hill properties, or those most remote from the C. & C. shaft, withdrew their financial support.

About this time the Ward Shaft Association was formed and the nine com-

panies composing it also ceased paying toward the North End expense, in order to devote their surplus toward the opening of the Ward shaft, as set forth in the section relating to the Ward shaft.

The fact that through the efforts of your association the Ophir and Con-Virginia have been enabled to work on all levels above the 2,450 has added, since the organization of your association, the sum of \$2,524,421.18 to the world's material wealth. Of this sum, the Con-Virginia has produced in bullion \$995,766.09, and the Ophir \$1,528,705.09. The Con-Virginia, during the period, has paid \$64,800 in dividends and the Ophir has divided among its stockholders \$221,760. Next in importance to the operations being carried on at the C. & C. shaft and upon which the greatest hopes of discovery lie is the plan now under development at the Ward shaft, and in view of their importance these plans will be discussed in considerable detail.

Con-Virginia and California.

For the purposes of mining and drainage the Comstock Pumping Association, early in 1898, entered into an agreement with the Consolidated California and Virginia Mining Company whereby the Pumping Association secured the right to operate through the C. & C. shaft with the understanding that this property should be maintained in good repair. As before stated, it installed the requisite pumping facilities to drain the shaft to the 2,150 level. At about this time, the Con-Virginia Company again having the necessary funds, installed the three Riedler pumps, a new 200-horsepower air-compressor and considerable other machinery, all of which was immediately placed in charge of your association with the idea that it should be operated for the general good of the Comstock, each member of the association, of course, paying its pro rata of the total expense.

Besides maintaining and operating this plant, your association has done the actual mining work for the Con-Virginia and Ophir under the personal supervision of the superintendent of these companies and it is to be regretted that the scope of this organization has not been enlarged so as to combine and centralize all operations under one head and by purchasing all supplies for use of the various companies, thereby reduce the cost of mining to a minimum.

As heretofore asserted, the real progressive future of the Comstock lies in the unification of ideas so that the entire Lode may be operated in harmony as one great property with one object in view—to prospect and develop it from one end to the other.

Owing to the loss of records in the conflagration of 1906, it is impossible to give a complete financial statement so that no attempt will be made along these lines.

The Ward Shaft.

After four years of toil, involving the successful solution of unforeseen and most difficult problems, the Ward shaft has been recovered to the 2,550 level. There is no question, judging from evidence at hand, that had many of these difficulties been foreseen the recovery of this shaft would not have been decided upon, but a new shaft sunk in its place. However, the difficulties have been met and before the present month has closed, the work of lowering the great Blake-Knowles pump into position at the 2,475 level will be well under way, and the most important step taken toward the carrying out of the plan to resume sinking to the 3,100 level. There the second unit of the Blake-Knowles pumps will be placed and, if it is desired, sinking can be resumed and, by the use of auxiliary pumps, additional depth of 500 feet or more attained, providing, of course, that no greater flows of water are encountered than the history of the Lode indicates will be met in the shaft.

The pump station at the 2,475 level, a splendidly timbered excavation on the south side of the shaft, was completed last week and the work of preparing the pump foundation is progressing rapidly and will be in condition to receive the pumps by the time the new hoist, borrowed from the Con-Virginia Mining

Company and the Combination shaft, is ready for operation. The Ward shaft hoist was found to be too light for the burden of lowering the massive pumping machinery into place or for operating at a greater depth than 2,550 feet and the utilization of more powerful machinery was imperative. The new hoist is now practically in position, all of the heavier pieces having been placed, and by the end of the month will be in operation. This hoist has ample capacity for all burdens that may be placed upon it to the 3,100 level.

Rehabilitating the Shaft.

