# The Story of the Water Supply for The Comstock

Prepared in cooperation with the Nevada State Department of Conservation and Natural Resources

GEOLOGICAL SURVEY PROFESSIONAL PAPER 779

# The Story of the Water Supply for the Comstock

Virginia City probably in the late 1870's. Courtesy of Nevada Historical Society.

# THE STORY OF THE WATER SUPPLY FOR THE COMSTOCK

## Including the Towns of Virginia City, Gold Hill, and Silver City, Nevada

Together With Other Water-Related Events
For the Period 1859–1969

HUGH A. SHAMBERGER

*Prepared in cooperation with the Nevada State Department of Conservation and Natural Resources*

GEOLOGICAL SURVEY PROFESSIONAL PAPER 779

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The personnel of the Nevada Historical Society were most helpful, as were those of the Nevada State Library, the University of Nevada Library, the Ormsby County Library, and the Mackay School of Mines Library.

For making the reproduction copy of the Buck and Schussler letters, as well as other material, I am indebted to the late Jack McCarthy, State Printer, and his assistant Tom Carter, now Acting State Printer.

For some of the engineering details, I want to acknowledge the assistance of Walter Reid, P.E., of Virginia City.

On the matter of editing, I needed considerable help. I was fortunate to have the advice of Victor O. Goodwin, well-recognized writer of Nevada history. I also received help from my daughter, Mrs. Roy (Ann) Callahan, my son Allan, and my wife Ethel. Some of the old timers in Washoe Valley who furnished information were Henry Heidenreich, Bill Pedroli, and Norman and Don Cliff.

I want to especially acknowledge the work of Ethel Murphy, of the Department of Conservation and Natural Resources, in typing this story, as well as other personnel in that office.

The writing of this story has been done under the auspices of the U.S. Geological Survey and the Nevada Department of Conservation and Natural Resources. I am appreciative of the counsel and guidance given me by George Worts, District Chief, U.S. Geological Survey, and his assistant Thomas Eakin, and by Elmo DeRicco, Director of the Department of Conservation and Natural Resources, and his assistant Norman Hall.

The list of all those who gave me assistance is too long to include here, but I want them to know I am most appreciative.

HUGH A. SHAMBERGER

October 1969

# PREFACE

After spending nearly 34 years in State service, mostly in the field of water and related resources, I have retired from the daily grind of full-time work. From 1935 to 1957, I served in the Office of State Engineer; from 1957 to 1965, as Director of the Department of Conservation and Natural Resources; and then 2½ years as Director of the Center for Water Resources Research of the Desert Research Institute.

Like so many professional men who retire, I wanted to spend a part of my time in work that would be both interesting and productive. One day when I was visiting George (Skip) Worts and Thomas Eakin of the U.S. Geological Survey here in Carson City, the discussion got started about the water supplies for the old mining camps of Nevada. It was recognized that very little attention had been given to this particular subject of water supply, with the possible exception of Virginia City.

Mr. Worts suggested that I might wish to try my hand on a part-time basis under the Federal-State cooperative program between the U.S. Geological Survey and the Department of Conservation and Natural Resources. Since I have always been interested in our State's history, I lost no time in getting started. My first effort was on the water supply of the Comstock, bringing its history up to 1969, which is covered herein.

Since starting the Comstock water-supply story, I have been working on the history of other of the old mining camps and their quest for water. I am finding it exceedingly interesting, and in time I am hopeful that I can cover most of the old mining camps in Nevada, especially those where an adequate source of water for the townsite and mills was not readily available, which generally was the case.

HUGH A. SHAMBERGER
*Research Hydrologist*
*U.S. Geological Survey*

October 1969

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# STATISTICAL SUMMARY

## Virginia City, Gold Hill (Comstock District) and Silver City

| | |
|---|---|
| Discovery of ore at Virginia City [1]* | 1859. |
| Virginia & Truckee Railroad [2] | Completed Carson City to Gold Hill, Dec. 21, 1869. Completed Carson City to Virginia City, Jan. 29, 1870. Completed Reno to Carson City, Aug. 24, 1872. Completed Carson City to Minden, Aug. 1, 1906. |
| Sutro Tunnel [3] | Started Oct. 19, 1869 and completed July 8, 1878. |
| Pipelines from the Sierra Nevada to Virginia City: [4] | |
| First pipeline | Completed August 1873. |
| Second pipeline | Completed 1875. |
| Third pipeline | Completed 1887. |
| Mineral Production, 1859–1921 [5] | $386,346,931. |
| Silver $222,315,814 | |
| Gold 164,023,917 | |
| Copper and lead 7,200 | |
| Mineral production, 1859–1957 [6] | $393,963,725. |
| Peak years of production, 1862–80, approx | $296,400,000. |
| Peak population, Storey County (Virginia City, Gold Hill) [7] | 17,528. |
| Population, 1960 Census, Storey County | 568. |
| Present population, Storey County | 606.[8] |
| Life of towns: | |
| Virginia City | 1859 to present. |
| Gold Hill | Do. |
| Silver City (Lyon County) | Do. |

*See numbered footnotes at end of text.

# THE STORY OF THE WATER SUPPLY FOR THE COMSTOCK

## (Virginia City, Gold Hill, and Silver City, Nevada, 1859–1969)

### EARLY HISTORY

Of all the mining towns in Nevada, more has been written about Virginia City than any of the others. When Virginia City is spoken of, Gold Hill, which is located south of Virginia City in Gold Canyon, must be included, since the Comstock Lode extended to Gold Hill. Silver City, which is a few miles farther down Gold Canyon in Lyon County, was actually settled before Virginia City and was a place of considerable importance in 1860. In the early days the mines of Silver City rivaled those of Virginia City, but no bonanzas were ever developed in Silver City.[9]*

Virginia City became famous and has remained famous for many reasons. Probably foremost is the fact that it was the greatest producer of silver and gold high-grade ore in history. The recorded production of the Comstock district to 1957 was $393,963,725 in silver and gold,[10] the silver portion being about 58 percent of the total. This production figure was probably greatly exceeded, as there was a large unrecorded production in the early days. Another reason for Virginia City's fame is the large number of people who were associated with the development of the Comstock who later became famous; men such as John W. Mackay, James G. Fair, Adolph Sutro, Samuel L. Clemens (Mark Twain), James C. Flood, W. S. O'Brien, William Sharon, D. O. Mills, and H. M. Yerington, to name only a few.

While Virginia City and the Comstock Lode were famous in their own right, especially throughout the West, they have gained worldwide notice during the past decade as the result of the "Cartwright family" in the National Broadcasting Company television series "Bonanza." The locale of "Bonanza" is, of course, Virginia City, and the "Ponderosa Ranch" is supposedly near Lake Tahoe. The episodes shown on television are, like most television series, imaginary; yet the locale is real and some of the episodes were developed from actual events. A facsimile of Ponderosa Ranch, the make-believe home of the "Cartwrights," was recently constructed at Incline Village on the shores of Lake Tahoe, Nev., and is becoming a great tourist attraction.

The Comstock Lode stands alone in the history of Nevada and the early West, in the difficulty of the water problems presented in the extraordinary engineering feats accomplished in order to overcome these problems and to develop the Comstock, and in the ingenuity and courage demonstrated in the undertaking of these projects.

The first serious prospecting in the Virginia City–Gold Hill area occurred as early as 1850, and a mining camp existed in Gold Canyon continuously from 1851. The early history of the Comstock is recorded in the following article entitled *Sketch of Early Times*, which appear in the *Territorial Enterprise* on June 20, 1875:

> In the summer and fall of 1857 there was considerable prospecting done for placer mining in the section where lower Gold Hill now stands. It is impossible to give the names of the early pioneers who at that time sought the fickle goddess in these parts. They were generally a wandering adventuresome class, who went where the tidal wave of speculation for the time sent them.
>
> The next spring a prospecting party was started for the Walker River, which, however, returned during the summer, having met with no success. It was not until early in the year 1859 that prospecting between the works at Gold Canyon and the diggings which were then worked in the ravine below where the Virginia City Cemetery now stands was carried on to any extent. At that time Mount Davidson was known as "Sun Peak" or "Sunrise Peak" because it caught the first rays of the rising sun, and it was a great pity the name was ever changed.
>
> At that time John Bishop and Aleck Anderson discovered in what was then known as the right fork of Gold Canyon, a good-looking ledge. "Old Virginny" was told of the find, and this early oracle in mining matters agreed that it might be something good. Comstock, who in that year had a store

*See numbered footnotes at end of text.

in Carson, Vigneau and others followed. The first pan of dirt went fifteen cents. Water was brought up from the canyon by means of a rough flume built of boards obtained over in Washoe.

At that time fifty feet per man was all that the early-established code of the miners allowed a man to claim in one place. The locality was called Gold Hill because it was situated on a little hill just outside of Gold Canyon. It was thus named February 8, 1859, and today (1875) the place contains about twelve thousand inhabitants.

The flume above-mentioned, in which water was brought to what we shall hereafter designate Gold Hill, was nailed together on the precise point where the Crown Point works now stand. . . .

It was the middle of April before the rockers were at work. The first one hundred rockers yielded $5 and a little over. The next day quicksilver, which had been brought from Johntown, was introduced, and $17 were [sic] taken from a single days work of one man. This was not very heavy but it beat the $2, $3, to $5 per day of Gold Canyon so badly that quite an excitement was created by it. Afterwards some averaged $50 and even $100 per day.

The first locaters of Gold Hill were John Bishop, Aleck Anderson, "Old Virginny," Vigneau, Comstock, Camp, Sandy Bowers, Joe Plateau, and one Richards, a renegade Mormon. Immediately after the locations above-mentioned were made Bishop and Camp located the present Yellow Jacket. . . .

Then came the building of a log shanty to live in. This was located immediately in front of the Gold Hill croppings. By the 1st of May so many miners had come to the hill that there was neither work or room for them. Several of these started off and located claims all along the Comstock where the City of Virginia now stands. The present Ophir was located at that time by John Jessup. . . .

About this time it became necessary to build a large shanty in Gold Hill to accommodate the influx of miners. Jessup, of the Ophir, turned in and helped put it up. After it was finished, Jessup and Sides sat down to play a game of cards for drinks. A dispute arose, and Jessup was killed by Sides, who stabbed him twice with a bowie-knife. This was about May 1, 1859. Sides was taken to Eagle Valley (Carson) for trial, but there was never anything done with him. Thus the reign of violence inaugurated on the Comstock. . . . After the death of Jessup, and while the majority of the inhabitants of Gold Hill were over in Eagle Valley with his murderer, Reilly and McLaughlin jumped his claim, and have received credit of first discovering the Comstock.

The claim was afterwards enlarged by the addition of other claims and had several owners, among whom were Penrod, Comstock, Finny (Old Virginia), Reilly and McLaughlin and was at one time run by Penrod, Comstock & Co. The name was several times changed 'til at last the name "Ophir" was given it. This is the claim which gave the name of Comstock to the lode. There were several ambitions of the honor of standing godfather thereto, but Comstock is the only one who was fortunate enough to achieve immortality in that regard. If the lode had been called after the first discoverer, it should have been named the "Grosch lode," for the brothers located claims for themselves and others thereon long before the days of Virginia City and Gold Hill were known.

John L. Newman, who died in the fall of 1861, built the first substantial dwelling ever erected in Virginia City. This was situated on the corner of "A" Street and Sutton Avenue, and constructed in the summer of 1859; but at what time of the summer occupied it is impossible to say. It was not, however, until the second house had been put up at Gold Hill. . . .

In the fall of 1859, Virginia City had a population of between two and three hundred. Their accommodations would not be considered first-class today. Many of them slept in the sage brush on the mountain side, for but a small proportion of them could get tents or other lodging accommodations. But there was plenty of timber here then, and their sleeping-rooms were not so desolate and dreary as are the hill-sides now. The winter of 59–60 was a very severe one, and those who could not procure shelter otherwise lived in "holes in the wall," that is, they dug holes in the hillside and used them for dwellings. . . . The first snow fell about the middle of November, and was from a foot and a half to two feet deep. About Christmas a heavy fall was experienced, which covered the ground about five feet deep. . . .

The first frame house ever built in this city was erected by James H. Hickman and was located on "A" Street, between Union and Taylor. It was, however, unroofed by a zephyr the following May. The first International Hotel was built on the corner of "B" and Union Streets, of lumber whipsawed down in Six-Mile Canyon by the men who were the proprietors. John Connell was one of the proprietors and ——— Paul the other. It was erected in the winter of '59 and spring of '60. It was one story high, had a bar-room, dining room, and about a dozen lodging-rooms. The kitchen and dining rooms were in the basement. The furniture, as may be surmised, was neither mahogany, rosewood, nor yet walnut, yet the first day it was opened the receipts were $700. It was afterwards (about '62) packed in two wagons and moved to Austin where it now stands.

In the above news article, mention was made of the settlement of Johntown. Until the writer started his research for this story he does not recall ever having heard of this place, and in all likelihood not too many other people have. Several of the early writers mention it; it was situated in Gold Canyon about 4 miles above Dayton. Its population consisted mostly of Chinese placer miners. From 1856 to 1858 it was described as the "big" mining camp of western Utah Territory, although it never had more than a half-dozen flimsy wooden shacks at any one time.[11]

## THE EARLY STRUGGLE FOR WATER

Virginia City and the Comstock Lode faced a variety of water problems, which can be considered in three general groups. First, it was necessary to provide an adequate supply of water for the population. Secondly, the operation of the mines required an inordinate amount of water. The final problem was an excess of water in the lower levels of the shafts. Adequate solutions were found for the supply for the population and the mines, but the conditions created by the excess amounts of scalding water in the shafts were never overcome and resulted in the discontinuation of deep mining on the Comstock in 1886.

Dan DeQuille described the early struggle for water as follows:

> In the early days, when the first mining was done at Virginia City and Gold Hill, natural springs furnished a supply of water for the use of the few persons then living in the two camps. For a time after the discovery of silver, these springs, and a few wells that were dug by the settlers, sufficed for all uses; as the town grew in population, an increased supply of water was demanded. A water company was formed and the water flowing from several tunnels that had been run into the mountains west of Virginia City for prospecting purposes was collected in large wooden tanks and distributed about the two towns by means of pipes. At length the tunnels from which this supply was obtained began to run dry, and a water famine was threatened. It then became necessary to set men to work at extending the tunnels farther into the hills to cut across new strata of rock. This increased the supply for a time, but at length the whole top of the hill into which the tunnels extended appeared to be completely drained.[12]

Although thousands of dollars had been expended in these various experiments, the danger of water famine constantly confronted the people.[13]

Two companies, the Virginia Water Company and the Gold Hill Water Company, had been formed to collect and distribute water. These two companies were consolidated on May 12, 1862, as the Virginia and Gold Hill Water Company.[14] Eliot Lord gave the following description of the efforts of the company to meet the water needs.

> Before September 1863, they had bought or leased the streams from seven tunnels, the principal water sources, and conducted them through flumes and ditches into large cisterns, from which the water was distributed to all points in Virginia City and Gold Hill. The mains first laid were wooden boxes, roughly joined, and placed on or near the surface, with branch pipes of lead tubing. In August 1863, iron supply pipes were laid in South C Street and were thenceforth substituted for wood to a considerable extent. If the supply had been commensurate with the demand, the profits of the company would have been extraordinary, but the amount obtained was so scanty that it was necessary to dole it out at exhorbitant rates.
>
> In October 1863, only 56½ flowing inches (664 gallons per hour) of water could be obtained for the use of Virginia City, 48 of which came from the Santa Rita tunnel alone, and if the stream from the last named tunnel decreased, as appeared probable, a water famine was imminent, (Santa Rita tunnel was located in Ophir Ravine). . . . Fortunately the supply was maintained with slight diminution until the melting of the winter snows refilled the springs. Every succeeding year, as the city grew, the peril of water-drought increased; every year the record was repeated—flumes and pipes running full in spring and half empty in autumn.[15]

The Santa Rita Tunnel was the main water supply for Virginia City until a prospecting adit, known as the Cole Tunnel, encountered a quartz seam on January 7, 1867, that produced 135 inches of water (1,515 gallons per minute). Apparently this quartz seam also supplied the Santa Rita Tunnel water because its flow ceased at once. Following this the Virginia and Gold Hill Water Company leased the water from the Cole Silver Mining Company. This supply was still insufficient, and the water company was forced to supplement their good quality water supply with Virginia City mine water, primarily from the Ophir mine shaft.

This caused the people of Virginia City and Gold Hill to complain about the water quality, but the water company very shrewdly encouraged each of the cities to believe that it was the favored one, and that the other was receiving poor quality water.

The Cole Company, realizing the value of a pure water supply, refused to renew the water company's lease on the water at the expiration of the old lease in 1870, and immediately began to lay a new system of pipes alongside those of the water company.[16]

The Virginia and Gold Hill Water Company, apparently anticipating such a move, commenced the extension of an adit known as the Nevada Tunnel, which would intercept the heretofore noted quartz seam at a point about 30 feet lower than the Cole Tunnel. This work was carried on as rapidly as possible, although it later developed at the hearing before the Ninth Circuit Court, which will be discussed subsequently, that the timing by the water company was such that the quartz seam supplying the water supply would be reached at the time their lease terminated.

The Cole Silver Mining Company filed a bill of complaint before the Ninth Circuit Court, applying for a preliminary injunction restraining the water company from diverting the water until a final hearing. The case was heard before Circuit Judge Sawyer February 13, 1871. The plaintiff alleged that it had discovered and actually appropriated and enjoyed the water for many years. The water had been sold to the defendant, the Virginia and Gold Hill Water Company, by the plaintiff, the Cole Silver Mining Company, and paid for under a lease agreement for several years prior to September 1870.

Judge Sawyer, in his opinion, stated that the plaintiff, in excavating a tunnel in a mountain to its mining claim on the public lands of the United States, struck a subterranean flow of water, which it appropriated and enjoyed for several years. That the defendant ran a tunnel from a distant point into the mountain, to a point some 30 feet in altitude, directly below the point where the plaintiff obtained the same water; and thereupon the water which flowed through plaintiff's tunnel was intercepted and discharged through defendant's tunnel, and was by it appropriated to its own use. It was held by Judge Sawyer that said diversion and appropriation of the water was wrongful, and that the complainant was entitled to an injunction.

It was further stated that the defendant started a tunnel to run to its ledges, commencing lower down the mountain, and at a considerable distance to the southward of the entrance to complainant's tunnel. The excavation of this tunnel, called the Nevada Tunnel, was prosecuted at times, for several years. Finally, the said defendant entered into a contract to extend the tunnel into the mountain until it should strike a ledge, called the Macey Ledge.

The complainant insisted that defendant extended the said tunnel expressly to take its water; the defendant claimed that its objective was to prospect ledges beyond the complainant's claim. A preliminary injunction was granted October 6, 1871. Later a motion by the defendant to dissolve the injunction was denied by Circuit Justice Field.

Following this ruling, the defendant effectually bulkheaded the Nevada Tunnel, causing the water to once again flow out of the Cole Tunnel. The Cole Company then continued to furnish most of the domestic water to the area, but as the Virginia and Gold Hill Water Company continued to furnish water from the mine shafts to the mills in Gold Canyon exclusively, their revenue exceeded that of the Cole Company.

The writer recalls that many years ago he had occasion to investigate this source, which was flowing out of an old mining tunnel that was completely caved in. It was known as Cedar Hill Canyon Spring. Later, in 1952, Mr. H. E. Winchester, Division of Water Resources, also investigated this source, in connection with the possibility of developing an auxiliary water supply for Virginia City. In his report he stated that the flow of the spring on November 10, 1952, was found to be 39 gallons per minute, which is about 56,000 gallons per day.

It had long been evident to the water company that an extraordinary effort was required in order to secure water from some unfailing source; however, according to Eliot Lord, when the plan to conduct water from a Sierra creek across Washoe Valley was broached, in the early 1860's, even the boldest speculators were startled.[17] The decision to go to the Sierra Nevada for water was finally reached at a meeting of the directors of the water company held in August 1871.

Just recently during a visit to Virginia City, Hobart Leonard, President of the Virginia City Water Company, showed me two letters that certainly have historical value and, so far as is known, have never been made public. Mr. Leonard kindly agreed to their use and they are reproduced here in facsimile form. The first one, dated July 14, 1864, addressed to Virginia and Gold Hill Water Company, was from a civil engineer by the name of S. M. Buck. In this letter, it will be noted, Mr. Buck gave an adverse report as to conveying water from the Sierra to Virginia City. The second letter was in the form of a report from Hermann Schussler, addressed to Messrs. Flood and O'Brien, which was dated October 1871, outlining a plan to bring the water from the Sierra Nevada to Virginia City.

There are several things of interest in this letter. It was written about 3 months prior to statehood and 9 years prior to the actual construction of the first pipeline. It must be remembered that at that time no pipeline had ever been laid with a head of as much as 1,000 feet. As Mr. Buck stated near the end of the first paragraph ". . . to bring water across Washoe Valley at a sufficient height to make it available to supply Virginia City would, to say the least, be one of the most arduous undertakings of engineering and mechanical skill in modern or ancient time." Later in his letter he stated, ". . . it is an undertaking in which no prudent capitalist would ever invest his money; and I hardly need observe that without capital, and that in great abundance, this undertaking could never be accomplished."