The work of recovering and rehabilitating the Ward shaft was begun early in October, 1903, and has been carried on continuously up to the present time. Years ago the Ward shaft was sunk to a depth of 2,481 feet for the ostensible purpose of prospecting the ground now owned by the Bullion Mining Company and before work was discontinued, it was connected with the old Bullion incline on the 2,100 level and considerable exploratory work done on the levels below the 1,800. During all of this period the Ward shaft was never connected with the Suto tunnel, and as a consequence, the facilities for drainage and ventilation were exceedingly limited. In 1882 a great volume of water was encountered on the lower levels of the Gold Hill mines and this shortly afterwards caused the abandonment of all work in the South End below the Suto tunnel level. Explorations were then being carried on on the 2,450-foot level and the mine would have been flooded but for the timely precaution taken in bulkheading the 2,100 level. This bulkhead, a solid brick structure built across the drift, made it possible to continue work for some years below the tunnel level until finally lack of financial aid caused a permanent suspension of work.

The water that flooded all of these mines was encountered on the 2,810 level of Exchequer, which was at the time being operated through the Yellow Jacket new shaft. A considerable amount of good ore had been opened up upon this level and the one above, and great anticipations were based upon the probable extent of the same. An effort, at that time, was made to unwater the mines and the Yellow Jacket pumps and bailing tanks were run at their full capacity and held the water just below the 2,300-foot level, but the effort was finally given over because some of the companies interested would not contribute to the expense of pumping. The mines were allowed to fill to the tunnel level and no attempt was made to unwater them until, in February, 1890, the Gold Hill Pumping Association was formed and a Dow steam pump installed in the Crown Point incline. After a considerable expenditure, this attempt was abandoned.

Comstock Pumping Association.

Early in 1898, the Comstock Pumping Association was formed and the successful campaign to lower the water in the North End mines was inaugurated. Encouraged by this success, in August, 1903, the Ward Shaft Association was formed for the ostensible purpose of unwatering the middle lode through the Ward shaft. This shaft had lain idle for about twenty years, but, having been one of the last to close down, was thought to be in good condition and was naturally selected as the proper base for the extensive operations which would ultimately result in the exploration and development of all of the middle mines and Gold Hill.

A working agreement was made with the Julia and Bullion companies and the surface works were put into first-class condition. The shaft was found to be badly caved to a point 210 feet below the surface. This was repaired and work continued to the 800-foot level, where a platform was encountered. This platform was removed and little trouble was experienced in reaching the 1,543-foot level. At this point a large cave occurred on the east side and the shaft from here down was in very bad condition.

From the 1,543 to the bottom at 2,481 feet, the shaft was filled with debris that had been dumped into it while the 800-foot level was being explored, and this circumstance, together with the hot

water encountered below the 2,100, made the reopening an almost superhuman task. The bottom was reached late in 1906 and very much better progress by sinking in new ground was anticipated. At this writing the shaft is 2,550 feet in depth and the bottom is in quartz near the footwall of the Comstock vein. Early reports indicated that the shaft had passed through the Comstock but the material encountered proved to be a vein overlying and to the east of the true fissure. The lower vein is over 60 feet in width, of a permanent character, is mineralized and carries quantities of very hot water.

A Bad Cave.

While recovering the shaft, the 2,450 station, opened many years ago on the east side of the shaft, was found to be badly caved and 300 gallons a minute of hot water (160 degrees Fahrenheit) was flowing from the various workings thereon. This unexpected circumstance compelled the opening of a station just below on the 2,475-foot level, in order to catch up and free the shaft of water. A splendid 5-step centrifugal pump with a 200-horsepower motor was placed on the 2,400-foot level and this was fed from the bottom by means of a nine-inch Blake sinking pump, assisted by an auxiliary single-step centrifugal pump. The shaft was then sunk about 100 feet in new ground and, the water continually increasing as depth was gained, it eventually taxed the capacity of the pumping plant to the utmost. Following upon this, the directorate decided to install one of the two new 800-horsepower Blake-Knowles pumps on the 2,475-foot level and the day for this installation is at hand.