It is surmised that the route Mr. Buck had in mind crossed Washoe Valley near its southern end, with the intake in Little Valley about 2 miles north of Red House. His elevations were reasonably accurate, and he stated that his starting point would be about 300 feet above the level of Lake Tahoe, which would make the inlet about 6,520 feet above sea level in elevation. Mr.

Report of O. M. Buck

Virginia City, July 14th 1864.

Messrs. Va & Gold Hill Water Co

In accordance with your request I made a cursory Survey for the purpose of ascertaining the practicability of supplying the City of Virginia with an abundance of water from Alta lake. To ascertain this fact I run a set of levels from a point on the Virginia and Gold Hill Water Co's flume, immediately back from the Gould & Curry office to and through Washoe valley. I find from this that Washoe lake is 1363.4 feet below the Starting point above named. I did not run a level to Thompson's Lake View House — but took a general observation from which I ascertained that that point is 1200 feet in round numbers below said Starting point. Of course to bring water across Washoe Valley would require pipes of immense strenghth; and the distance to be piped would be from six to ten miles. I have not attempted to make an estimate of the expense of such an undertaking; for with the data at hand I could not approximate nearly enough to make such an estimate as would prove of any practical value. But, as is apparent from the enormous pressure — say 1000 feet — for miles brought to bear upon pipes, the outlay would be very great even if it could be done at all. Any one at all acquainted with hydraulic pressure can at once see that to bring water across Washoe valley at a sufficient height to make it available to supply Virginia City would to say the least be one of the most arduous undertakings of engineering and mechanical skill in modern or ancient times

I visited Alta Lake and found that it was a pond of limited area — about two acres — with neither inlet or outlet. I deem this lake of no value from which to attempt to procure water; as it would require a tunnel of at least 2,000 feet in length to tap the water and then in all probability it would

drain shortly. There are however sev-
eral streams of water whose sources are
sufficiently hight upon the Eastern
slope of the Sierras to furnish water
at Virginia could they by any means be
brought across Washoe valley. But in
my opinion,— based upon what obser-
vations I was able to make in the
short space of time I was engaged
in examining this matter it is an un-
dertaking in which no prudent capi-
talist would ever invest his money; and
I hardly need observe that without cap-
ital, and that in great abundance, this
undertaking could never be accomplished.
Leake Tahoe is about 800 feet in
round numbers below the starting
point mentioned herein. But
the remarks herein contained are
of course equally applicable to
that or Summit lake, even did
they possess the necessary altitude.

S. M. Buck
C. E.

Buck mentions Alta Lake and Summit Lake. I have found no maps showing these lakes, but I am sure that Summit Lake is now known as Spooner Lake. Perhaps his Alta Lake is what we know as Marlette Lake although at the time of his letter it was called Goodwin Lake.

Nine years after Mr. Buck's letter, when the pipeline was an actuality, it was considered one of the engineering marvels of all time. Accordingly Mr. Buck should not be condemned for his conservative outlook. It was unlikely that in 1864 any competent engineer would have given a favorable report.

However, the need for pure water in large quantities continued, and no more reasonable alternative was discovered. More significantly, the powerful combination of Mackay, Fair, Flood, and O'Brien was formed and in March 1869 wrested control of the Hale and Norcross mine from William Sharon. In the same year, they bought Sharon's interest in the Virginia and Gold Hill Water Company, which was subsequently reorganized in 1871. The directors of the new company were Walter S. Dean, W. S. Hobart, John Skae, John W. Mackay, James G. Fair, James C. Flood and W. S. O'Brien.

Following the discovery of the Crown Point-Belcher bonanzas in 1870, the new owners of the water company formally decided to go to the Sierra Nevada for water. Mr. Hermann Schussler, a consulting engineer who was also the Chief Engineer of the Spring Valley Water Works of San Francisco, was requested to submit a report concerning the feasibility of the project. He compiled a favorable report and submitted it to Messrs. Flood and O'Brien in October 1871. Mr. Schussler had conducted a survey of the proposed Sutro Tunnel in about 1869, and was no doubt well acquainted with the locale of the area and the water problems confronting the Virginia and Gold Hill Water Company.[18] A facsimile of the original report is given here.

It would appear that prior to the time of Mr. Schussler's report, a tentative route had been decided upon. Dall Creek mentioned in the report as the first source of supply was at that time so named because a Mr. Dall had a lumber mill in Little Valley. Later the name was changed and that portion of the creek above Red House was called Hobart Creek. The portion below Red House was named Franktown Creek. Messrs. Flood and O'Brien, to whom the letter was addressed, as well as those mentioned in the letter—Messrs. Skae, McKay (Mackay), Hobart and Fair—were all directors of the Virginia and Gold Hill Water Company as reorganized in 1871.

A portion of the report was devoted to a power scheme which would require a larger pipe alongside the first pipeline to convey a large volume of water to the Gold Hill area, where it could be passed through turbines. While two other pipelines were later installed, they were for an additional water supply to Virginia City and not for the power development as mentioned. In 1887 a power scheme was developed, which will be referred to later.

A few months after submitting the aforementioned report, on May 18, 1872, Mr. Schussler submitted the specifications and requisition of iron for the pipe. A month later, June 15, 1872, he submitted the specifications and requisition of rivets for the pipeline. The number of rivets as requisitioned figured out to be 952,900.

Messrs. Flood & O'Brien

Gentlemen!

At your request I visited Virginia City, with the view of getting a thorough insight into the newly proposed works, intended to supply Virginia City & Goldhill with an abundant supply of fresh water.

*Proposed Line of pipe.*

In Company of Mr. Skae I first followed the route of the proposed pipe & found that it had been very properly located on an elevated ridge, which crosses Washoe valley, thus avoiding the heavy pressure of 1400 feet, with the exception of about one mile of its length. A few alterations in the route of the pipeline, so as to avoid short turns, rocky bluffs etc, will make the line perfect.

*Marlet lake Reservoir.*

The following day we proceeded by way of Carson City to Lake Marlet the bottom of which is at an elevation of about 7800 feet above the Ocean & about 1200 ft above Virginia City. I found it to be a magnificent natural reservoir of an area of from 500 to 600 Acres. Its only outlet is a narrow gorge, 25 feet wide at the bottom & at an elevation of 20 ft from 100 to 120 feet wide, so that a log dam containing about 75000 feet of timber (the logs being cut on the ground) which can be constructed for about $1000. would (make a reservoir) containing about 4000 Million gallons of water. This reservoir will fill itself every winter from smelting snow, in addition to its natural supply, which is over 100 Inches per day at present. You

Daily supply

would thus have secured a steady supply of 11 Million gallons a day which is 50% more than the entire City of San Francisco uses at present.

Route of flume

The water can be easily brought around in either a northerly or southerly direction by means of a flume to the inlet of the pipe, the route by way of Dall Creek being more preferable although it may involve the expense of drifting a short tunnel through the divide in the Main Ridge near Dall Creek.

Dall's Creek — The ~~next~~ next Trip I took with Mr. Hobart to the Dall Creek, which even at the present date runs a very fine stream of Water, ~~of~~ about

Capacity — 150 Miners Inches or 2½ Million gallons a day. Of this amount the 11 Inch pipe would take only 50% or with an additional head of 200 ft 75%, which shows that in this creek alone there is an abundant supply. This creek has a very large watershed & a very constant supply during the dry season being mostly fed by springs. About a mile

Reservoir. — above the sawmill a log dam has been constructed, which if carefully repaired & raised would form a very good reservoir containing from 30 to 40 Million gallons. Both these sources as well as the Ophir Creek are located sufficiently high ~~the~~ run their waters by means of small flumes under heavy grade into the inlet of the pipe.

After ~~due~~ due deliberation & Consultation with Messrs McKay, Hobart & Shaw we came to the conclusion to propose to you & Mr Fair the following:

*Proposition*

Dall Creek being the nearest & having an ample supply of water, to make this creek the first & principal feeder for the works proposed at present.

To repair & raise the Dam in that Creek, so as to make a storage reservoir containing from 30 to 40 Million gallons.

Commencing at the proper level below the dam, to construct a flume out of boards 14" x $1\frac{1}{2}$", clamps every 4 ft & tops covered crosswise by $1\frac{1}{2}$" plank, this flume being about 4 Miles in length & having about 20 ft fall per mile. The flume ending at a level above the pipe inlet sufficient if necessary to give 400 ft head while at present we shall only use 200 ft head.

*Pipe*

*Manner of Manufacturing & Laying*

The pipe having a length of $6\frac{1}{3}$ Miles, to be made out of sheets 3 feet square, double rivetted in the straight seam & singe in the round ones. That mile of pipe, which has to resist the heaviest pressure, to be made in San Francisco, hot rivetted into 23 feet lengths & to be shipped to its destination; the balance of the lighter Iron, to be punched in

San Francisco, then shipped in sheets to the pipeline & there rolled, rivetted & dipped & laid in the ground. The 23 foot lengths to be joined together by a lead joint, the ditch to be dug 2 ft wide at the top, 18" at the bottom by 4 feet deep, with a joint hole every 23 ft.

(the pipe) The flume to convey the water from to Virginia City to have a grade of 6 feet per mile, to be made of 3 boards 18" x 1½ & built the same as the one above. Its length will be about 13 Miles.

Reasons for 11" pipe preferable. (omit) The reasons why we propose a 11 Inch pipe instead of a larger one are as follows:

A 11 Inch pipe in addition to the present supply gives you an abundant supply of water for home & Municipal purposes as well as for the mills & hoisting works for many years to come. A pipe to deliver twice the amount of water would cost 80% more, one for 3 times the amount 150% more & one for 4 times the amount 200% more, so that the cost would increase ~~as follows:~~

Proportion of Cost

| | | |
|---|---|---|
| Supply as proposed | — Cost | 100 % |
| —"— doubled | — —"— | 180 % |
| —"— trebled | — —"— | 250 % |
| —"— quadrupled | — —"— | 300 % |

Now, as you are aware, the big body of water for the power scheme would be needed only at a considerably lower level, than for the supply scheme; thus reducing the cost of a pipe of 4 times the Capacity from 300% to about 250%.

For these reasons it would be advisable to have the supply scheme entirely separated from the power scheme, a 11 Inch pipe being amply sufficient which of course would have facilities to run the surplus water from the upper into the lower level.

Then, after the smaller pipe has proved a perfect success, as I am confident it will, you can go ahead with a great deal more satisfaction & construct a much larger pipe alongside of the first one, to convey a large amount of water to a lower level for

The Power scheme

Water being got from Marlett Lake

The mills being mostly located along the cañon below Gold Hill & each succeeding one on a lower level than the other, a stream of 300 Miners Inches or 1200 flowing Inches, which we can deliver through an 18½" pipe to the lower level, would give for a total fall of 1000 ft an effective work of 750 Horsepower, which power by judicial managment could be distributed to from one to a dozen different mills.

The materials needed for 11" pipe

The amount of Iron & Rivets required for the 11" pipe will be 11614 sheets. 3 feet square varying in thickness from $\frac{1}{4}$ to $\frac{1}{16}$ Inch according to the pressure & having a total weight of 620000 lbs or 310 Tons also about 450 Kegs of rivets @ 100 lbs varying in size from $\frac{1}{2}$ Inch in diameter to $\frac{9}{32}$ Inch.

Cost.

The cost of the entire pipe laid in the ground complete will fall a little short of $100000.— provided the entire freight does not exceed $30. per ton.

As soon as you are ready for ordering the Iron & rivets, I will prepare the exact list of Materials of all sizes required.

Thanking you & your friends in Virginia City for their kindness & hospitality with which I was received, & for the facilities rendered to me for seeing so many interesting things I ~~remain yours~~ Faithfully

Hermann Schussler

San Francisco.
Oct 1871.

Report on water supplies &c by H Schussler

## THE FIRST PIPELINE

The initial project involved the construction of a diversion dam on Hobart Creek (fig. 1) from which a wooden flume 18 inches deep, 20 inches wide, and 24,403 feet (4.62 miles) long, conveyed the water to a tank at the inlet of the pressure pipe (fig. 2). The pressure pipe formed an inverted siphon which was 11½ inches in average inside diameter and 7 miles 140 feet in length. At Lakeview Hill saddle the pipe was 1,997 feet lower than the intake and at the outlet end of the pressure pipe a wooden flume 16 inches by 18 inches in cross section and 21,370 feet (4.04 miles) in length conveyed the water to a saddle where a reservoir named Five Mile Reservoir was later built (fig. 3). From the reservoir site a wooden flume followed around the mountainside, a distance of 29,970 feet (5.66 miles), to tanks located above Gold Hill and Virginia City (fig. 4).

Good descriptions of the water system have been given by Galloway,[19] DeQuille,[20] and Lord.[21] Some discrepancies exist, especially as to elevations. In 1964 Walter G. Reid, P.E.,[22] ran a level profile from Marlette Lake to the Virginia City Tanks for the State of Nevada. The Reid elevations compare closely with the latest topographic maps of the U.S. Geological Survey, and are no doubt correct. His profile indicates that

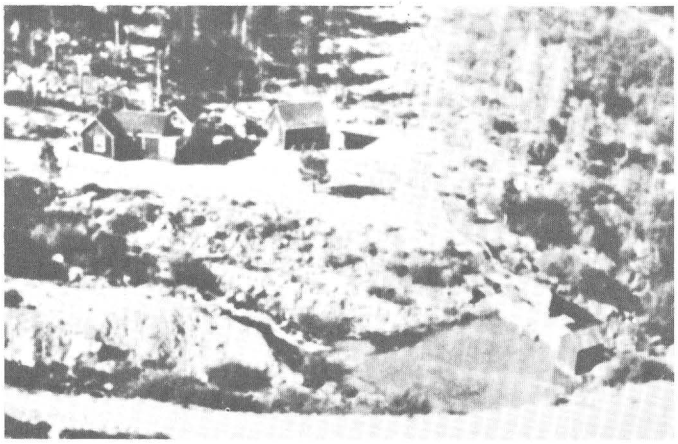


FIGURE 1.—Red House and diversion dam about 1928, located below Hobart Creek Reservoir. Courtesy of Harold Berger.

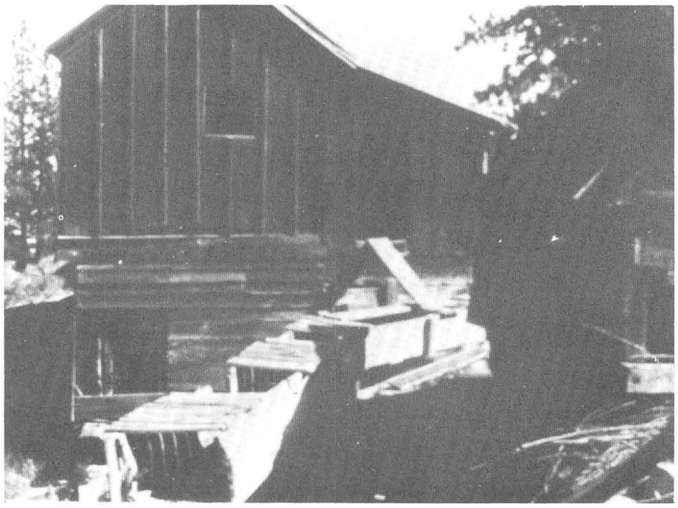


FIGURE 2.—The Tanks, 1969. At this point water entered the inverted siphon. Picture by George Woods. Courtesy of Harold Berger.

the pipe at Lakeview Hill saddle is 1,997 feet below the intake and the outlet end of the pressure pipe is 471 feet below the intake. The pressure head at Lakeview saddle (the vertical distance from the pipe to the hydraulic gradient of the pipeline) was 1,887 feet, giving a pressure of 819 pounds per square inch. The important elevations obtained by Mr. Reid are herewith shown.

| | |
|---|---|
| Marlette Lake | 7,838 feet (high-water line). |
| Hobart Reservoir | 7,554 feet (high-water line). |
| Inlet to pressure pipe | 7,140 feet (Tankhouse, the Tanks). |
| Lakeview Hill saddle | 5,143 feet (lowest point on pipeline). |
| Outlet of pipe | 6,669 feet. |
| Five Mile Reservoir | 6,645 feet. |
| Virginia City water tank | 6,525 feet. |

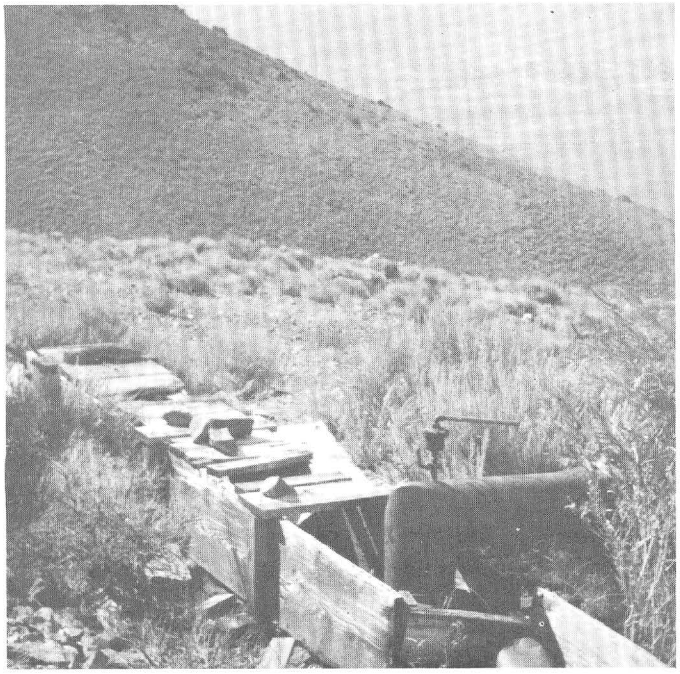


FIGURE 3.—Outlet end of the inverted siphon between Lakeview and Five Mile Reservoir, 1968. Carson City appears in the distance.

FIGURE 4.—The old flume between Five Mile Reservoir and Virginia City and the pipe replacement. Shown is Hobart Leonard, President, Virginia City Water Company.

The construction of the flumes presented no problem, but the engineering problem pertaining to the inverted siphon was of great magnitude, as up to that time no pipeline had been constructed subject to a pressure head of 1,887 feet, or 819 pounds per square inch.

It is likely that one of the reasons the water company desired Mr. Schussler's services was because of his previous experience in the design and construction of pressure pipelines for the Spring Valley Water Works and for the Cherokee Hydraulic Mining Company. For the latter company he designed and supervised the construction of a 30-inch pipeline 12,100 feet long, which crossed a branch of Feather River near Oroville, Calif., and which was subject to a pressure head of 930 feet, or a pressure of about 400 pounds per square inch—about one-half of the pressure of the Virginia City pipeline at Lakeview Hill saddle.

The writer was fortunate to find a very illuminating article concerning the Virginia City pipeline in the December 13, 1873, issue of the *Mining and Scientific Press* in the Mackay School of Mines Library at the University of Nevada. According to the author of the article, the information as well as the illustrations were furnished by Mr. Schussler shortly after the first pipeline was completed. In describing the specifications of the pipe, reference will be made mainly to this article, although the specifications noted by Galloway are similar but not as detailed.

The iron used consisted of 10 different numbers of the Birmingham gauge, graduated from No. 16 (0.062 inch) to No. 0 (0.312 inch). The firm of McCrindle and Company of San Francisco furnished the Scotch iron, which was shipped from Scotland in plates 3 by 10 feet. The George C. Johnson & Company of San Francisco furnished the rivets, which were of American manufacture. The contract for fabricating the pipe was awarded to the Risdon Iron and Locomotive Works, also of San Francisco. This company had made most of the iron pipe in use at that time in the hydraulic mines in California, especially when high heads were needed.

The *Mining and Scientific Press* article stated that ". . . after three months use, the pipe has proved wonderfully successful. It is worthy of remark, as showing the kind of pipe turned out by the Risdon Works, that there was absolutely no leakage in the pipe joints, it only occurring at the lead joints where the pipes are joined together."

The pipe lengths, having an average inside diameter of 11½ inches, were fabricated at the Risdon Iron and Locomotive Works by cutting the plates and rolling them into a cylinder and lapping the edges an amount sufficient to permit two lines of rivets to be driven, thus forming a "double riveted" longitudinal joint. The sections thus formed were about 36 inches long and were joined to form individual lengths of pipe 26 feet 2 inches long. The transverse, or circular, seams between the 36-inch sections were overlapped and single riveted. At one end of each pipe length a nipple 6 inches in width was riveted, with 3 inches projecting beyond the pipe. Joints between sections in the field were made by placing a wrought iron ring, 5 inches wide and of sufficient diameter to leave a space of three-eighths of an inch between the inside of the collar and the outside of the pipe. This space was filled with lead and calked to make a tight joint. A total of 35 tons of lead was required to seal the joints in the field. The total weight of the pipe in place was given as about 700 tons. Figure 6, copied from the *Mining and Scientific Press*, shows the lead joint in detail.

All the iron pipe used was coated, inside and out, with a mixture of asphaltum and coal tar, thoroughly boiled together. Each separate length of pipe was plunged and rolled about in a batch of this mixture for 7 to 10 minutes before being shipped. The fabrication of the pipe commenced in March 1873, and it was in place and water was flowing 5 months later.