Barring unforeseen difficulties, it was the original intention to install these Blake-Knowles pumps on the 3,100-foot level and to operate them in conjunction with two vertical centrifugal sump pumps. The present expedient of placing one of them on the 2,475 level will not in any way disrupt the original plan, because it can at any time be lowered into position with its companion when the 3,100 level is reached. These pumps were purchased at a cost of \$80,000 about three years ago and were fully paid for shortly after their delivery at Virginia City. They consist of two electrically driven duplex, double-acting pumps 6 11-16 inches by 15 inches and each unit is to be directly driven by means of an 800-horsepower Westinghouse induction motor. Their total capacity is 3,200 gallons a minute against a head of 1,550 feet (680 lbs. to the square inch) and the discharge will be through a vertical 16-inch column to the Suto tunnel level. Every precaution has been taken to make this one of the most perfect installations of its kind.

Great difficulty was encountered in maintaining proper ventilation in the shaft, owing primarily to the great amount of vapor rising from the hot water. To obviate this, it was decided to install a large suction fan at the surface and to exhaust the air through the pump compartment. At the present time, about 50,000 cubic feet a minute is drawing up the shaft and the temperature has been reduced from 104 degrees Fahrenheit to 80 degrees and the men can now work in comfort. Another air compressor of large capacity will probably be purchased in the near future, so that with these improvements, together with the above-mentioned ample pumping facilities, the Ward shaft management should be enabled to resume work in the bottom and press it to an early successful conclusion.

Shaft to Be Equipped.

Before sinking is resumed the shaft will be equipped throughout with all of the needed modern appliances, so that no stone will be left unturned to prevent the ultimate accomplishment of the purpose for which work was begun—to reach the ore known to exist on the lower levels of the adjoining properties. The bottom of the shaft is now in lively, fine-looking quartz, carrying sulphurets in large quantities and it is the prevalent opinion of all Comstock experts that an ore body of considerable magnitude is not far distant.

While a general statement of the conditions prevailing at the Ward shaft would be sufficient for the purposes of this report, details so far as limitations would

permit, have been given in view of the fact that the importance of this shaft in its relation to the drainage problem of the entire Lode cannot be overestimated. Not only will the pumps, installed in the shaft, handle the water of the middle mines, but through them, it is possible to drain the South End mines and relieve the North End pumps of a great burden by relieving the pressure coming from the Combination side of the Lode. By driving a connecting drift on the 2,400 level 500 feet northerly from the Ward shaft, it will be possible to drain the Combination shaft and adjoining territory to this level. A bulkhead with proper valves, etc., exists in the 2,150 drift connecting the Bullion incline with the Ward shaft. By opening the valves in this bulkhead, the entire south end may be drained to this level, provided, of course, that all of the old connections have not been closed. Then again, by driving less than 200 feet southerly on the 2,400 level, a connection may be made with the Exchequer workings.

Unwatering the Mines.

From the best and most reliable reports, no particular pressure showed itself above the 2,400, so it is certain that a determined effort in the Ward shaft will unwater the major part of the old workings between the Gould and Curry and the Overman. For this reason alone the Gold Hill management should lend their heartiest support, financial and otherwise, to this great enterprise. However, further suggestions as to another and, perhaps, a better method to unwater the South End mines through the medium of the Alta shaft will be here made.

The Alta Shaft.

Reference has been made heretofore in this report to the conclusion that co-operation in mining throughout the length of the Lode "is essential and is most strongly urged as marking the straightest line toward the successful achievement of your purposes." This being the fact, the relation of the Alta shaft to perfected drainage plans is most important, and that the Gold Hill Mining Companies enjoy perpetual right to the use of the Alta shaft should be an incentive to them to put this right into operation.

Early in the year 1890, during the pumping operations by the Gold Hill Pumping Association, it was positively demonstrated that a key to the unwatering of the South End mines lay in the Alta shaft. In February, 1890, thirteen of the Gold Hill mines formed a pumping association for the ostensible purpose of draining these mines to a depth that would, ultimately, expose the ore formerly developed on the 2,700 level in the Belcher mine, but the water was lowered to a depth of only about 200 feet. At this juncture the Alta pumps were started and a marked lessening in the water level was obvious, this showing a direct connection with the flooded mines and consequently an easy medium for the final solution.

Repairs to the Alta.