The pipe was shipped to Reno on the Central Pacific Railroad and thence to Lakeview by the Virginia & Truckee Railroad, which had only completed the section from Reno to Carson City on August 24, 1872. The first section of pipe was laid June 11, 1873, and the last on the 25th of July of the same year. The laying of 7 miles of 12-inch pipeline over very rough terrain in just 6 weeks was obviously a remarkable feat, keeping in mind that the motive power was men and mules. Schussler's original specifications called for a trench 4 feet deep in which to lay the pipe, although DeQuille gave the depth as 2½ feet. Probably this varied, depending on the hardness of the material the trench penetrated. No doubt much of the trench was dug prior to the arrival of the pipe. The 14.32 miles of wooden flumes, together with the diversion works on Hobart Creek, were also ready to convey water as soon as the pipe was laid.

DeQuille wrote that the course of the pipeline was surveyed in the spring of 1872. The Risdon Iron and Locomotive Works was furnished with a diagram of the elevations and the course on which the pipe was to be laid. Each section of pipe was accordingly made to fit a certain spot. Where the route lay around a point of rocks, the pipe was made to fit the required curve, and other curved sections were required where the line crossed deep and narrow ravines. There was just one place and none other for each section of pipe as received from the iron works.

At each point where there was a depression in the pipeline, a blow-off valve was installed for the removal of any sediment and on the top of each ridge an air valve was placed for blowing off the air when the water was first let in and at other times when the pipe was filled. The so-called air valves were also designed to admit air, should a break occur in the pipeline below the air valve, and within its district. This device would thus prevent a vacuum and a collapse of the pipe. There were 14 air valves and 15 blow-off valves (fig. 5).

Figure 6 shows an example of the elbow designed for the purpose of making short curves in the line of the pipe around rocky bluffs and through sharp canyons. Angle irons were riveted on the pipe on the outside of the curves, which, by means of iron straps, were connected with the corresponding angle iron on the next pipe.

Figure 5 also shows the manner in which the pipes and elbows were strapped together, wherever the curve was sufficiently short to require this precaution against an outward movement. An iron strap was put on the outside of the curve to strengthen the pipe. The elbow, as shown in fig. 5, was made in San Francisco, the angle varying according to the degree of curvature.

Figure 5 shows the profile of the pressure pipe across Washoe Depression and the location of the air valves and blowoffs.

In addition to the special fabrication of the curved portions of the pipe, the foundry also took the pressure differences into account in maunfacturing a particular length of pipe for a particular location. At the point of heaviest pressure the iron used was No. 0 gauge (five-sixteenths of an inch). The water pressure decreased gradually as the ground rose to the east and west from the Lakeview saddle and the iron decreased in thickness from five-sixteenths at the saddle to one-sixteenth of an inch toward both the inlet and the outlet. On its course to the outlet, however, the pipe crossed a great many spurs and sags, and the thickness of the iron was varied to accommodate the changes in pressure.

The *Mining and Scientific Press* stated that although the inlet had a perpendicular elevation above the outlet of 465 feet (Reid's profile indicated a figure of 471 feet) only 300 feet were used, as that head would supply 10 times as much water as Virginia City and Gold Hill had theretofore used. With this head, the pipeline could carry about 2,000,000 gallons per day; by increasing the head to its full capacity, the supply would be increased to 2,350,000 gallons per day. With the water running under a 300-foot head, there was a perpendicular pressure head of 1,720 feet, or about 750 pounds to the square inch at the Lakeview saddle.

Perhaps the reader may be confused by the quote that only 300 feet of available head was used. *Head*, as used here, is the difference in elevation between the intake to the pressure pipe and its outlet. The greater

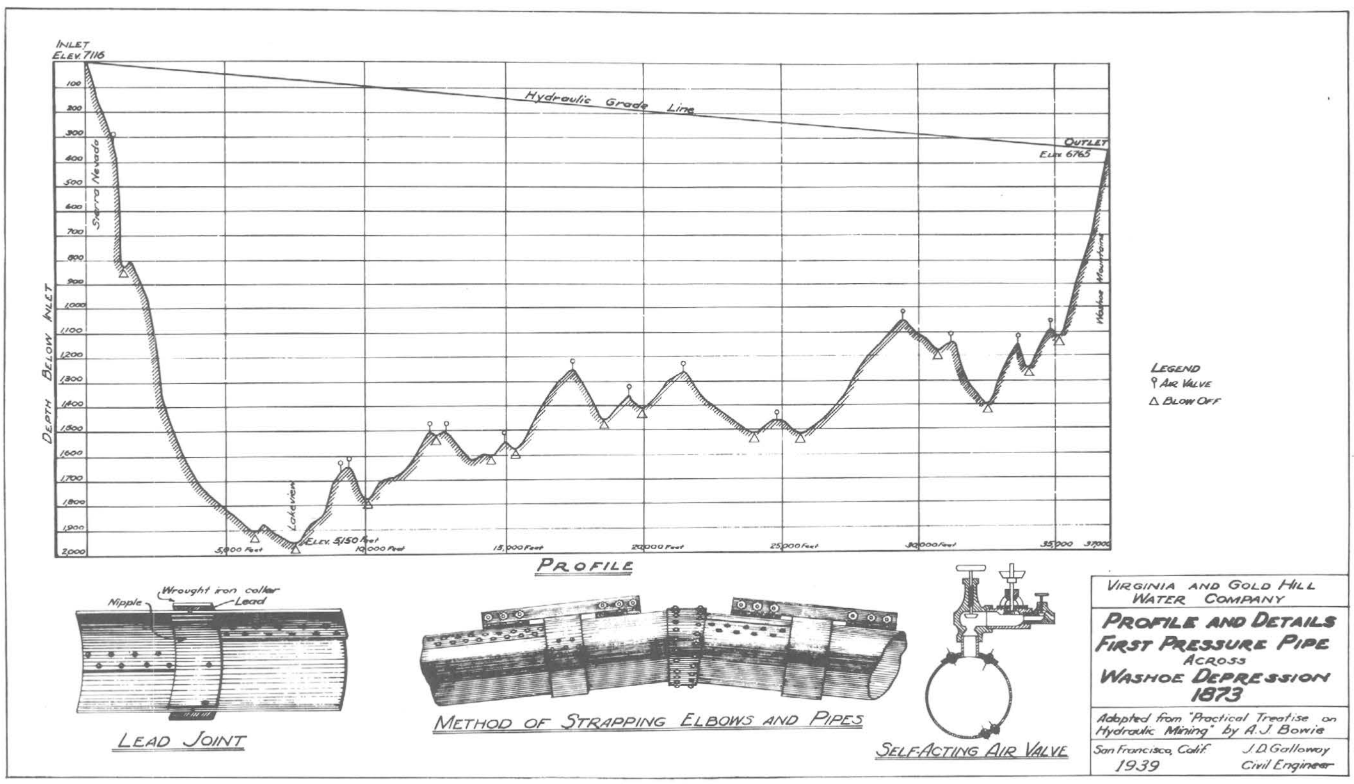



FIGURE 5.—Profile of siphon and location of air and blow-off valves. Courtesy of Nevada Historical Society.

the head, the more water the pipe will carry. As constructed, this difference was 465 feet, but as the water company didn't need the full capacity at first, the inlet at the tank was lowered a vertical distance of 165 feet. With this lowered head, the pipe carried 2 million gallons per day. The need for water increased rapidly, and no doubt within a short time the pipeline was used to its full capacity.

The Risdon Works tested the pipe at the foundry to a maximum pressure of 1,400 pounds to the square inch. After installation, the pipe was tested in place using the full head.

Immediately after the pipe was put in use, some of the leaded joints developed leaks, primarily as a result of the longitudinal movement of the pipe due to expansion and contraction. Captain John B. Overton, who was Superintendent of the Virginia and Gold Hill Water Company, realizing that this trouble would continue, took emergency measures to correct this condition. A clamp was developed that fitted over the 5-inch collar, and when tightened, forced the lead back in place. Then permanent brackets were fitted over the collar. Figure 6 shows the clamp as it was used to force the lead back. A sample of the permanent bracket is shown resting on the pipe. The brackets were 5½ inches long and 3 inches wide, with a 1-inch lip at each end. It took 13 of these brackets for each leaded joint (fig. 7).

According to Davis, Captain Overton hired all the blacksmiths he could find to make the wrought iron clamps.[23] No figure has been found as to the number of brackets which were made, but it well could have been in the thousands.

The newspapers of the period in question often are the best source of information concerning early western history, and in many cases they are the only source. In describing the arrival of Sierra mountain water in Virginia City, the *Virginia Evening Chronicle* carried the following articles:

> July 31, 1873—The Sierra Nevada water was turned on again last evening and reached and ran into the flume for some time, when two leaks were discovered by Engineer Schussler and deeming it unsafe to continue the pressure again caused the water to be shut off for repairs to the pipe. It was his intention to turn the water on again at 2 o'clock this afternoon, and he estimates it will take the pumped fluid six hours to reach Bullion Ravine after it passes into the flume, as the latter is dried up. The water will probably reach the Divide before morning.

> August 1, 1873—Water Works are like brewers yeast hereabouts at this season of the year, when the mercury is up 6,000 feet above the level of the sea. Yesterday the Sierra Nevada water came through the pipe and ran "up the flume" to a point near the Ophir Grade toll house. Then a "sleeve"

FIGURE. 6.—A section of the first pipe that was laid in 1873. The clamp used to force the lead back into the sleeve is shown at the bottom of the photograph. The permanent clamps are shown on the top of the pipe.

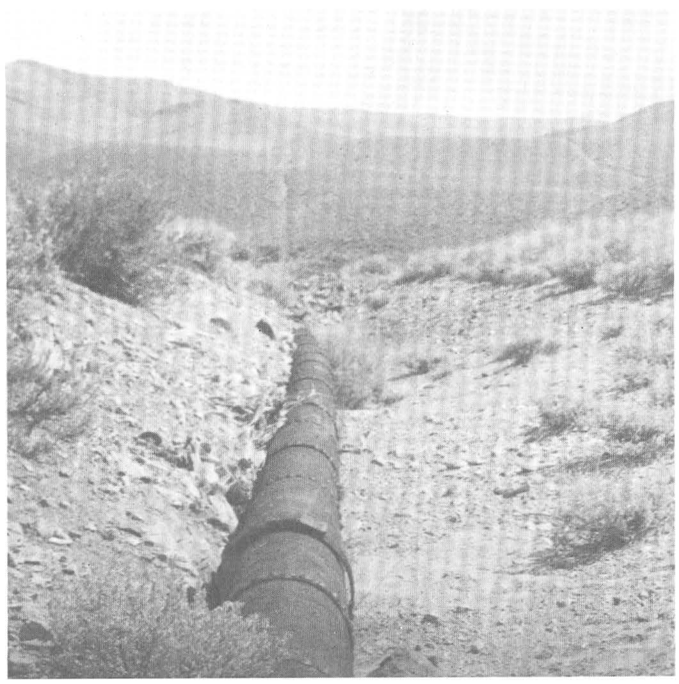


FIGURE. 7.—A section of the first pipeline laid in 1873, still in place between Lakeview Hill and Five Mile Reservoir.