During the year 1904, it became evident that the Alta shaft required extensive repairs and, through an agreement with the Alta Company, the Gold Hill mines, by an expenditure of \$7,237.80, acquired a permanent right to use this shaft for pumping and development purposes. The collar of the Alta shaft is 835 feet below the Gould and Curry croppings and the Sutro tunnel connection 1016 feet below the surface. The total depth of the shaft is 2,150 feet or a total depth, as compared with other workings, of 2,985.

This shaft being in splendid holding ground, a minimum expense only is necessary for repairs; therefore, from an engineering standpoint, it is an ideal point for South End drainage possibilities. The south lateral of the Sutro tunnel has been opened and connected with the Alta shaft during the last year and the shaft itself lagged and put into a safe condition so that, upon the resumption of deep work in Gold Hill, it will be a valuable acquisition. Barring caves and other obstructions, it is possible to drain all of Gold Hill through the Ward shaft. However, there is at the present time a pressure of over 400 pounds to the square inch from the south end and it is a matter of policy whether or not this water should be re-

moved through this shaft or through the Alta.

The conditions at the Alta are ideal and it would be most advisable that this shaft, like the C. & C. and Ward shafts, should be equipped with a pumping plant so as to operate in conjunction with them. As before stated, the Comstock Lode must be treated as a whole and operated as one mine. Therefore, it is not only right but expedient to equip this shaft at the earliest possible day.

Present Condition of Mines.

That the present condition of the mines and workings of the Lode and the operations now being carried on may be known, the following summary is given:

Utah.

Since the reorganization of your body the shaft of this property was repaired and some work done on the lower levels. The shaft was equipped with a 50-horsepower electric hoist and a 20-horsepower air-compressor but recently the hoisting rig was sold to the Imperial New Shaft. The mine is now shut down, awaiting the day when the drainage of the lower levels shall have been accomplished.

Sierra Nevada.

The old Sierra Nevada shaft was the first shaft equipped with an electric hoist. The old steam rig was converted and a 20-horsepower motor attached thereto. This shaft has been shut down for several years. The new Sierra Nevada Works was sold to A. J. McCone and has been dismantled. Operations are now being carried on through the Union shaft, in which the Sierra Nevada holds a third interest. Interesting developments are now under way in this property.

Union Consolidated.

This property has no equipment but owns a third interest in the Union shaft, through which prospecting is being carried on.

Mexican.

There is no equipment on this property but it has a third interest in the Union shaft. Work has been done through the C. & C. shaft on the 2,000 level to the extent of extending the north-east drift 260 feet, and considerable prospecting done on the Sutro tunnel level. No work is being done at present, except joint work through the Union shaft. A south drift is being run into Mexican ground through the East Union crosscut at the 2,000 level and a favorable formation is now being entered.

Union Shaft.

The Union shaft is owned jointly by the Sierra Nevada, Union and Mexican companies and was originally equipped with the finest works and machinery on the Comstock. The shaft was sunk to the 2,700 level and considerable ore extracted near the shaft between the 2,400 and 2,600. The stopes being near the shaft, caused it to collapse when the water rose. The original Sutro tunnel connection also closed during the suspension of deep mining and it was re-opened after the organization of your association. Considerable prospecting was done on the tunnel level without results, notably the long crosscut to the east on the 1,600 which was run into Scorpion ground at the time the Union shaft and works burned in the summer of 1904.

This fire completely destroyed the plant and caved the shaft to the 900 level. Insurance to the amount of \$20,000 was collected and, utilizing this, with a regular monthly expenditure of about \$5,000, the plant was completely rebuilt with iron covered buildings and re-equipped with electrical machinery and a steel head frame. The shaft was reopened and re-timbered to the 900 level and then repaired to the 2,050. At this point the shaft is filled with rock that will have to be removed when deeper explorations are contemplated. An east crosscut was driven about 1,500 feet on the 2,000-foot level and a north and south drift is being run from this, the latter to make connection with the 2,000 from the Ophir in Mexican ground. At the time deep mining was suspended, a small steam rig was installed and much work was accomplished with this on the 900 level to the north and west of the shaft. This rig was

replaced with an electric hoist, a motor driven compressor and a motor for the carpenter shop. This was all destroyed and now that it has been renewed, the Union shaft stands at the head of the list with a complete new equipment modern in every sense. Through this shaft, the Sierra Nevada, Union and Mexican may be worked to the 3,000-foot level, the machinery being of ample capacity whenever the water has been sufficiently lowered by the C. & C. pumps. It also offers an opportunity to increase the facilities for ventilation on the lower levels of the North End mines.