> (the bell portion of the overlapping pipe) gave way and the water was shut off for repairs to the pipe. The water may reach Bullion Ravine late this afternoon and it may not be for several days.
>
> August 2, 1873—The pouring into this city and Gold Hill of a large stream of water from the Eastern Summit of the Sierra Nevada Mountains at 6:45 last evening, marked an epoch in the history of the Comstock, and was the signal for a general jollification and rejoicing of twelve or thirteen thousand people. Bonfires and rockets girdled old Mt. Davidson for hours and cannons continued to roar until a late hour in the night. A stream of 153 inches of water (about 1717 gallons per minute) poured through the flume into Bullion Ravine, between this city and Gold Hill. The water was turned into the pipe on the Sierra at noon yesterday and reached here in six hours and forty-five minutes. It had been estimated that it would take the stream eight hours to reach here, a distance of twenty miles, 134 feet.

The author lives near the foot of Lakeview Hill in Washoe Valley. It is easy to look across the valley, trace the course of the pipeline towards Virginia City, and visualize the scene that took place as the first water entered the pipeline. As described by DeQuille:

> As the water came surging down through the great inverted siphon from the elevated mountain spur and began to fill . . . one after another of the blow-off cocks on the crests of the ridges crossed, opened, and allowed the escape of compressed air. Compared with what was heard when these cocks blew off, the blowing of a whale was a mere whisper . . .
>
> As the pipe filled, the progress of the water in it could be traced by the blowing off of the air on top of the ridges through the valley, and at last, to the great joy of the engineer and all concerned in the success of the enterprise, the signal fire at the outlet, on the summit of Virginia range, was for the first time lighted, showing that the water was flowing through the whole length of the pipe.[24]

About 4 months after the completion of the first pipeline, the *Mining and Scientific Press* observed that "It was an engineering feat of no small magnitude to carry this enterprise to a successful completion; and in view of the difficulties to be overcome, it will attract the attention of engineers all over the world." The same article noted that the Virginia City pipeline was the greatest in the world, and withstood almost double the pressure of the next highest pressure line.

The reader will no doubt be interested in learning more about Hermann Schussler. According to the *Mining and Scientific Press* of December 13, 1873,

> Mr. Schussler was a graduate of the Prussian Military Academy of Oldenburg, of which he was a student from 1859 to 1862, and was promoted to lieutenant on January 1, 1862. In the fall of that year he took leave of absence for 2 years, and during that time attended the civil engineering schools of Zurich and Carlsruhe, for the purpose of perfecting himself in his intended profession of civil engineering. In the fall of 1864 he had his leave of absence changed into a definite leave, and then came to San Francisco where he entered into the service of the Spring Valley Water Works, first as an Assistant Engineer and then Chief Engineer. From that time his career in other large works on the Pacific Coast commenced. He was connected, as consulting engineer, with the Oakland water works, San Jose water works, Vallejo and Stockton water works. He was Chief Engineer of the Marin County water works and then that of Virginia City and Gold Hill. During 1873 he was Chief Engineer of the Sutro Tunnel Company (fig. 8).

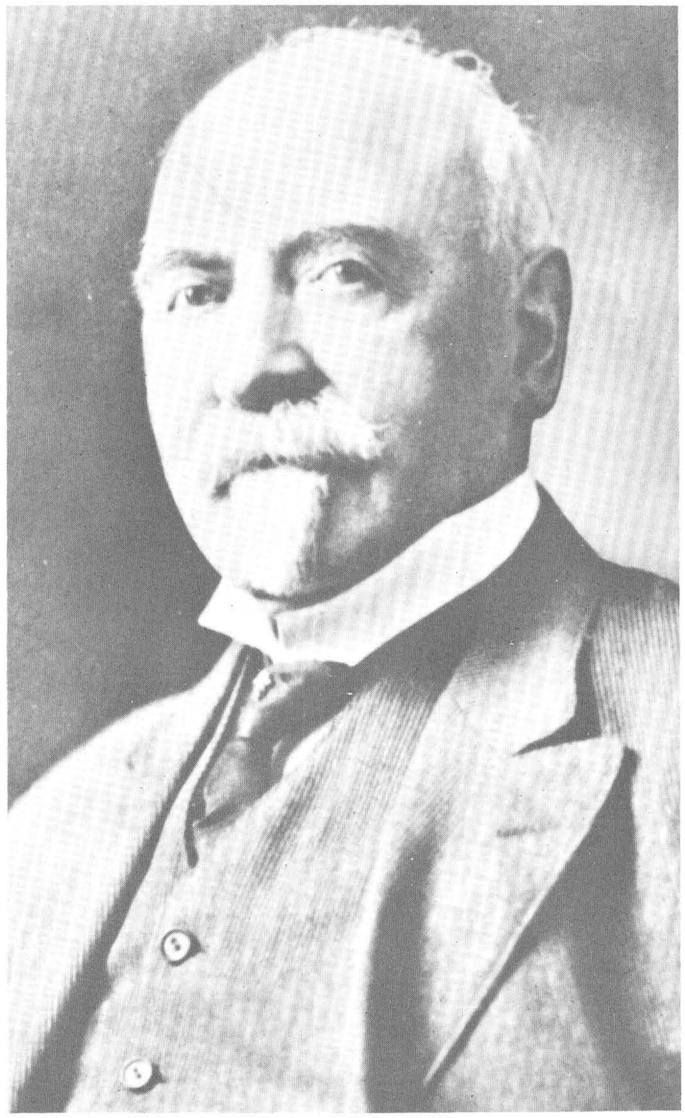


FIGURE 8.—Hermann Schussler, the consulting engineer who designed the 1873 pipeline system. Courtesy of Hobart Leonard.

In addition to the above duties, he was employed partly as consulting engineer and partly as projector in various hydraulic enterprises in California. Mention was made in the article that he projected the Pioche water works in Nevada, where he made a 5-inch pipe of No. 16 iron, 6 miles in length, sustain a vertical pressure of 600 feet. The article mentioned other projects he worked on, and concluded by stating . . ."other undertakings could be mentioned if space permitted, but enough has been given to give our readers an idea of his ability in hydraulic engineering."

In researching the installation of the Tuscarora (Elko County) pipe line, it was noted that Mr. Schussler was employed as a consultant for the Tuscarora Water Company in 1888. Also, as previously noted, Mr. Schussler surveyed the alignment of the Sutro Tunnel in 1869.

Figure 9 shows the essential features of the first pipeline, as well as the two later pipelines and other facilities. This map was prepared by E. D. Boyle, Mining Engineer, in 1913. Mr. Boyle served as State Engineer in 1910 and served as Governor of Nevada from 1915 to 1922. It is to be noted that the 1873 pipeline has the most bends, while the 1887 pipeline is the straightest.

## THE SECOND PIPELINE

Commenting on the water supply of Virginia City, the *Territorial Enterprise* of June 17, 1875, had this to say:

> One of the boasts of Virginia City, Gold Hill and Silver City is, that in this land of barrenness—of shifting sands and burning alkali, they have the purest and best mountain water and plenty of it. Nor is the boast lightly made. There is no place in the world where so many natural difficulties have been overcome and so many triumphs achieved as in bringing the pure, fresh and soft water of the Sierras across Washoe Valley and into the places above mentioned . . . but already is the necessity arising for an increased supply. Mills are daily requiring more and more; the mines an increased supply for steam and other purposes; people are flocking in by the thousands, and manufactures are increasing in proportion. . . .

*The Gold Hill Daily News* of July 1, 1875, also described the need for an increased supply:

> The supply of water for milling and mining purposes has been gradually lessening for the past two weeks and if the utmost economy is not exercised in its use by our people, may continue to do so until even some of our mills may have to suspend operation. During the past week the Virginia Consolidated Mill has lost four hours per day, for the want of a sufficient supply. The Water Company wisely looking forward to such a necessity, has already got the placing of another line across Washoe Valley well under way.

The need for a larger water supply for fire protection was made evident on October 26, 1875, when the major portion of Virginia City and the headworks of the principal mines were burned in a fire that lasted throughout the day. Long before this, and in fact as early as 1873, preliminary plans for another pipeline across Washoe Valley were developed.

It was estimated that during the spring months the flow of Hobart Creek could furnish more than 25 million gallons daily; however, it was not possible to store the excess water, and during the summer months the flow diminished until it dropped to about 700,000 gallons per day. An added supply of water was needed, and could only be obtained from the western side of the Carson Range of the Sierra Nevada above and east of Lake Tahoe.

The *Territorial Enterprise* of August 17, 1875, stated that some idea of the increase in the consumption of water in Virginia, Gold Hill, and Silver City during the preceding few years could be formed from the fact that the amount used in 1875 was 100 times greater than that used in August of 1873. The article also indicated that when the Consolidated Mill started operating that spring, the full capacity of the water company's supply pipe was reached. The article described the new water supply as follows:

> The Company being determined to keep pace with the wants of the community . . . at once set about taking the necessary steps toward laying a new pipe and largely increasing their source of supply. The outlay involved in the improvements will be somewhere in the neighborhood of $600,000. The cost of their present works was $750,000. Ground for the bed for the new pipe was broken on the 1st of May last. The new pipe, which was manufactured by the National Tubing Company of McKeesport, Pennsylvania, is ten inches in diameter and five-sixteenths of an inch in thickness, and welded instead of being riveted together. The joints are constructed so as to be screwed together like gas-pipe, no riveting being required. Messrs. Breed & Crosby, of this city, upon whom developed the business of hauling the pipe from the railroad up the steep mountain sides, have executed their task with commendable dispatch. Nearly all the pipe is on the ground and ready to be placed in position. No haste, however, will be used in laying the same, as the old pipe carries all the water which the Company can at present control.

As described by Galloway, the work was started on the trench May 1, 1875, and the pipeline completed that year.[25] The pipe sections were of wrought iron, 16 feet in length and one-fourth of an inch in thickness; the seams were lap welded and the joints screwed together. The cast-iron sleeves and lead packing used on the first pipeline were being discarded. The pipe was 10 inches internal diameter, and was designed to deliver about 2 million gallons per day, the same capacity of the first pipeline (Fig. 10). The pipeline closely followed the route of the first pipeline but was 1,900 feet longer, according to Galloway. A second flume from Hobart Creek to the inlet tank (The Tanks), 25,005 feet (4.72 miles) long was built parallel to the first flume, and a second tank constructed at the inlet for the pressure pipe. From the outlet end of the two pipelines a second flume, 21,050 feet (3.98 miles) long, was built to Five Mile Reservoir, located about 5 miles from Virginia City. The reservoir had a capacity of approximately 5 million gallons of water (fig. 11). A second flume, 38,670 feet (7.31 miles) long, led from Five Mile Reservoir to Gold Hill and Virginia City. The flume was located above the first flume, high above the city, and extended to Cedar Hill at the north end of the city. Another reservoir, constructed to hold 2,500,000 gallons, was placed on the dividing ridge between Virginia City and Gold Hill.