Andes.

About three years ago the old steam plant at the Andes was replaced with a 50-horsepower electric hoist and explorations were begun on the old "Virginia Vein." As a result several hundred tons of milling ore have been extracted above the 400-foot level.

Ophir.

The Ophir shaft and works have been practically abandoned, except for the purpose of ventilation. The old pumping machinery and incline engine were sold for old iron. The vertical shaft was repaired about five years ago from the surface to the 1,465 level, at the joint expense of the Con-Virginia and Ophir companies. The collar of the shaft caved two years ago and it cost about \$10,000 to retimber the same. This shaft is a very important one, inasmuch as it is the upcast, or chimney, for all of the North End mines. In this connection, it may be said that for present needs of ventilation there are not enough outlets on the Comstock and those remaining will have to be equipped with large suction fans. See C. & C. shaft for details of underground operations.

Best and Belcher.

Very little has been done on this property since the formation of your association. At joint expense with the Con-Virginia, the 1,950-foot level was extended southerly into Best and Belcher ground and two crosscuts driven. Water was encountered and this work abandoned. It is possible to reach the Best and Belcher ground on the 2,150 and also the 2,250 through the C. & C. shaft. The 2,250 south drift is now within a few feet of the Best and Belcher north line. Some work has also been done through the Gould and Curry surface tunnel, but without important results.

Gould & Curry.

The Bonner shaft and works on this property have been abandoned and no work has been done below the Sutro tunnel level. Preparations are now being made to prospect this property from the north lateral. Among the first improvements was the construction of the Gould and Curry mill for working the low grade ore from the upper levels. This mill was sold to the Best and Belcher Company when the management of the company changed. The old Gould and Curry surface tunnel was repaired and considerable work has been done in the upper levels.

Osbiston Shaft.

This shaft was the joint property of the Best and Belcher and Gould and Curry companies and was originally sunk to the 2,500 level. Soon after your association began work, it was determined to reopen the Osbiston shaft because of its excellent location for deeper explorations. A new shaft house was built and the shaft re-timbered for a depth of about 250 feet. An enormous cave was encountered and, after an expenditure of about \$60,000, the attempt to rehabilitate this property was abandoned.

Mint Shaft.

The Mint shaft, located near the Best and Belcher mill, is a cribbed shaft that was originally sunk to the Sutro tunnel level. This shaft was repaired at an expense of about \$5,000 by the tunnel repair account and it has proved a very valuable acquisition, inasmuch as it furnishes sufficient pure air for operations on the Sutro tunnel level.

Savage.

The Savage shaft has caved and the works have been destroyed. Operations have been confined to work on the Sutro tunnel level of the Savage and considerable low grade ore has been opened up during the

past two years. These operations have been considerably retarded owing to poor facilities for transportation of ore and material through the Suro tunnel, but a correction of these conditions is under way.

Hale & Norcross.

This company has driven a tunnel westerly under Mt. Davidson to a distance of about 6,000 feet without practical results. Operations on this property are now confined to work on the Suro tunnel level. Jointly with the Chollar and Potosi companies, the company has installed a blower and 15-inch air pipe from the Mint shaft to the workings west of the South Lateral. It has opened up some fair grade ore that is being milled at the Pfeiffer mill in Six Mile Canyon.

Chollar and Potosi.

Considerable work has been done on this property through the surface tunnel and, through the efforts of leasers, some revenue has been derived from royalty on ore taken from the croppings, etc. The Chas. Butters Co. now has a lease on the surface workings. On the Suro tunnel level, a drift is being opened southerly from the Hale and Norcross connection, in order to prospect the vein on this level. As in the case of the Savage and the Hale and Norcross, all material, men, etc., are handled through the Ward shaft at about cost to the Ward Shaft Association.

No work is being done in the Julia, Bullion, Exchequer or Alpha outside of operations in the Ward shaft.

Imperial.

During the past year the old Bowers shaft has been re-equipped with the electric machinery purchased from the Utah Company and the shaft retimbered to a depth of about 100 feet. Crosscuts have been run and some stringers of ore uncovered, though not yet in paying quantities. Through this shaft the Confidence, Challenge and Imperial ground can be prospected.

Yellow Jacket.

The Yellow Jacket (old shaft) was among the first to be equipped with electric machinery and, during the past five or six years, considerable exploratory work has been done above the 1,200-foot level. The incline below this point is badly caved and will require considerable time and money to rehabilitate the same. The work in Confidence and Challenge was formerly carried on through this shaft. A surface tunnel about 3,500 feet in length was driven in a northwesterly direction from near the collar of the Jacket shaft and several veins cut, but very little ore in paying quantities was uncovered.

A splendid air connection was made between the Overman, Belcher and Jacket shafts. In fact, the operations in the Gold Hill mines, have, until recently, been carried on in such a way that each company could profit by the equipment of the other and, in many instances, the cost of operations was reduced to a minimum by reason of a combination of forces and joint work whenever possible. The control of the Yellow Jacket passed into new hands about two years ago and since that time a new 200-ton Kinkead mill has been built and is now in successful operation on low grade ore taken from the mine, dumps and surface workings. It is a known fact that great quantities of such ore exist in this company's ground and it remains to be demonstrated whether or not it can be made a paying proposition but indications are most favorable.

The Yellow Jacket is dependent upon the Belcher shaft for ventilation and for this reason has joined the other Gold Hill companies in keeping this shaft in repair. A 2,000-volt three-phase electric cable extends from the Overman shaft through to the Jacket shaft on the 1,200-foot level. This furnishes light and power for all of the underground work. Water in the Jacket stands just below the Suro tunnel level (1,423) and there is about 10 miners' inches of water flowing down the old incline.

Crown Point.

The Crown Point shaft has caved and the works have been destroyed. All work in this mine is now carried on through the Overman shaft and a very important drift

is being driven northerly on the 1,400 level. This drift can eventually be connected with the South Lateral and used to carry off all surplus water now flowing down into the old workings. It may also be used to explore all the properties, including the Jacket, to what is now the water level.

Kentuck.

No work has been done on this property for some years. It has no equipment.

Belcher.

The Belcher (old shaft) has been completely equipped with electric machinery and is in good condition for operation to the 850-level. The incline below this point is caved and, though open for the passage of air, is in bad condition. The vertical shaft has recently been repaired and is now perfectly safe. This shaft is important because it is the only upcast left for all of Gold Hill. About twelve inches of water are flowing down the Belcher incline.

Seg. Belcher.

Some work has been done on this property through the Overman shaft, without practical results. The vein in Seg. Belcher on the 1,200 is apparently about 1,000 feet between walls. There is considerable quartz in the vein material, but ore of value has not yet been uncovered.

Overman.

The shaft, works and mine of this property have been kept in excellent condition and are a credit to the management. These works are a very valuable asset, inasmuch as they supply the only practical means of exploring the Crown Point, Belcher, Seg. Belcher and Caledonia. The shaft offers an opportunity to open the Jacket to the 1,400 level, though, in this case, it is not a necessity. The shaft and mine have been equipped with electricity, although the steam hoist is still in use. Crude oil is used for fuel and has been found to be very economical, having cut the power bill for hoisting to less than half. Considerable work has been done on levels above the water and some low grade ore uncovered. The water in the Overman shaft stands about 46 feet below the 1,200 level, it having been lowered about 50 feet since the pumps were started at the C. & C. shaft, a fact, among others, that demonstrates that, ultimately, unless the Gold Hill mines make provision for handling their water, the C. & C. and Ward pumps will be burdened with this duty.

Caledonia.