During the events leading up to the design, construction, and installation of the first pipeline in 1872 and 1873, Herman Schussler was the "man of the hour." He designed the pipeline and supervised its installation. The writer, in carrying on research relative to the second and third pipelines, did not find any further reference to Mr. Schussler in connection with the Virginia and Gold Hill Water Company. The second pipeline, installed in 1875 under the direction of Captain Overton, had an altogether different design from the first line, as noted in the descriptions heretofore given. It should also be noted as a matter of interest that it is this second pipeline which is still in use across Washoe Valley and Lakeview saddle.

Apparently Captain J. B. Overton was not only the superintendent of the water company but also carried the main responsibilities in the development of additional water supplies. The *Territorial Enterprise* of August 17, 1875, made the following comments regarding Captain Overton:

> The controlling spirit in the planning and execution of the present work is Superintendent Overton, a man of tireless energy and limitless resources, who devotes himself with a remarkable self-sacrificing spirit and zeal to the interests of the Company: He superintends, personally, the minutest details of the great enterprise; is apparently everywhere at all times, infusing his own indomitable energy into the men employed on the work, and is the especial terror of shirkers. He does not believe that anything is impossible in combating with the forces of Nature. A modest and unassuming gentleman, he enjoys in a high degree the confidence of the Water Company, and had carte blanche to carry out his plans as seem to him most feasible and best. If the San Francisco Water Company people had half of Superintendent Overton's energy they would, long ere this, have had the water of Lake Bigler (Lake Tahoe) running into their city. Even now, we doubt not, Overton is meditating some plan to steal the waters of the beautiful lake and abduct them to this city.

The work of bringing water that normally drained into Lake Tahoe from the western slope of the Carson Range of the Sierra Nevada to augment the water supply of Virginia City involved increasing the storage capacity of Marlette Lake. From the lake the water was conveyd by flume northward to a tunnel, and from there conveyed to Hobart Creek (fig. 12). Galloway described Marlette dam in this fashion:

> On the western side of the mountains a small lake, named after Marlette, the Surveyor General of Nevada, had previously been made into a reservoir by the Carson and Tahoe Lumber and Fluming Company. That company had built from the lake or reservoir a "V" flume leading southward to Spooner Summit at the head of the main flume down Clear Creek, the water being used for fluming purposes. Arrangements were made by which the Marlette Dam was raised. As completed, the dam was about 213 feet long, 37 feet high, and 16 feet wide on the crest, with battered sides. The exterior walls were of dry rubble masonry with rough coarse laid stones. There is an interior core of earth to provide the necessary impervious element. There are 3,825 cubic yards of masonry and 1,365 cubic yards of earth in the dam. The lake formed is about 1¾ miles long by ¾ mile wide, and is said to contain 2,000 million gallons of water. It lies at an elevation of 8,000 feet above sea level. [26] (See fig. 13.)

From Marlette Lake a flume 14 inches by 30 inches in section and 23,175 feet (4.38 miles) in length leads to the west portal of the water company's tunnel through the ridge which divides the Lake Tahoe drainage from that of Hobart Creek on the eastern slope. The tunnel, excavated in granite, was 3,994 feet long, according to Galloway. Both DeQuille [27] and Thompson and West [28] erroneously give the tunnel length at 3,000 feet. Over one-half of the tunnel was timbered, its size being 7 feet high, 4½ feet wide at the top and 6½ feet wide at the floor. Eliot Lord states that the connection between the two headings was made on May 13, 1877.[29]

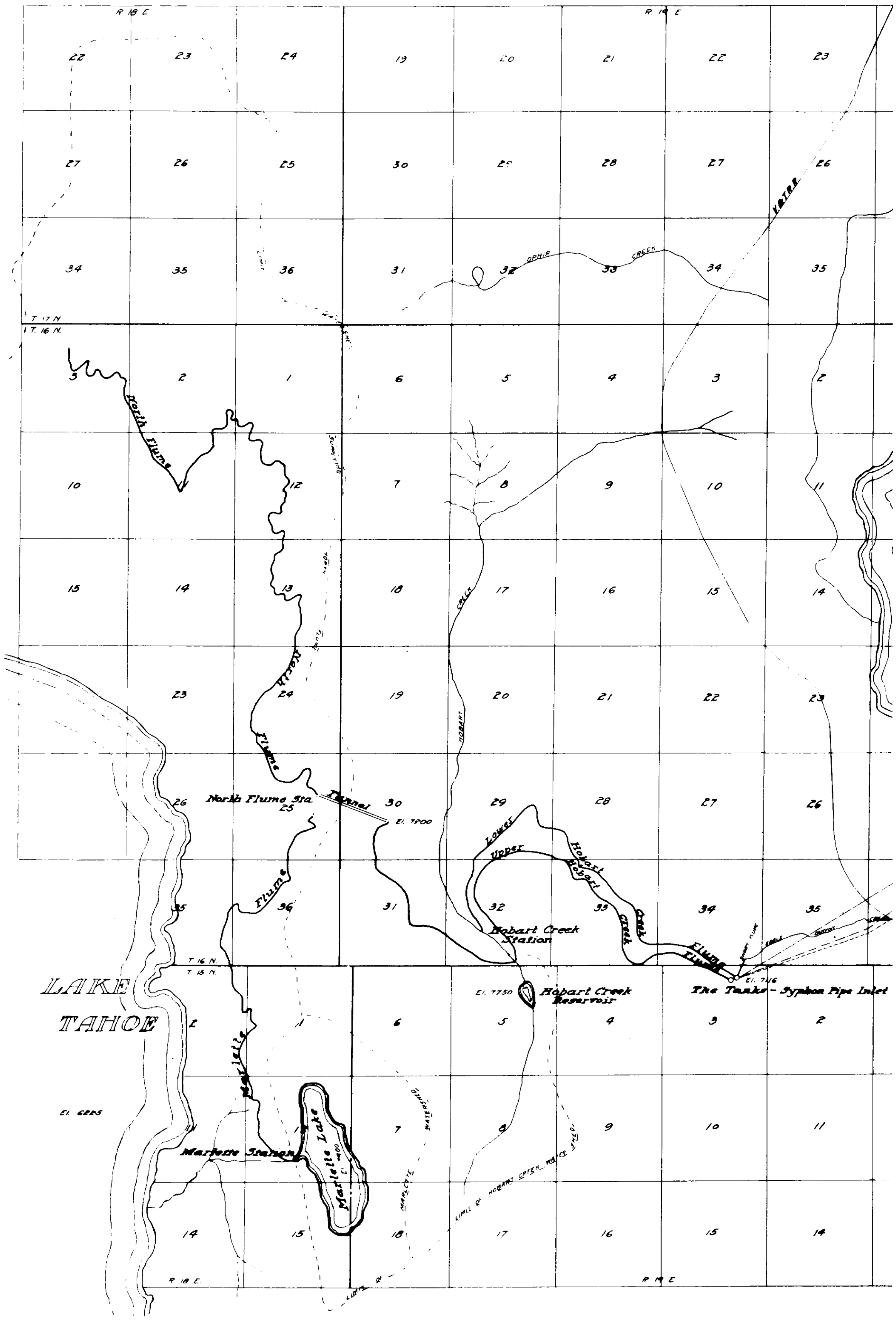
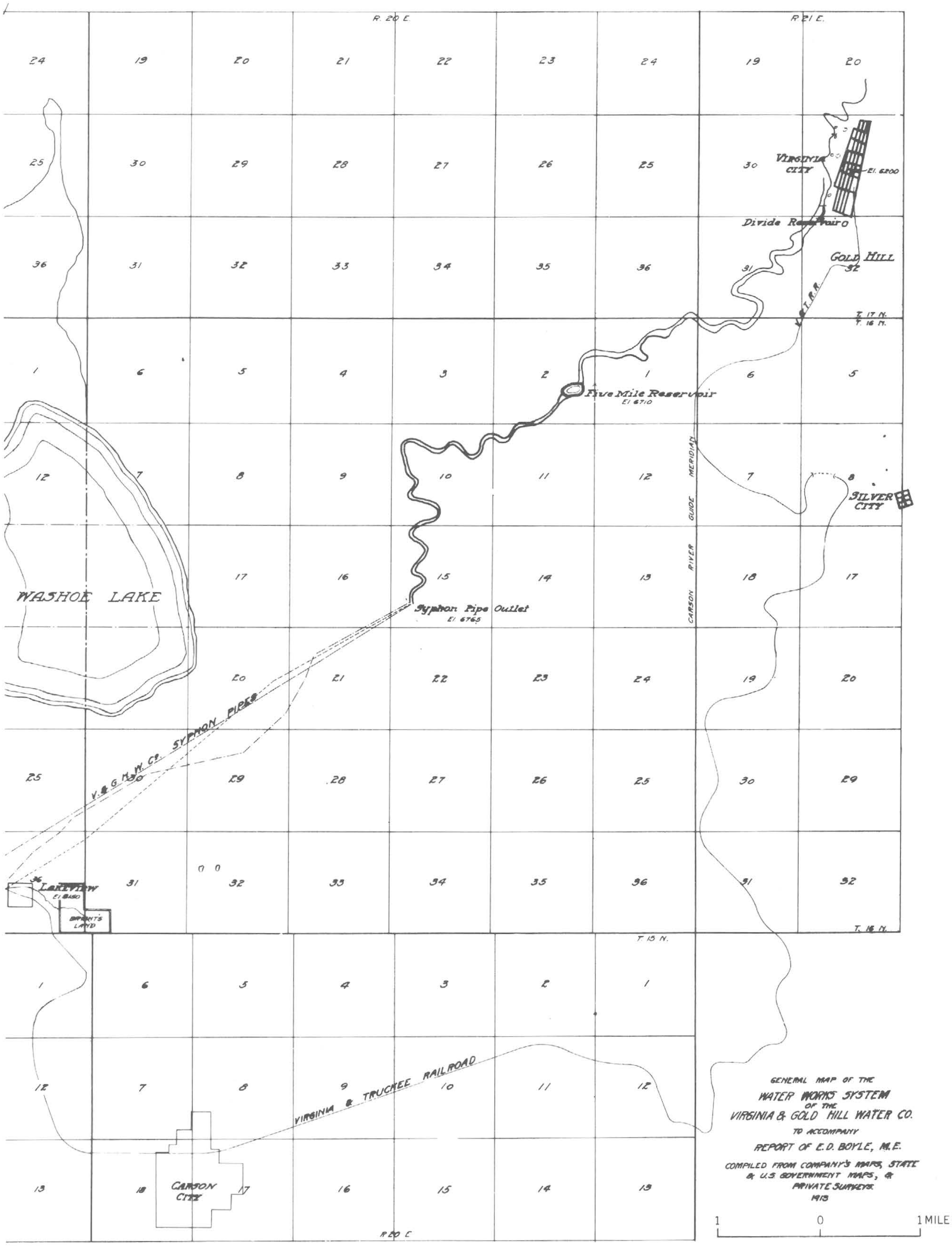



FIGURE 9.—General map of the water works system




of the Virginia and Gold Hill Water Co., 1913.