The Caledonia has no works. Operations are carried on through the Overman shaft. Recent work in the Caledonia has been extensive and important. On three levels a vein has been followed about 2,500 feet to the southwest and in some places it showed fair assays. On the 1,200 level, this drift has been continued westerly to the Comstock footwall and is now being continued southerly in the true Comstock. The vein is about 75 feet in width and carries values, though not in paying quantities. The Caledonia is equipped with electricity and is operating an air compressor over half a mile from the shaft.

New York.

The New York works and shaft were rehabilitated about four years ago and work started on the lower levels. Some ore was encountered, but after a few months of operation the mine was again closed down.

Justice.

Work has been confined principally to the surface, although some operations were carried on through the Woodville shaft. The Justice mill was equipped with an electric motor but it is not now in use.

Alta.

Work in the Alta has been confined entirely to the efforts of the Comstock Pumping Association to keep the shaft in repair and to open up an air connection with the South Lateral. Through an agreement with the Alta Company the Gold Hill mines have a perpetual right to work through this shaft. The Alta shaft is in good ground and is admirably located for a pumping station and for this reason should be maintained in good repair. Water stands at the Suro tunnel level; in fact, flows into the South Lateral.

Forman Shaft.

This shaft and works were destroyed by fire about four years ago. This was a splendid shaft owned jointly by the Crown Point, Belcher, Seg. Belcher, Caledonia and Overman companies and admirably located for deep mining. Its destruction was a great loss.

New Yellow Jacket Shaft.

The shaft has caved and its magnificent equipment sold for junk.

Combination Shaft.

The Combination shaft is one of the most important features in the rehabilitation of the Comstock. This shaft is 3,250 feet deep and will prove a valuable acquisition when connection has been made with the Ward shaft. It is impossible to operate any one of these hot mines without the very best facilities for ventilation, etc., and this shaft, in combination with the Ward, affords an easy solution for the problem.

The Combination shaft was repaired to the 1,600 level about three years ago, and, during the past two months, the Suro tunnel connecting drift and the 1,600 station have been repaired. Two reels and spur gears have been removed to the Ward shaft. It would be advisable to go through this shaft again at an early date.

Silver Hill.

The Silver Hill Mining Company's property is the most southerly on the Lode and has been a bullion producer for many years. The sum of \$91,800 has been disbursed, as seventeen dividends, among the stockholders.

Deep Level Prospects.

While unquestionably familiar to your organization, it is highly probable that there are many of the more recent stockholders in the various corporations composing the Comstock Pumping Association who are not acquainted with the report of the various superintendents of the Lode, setting forth their opinions as to the probability of uncovering valuable ore bodies in the lower levels of the mines yet to be drained. As this report supplied the basis of all of the endeavor heretofore set forth, it is deemed advisable that a synopsis of this report be made and it is here given. In the introduction of their report the superintendents say in part:

"The great width of the Comstock Lode calls for an enormous amount of development work in each level before the ground can be said to have been thoroughly prospected. In illustration of this fact we call attention to the great yield of ore from the Crown Point, Belcher, Yellow Jacket, Chollar, Hale & Norcross and Consolidated California and Virginia mines (bonanzas) after they were supposed to have been worked out. In the light of such developments as were made in the vicinity of these bonanzas and of the discoveries at and near the surface recently made in the north end mines, it can be truly said that there is not a level on the Comstock Lode that has been so thoroughly prospected that there is not yet a chance of finding ore in it.

"Becker in his 'Geology of the Comstock Lode' says: 'The first condition for the formation of a quartz body is an opening to receive it. The group of mines worked through the Union shaft and the Yellow Jacket, Crown Point and Belcher mines show peculiarities of structure which point to the likelihood of such openings in lower levels. Openings such as that which contained the Consolidated California and Virginia bonanzas, however, gave almost no warning of their approach from above and may at any time be struck in the intermediate mines.'"

Continuing, in a detailed discussion of the probability of discovering ore at depth in the various properties, the report, in brief, says:

Sierra Nevada.

"There are good chances of finding good bodies of pay ore from the surface to the deepest workings of this mine in any of the unexplored ground. This has been demonstrated in the upper workings near the old ground, where large ore bodies have been found where least expected.