FIGURE 10.—The screw-joint pipe used in the second pipeline, 1875.

FIGURE 11.—Five Mile Reservoir and the old caretaker's house, 1968.

The August 17, 1875, issue of the *Territorial Enterprise* described the location of the tunnel and the method of construction in the following manner:

> The Company has entered upon the herculean undertaking of getting control of Lake Marlette by running a tunnel through the Sierra Nevada Mountains. The point where the distance through the mountain chain is shortest, and the tunnel could be run most economically, is a high bluff nearly directly west of this city. The tunnel, which will be forty-two hundred feet in length (actually 3,994 feet), pierces this mountain chain at a depth of five hundred feet and is five miles north of Lake Marlette. The reason for the long detour is made from the lake to the tunnel is that a wooden flume can be built at much less expense than tunneling through a mountain. The tunnel, if run directly east from Lake Marlette, would have been four miles in length. . . . The work of surveying the route for the flume and tunnel was performed chiefly by Mr. Alfred Cravens, a young gentleman of acknowledged ability, who has executed his task entirely to the satisfaction of the Superintendent of the Company.

The article went on to say:

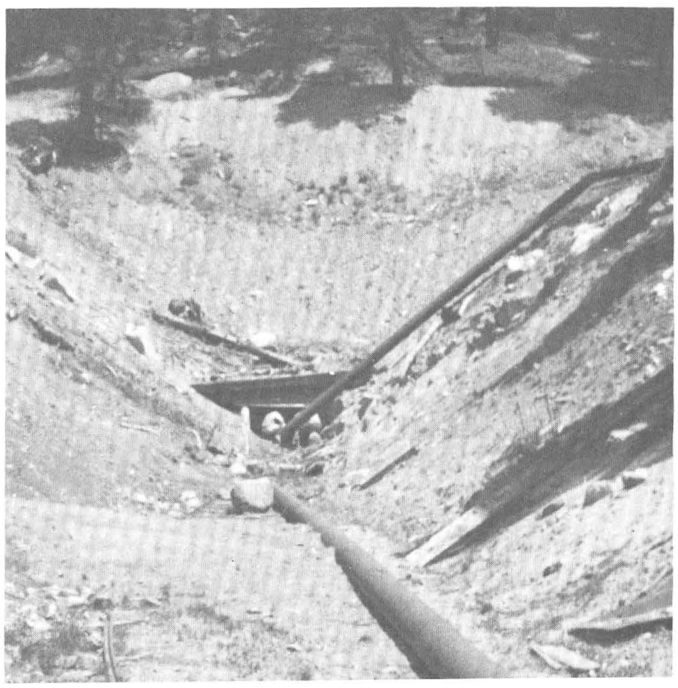


FIGURE 12.—The west portal of the tunnel through the Carson Range of the Sierra Nevada as it appeared in 1968.

> The work of running the tunnel has already been commenced, and is being pushed ahead energetically, all the modern appliances for assaulting mother earth being called into requisition. Tunneling is carried on from both ends under the direction of John Simpson and Thomas Brown, both of whom rank among the best miners on the coast. Power drills of the Rand pattern are used for tunneling purposes. They are driven by compressed air, one engine doing the work for both ends, besides furnishing air for ventilation purposes. In order to carry the compressed air to the west end of the tunnel, the engine being stationed at the east end . . . a string of iron pipe had to be

FIGURE 13.—Marlette Lake, 1920. Courtesy of Harold Berger.

laid over the mountain a distance of over a mile. Through this pipe the air is forced into a receiver stationed at the west end of the tunnel, from which it is drawn at will. About one hundred and fifty feet of tunneling has been completed at each end, and it is thought that the entire work will be finished by next May (1876). . . .

As heretofore mentioned, Lord noted that the connection was actually made May 13, 1877. The *Territorial Enterprise* of July 4, 1877 stated: "Last Saturday the Water Company completed their connection with Marlette Lake and let the water go through for a test." So, even though the second pipeline was laid across Washoe Valley in 1875, no water from Marlette Lake reached Virginia City until about July 1, 1877, almost 2 years later. It would seem likely, however, that the second pipeline carried Hobart Creek water prior to that time. From the eastern portal of the tunnel a flume 14,610 feet (2.77 miles) long conveyed the water to a small diversion pond on Hobart Creek.

In traveling along the pipeline from Lakeview saddle towards the outlet, the writer noted that at a distance of about 1 mile a block of concrete had been poured over the three pipes. This was on a rather barren southern slope, and apparently it was found necessary to anchor the pipe at that point. From looking at the structure, it appears likely that after the installation of the second pipe a concrete block was used to hold the 1873 and 1875 lines. After the installation of the third pipe in 1887 another block of concrete was added (fig. 14).

FIGURE 14.—Concrete block used to anchor the pipeline between Lakeview saddle and the siphon outlet. In the foreground is shown the 1875 pipe; on the far side is the 1887 pipe; and at right lower edge of the photograph the 1873 pipe can be seen. Picture by Allan Shamberger, 1968.

## THE THIRD PIPELINE

The production of silver and gold ore dropped off sharply following 1878 and reached a low in 1881, when only a little more than $1 million worth of ore was mined. This low period of production held somewhat steady until 1887, when production sharply increased. That year it reached a high for the period following 1878, when the value of ore produced amounted to more than $7.5 million.

Virginia City, as well as Gold Hill and Silver City, continued to build new mills, business establishments, and homes, during this 1878–87 period. The September 28, 1878, issue of the *Mining and Scientific Press* in commenting on Virginia City had this to say:

> Population about 25,000 . . . and as written by a prominent journalist of Gold Hill, "it contains more millionaires than absolute beggars."
>
> It has all the features of a great metropolis, hotels, stores, places of amusement, churches, clubs, banks, four or five daily journals, foundaries and machine shops, a railroad with 32 arrivals and departures daily, water works superior to that of any other city in the world furnishing an abundant supply of pure, soft water direct from the springs and snow-fed streams of the Sierras.

The increased activity on the Comstock and the demands for additional water caused the water company to construct a third pipeline across Washoe Valley, and also to develop new sources of water. The *Territorial Enterprise* of July 27, 1887, stated that Captain J. B. Overton, Superintendent of the Virginia and Gold Hill Water Company, had designed and supervised the laying of 7 miles of new iron pipe across Washoe Valley.

This new pipeline was substantially in the same location as the first two pipelines. As described by Galloway, it was made of lap-welded pipe similar to the second pipeline, except that the joints were of the converse lock-jointed type.[30] The pipe walls were three-sixteenths, one-quarter, and three-eighths inch thick; the inside diameter was 11½ inches and the length 37,685 feet (7.15 miles). On one end of each of the 21-foot sections were two knobs, the other end being fitted with a lock-joint sleeve with a layer of lead already in place. On assembling, the end with the two knobs was pushed into the lock joint and turned to secure "a lock." Lead was then poured in to make this a seal. This lock-joint sleeve was patented in 1882 (fig. 15).

In addition to its discussion of the new pipeline, the July 27, 1887, issue of the *Territorial Enterprise* described other work done during the spring of 1887 under the supervision of Captain Overton. A new flume was constructed from the inlet of the three pipelines to Hobart Creek, and the original flume from the east portal of the tunnel to Hobart Creek was replaced by a much larger flume. Also, from the west portal of the tunnel, a new flume would be put in to Marlette Lake.

FIGURE 15.—The pipe at the bottom of the photograph is the type used in the third pipeline, 1887. Next up from the bottom is the type used in the 1873 pipeline. The top section shows the method used in repairing a broken pipe.

In order, however, to increase the water supply substantially, it was determined that a new flume running northward from the west portal of the tunnel along the mountains rimming the east shore of Lake Tahoe was needed. The same issue of the *Enterprise* stated that Captain Overton was then employed in the construction of a new flume, running northwesterly from the west portal of the tunnel a distance of 9 miles to North (Third) Creek, which would tap several streams tributary to Lake Tahoe.

Galloway stated that this flume was 43,523 feet (8.25 miles) long, extending to Third Creek, which was sometimes referred to as North Creek.[31] The airline distance from the tunnel to the start of the flume at Third Creek was about 4½ miles. In addition to the water of Third Creek, the flume picked up water from First and Second Creeks, Mill Creek, Tunnel Creek, Incline Creek, and other small streams along the way. This flume emptied into the Marlette Lake flume at the tunnel's west portal.

The aforementioned issue of the *Territorial Enterprise* of July 27, 1887, stated that to conserve the water

FIGURE 16.—Hobart Creek Reservoir about 1928. The tree stump was and still is the measuring gage. The dam is shown in the upper right. Courtesty of Harold Berger.

supply and to have a reserve to draw upon, a small storage reservoir was being constructed on Hobart Creek about half a mile above where the flume from the tunnel emptied into it. The dam was about 350 feet in length and 20 feet high, and the reservoir so formed held about 35 million gallons, or about 100 acre-feet. This storage represented about a week's water supply for the Comstock (fig. 16). Also, during that same period a new flume was built from the outlet of the pipes to Five Mile Reservoir.

Captain J. B. Overton was in charge of the construction of all the works described herein, and in addition he designed the second and third pipelines after Mr. Hermann Schussler had designed the first pipeline built. Captain Overton, in addition to his responsibilities as Superintendent of the Sierra Nevada Wood and Lumber Company, was responsible for the development of the water supplies as well as being Superintendent of the Virginia and Gold Hill Water Company from 1873 to 1906, at which time Mr. James M. Leonard became superintendent (fig. 17).

The white house at Lakeview Saddle was built about 1873, and Captain Overton, although never living at the house, maintained quarters there until he retired in 1906. The structure is presently occupied by Harry E. "Red" McGovern, who has been in charge of the water system from Marlette Lake to Five Mile Reservoir for many years (fig. 18). Prior to Red's residence at the Lakeview house, it was occupied by Mr. Tom Higgins from 1899 to 1906 and by Mr. Joe Berger from 1906 to 1935 when he retired. The reader will learn a little more about these two men later in this story.

Lord states that to protect the city in case of fire, pipelines aggregating 4 miles in length were laid in Virginia City, Silver City and Gold Hill.[32] These were 2⅔ miles of 10-inch and 1⅓ miles of 8-inch pipe. This pipe belonged to Virginia City, as well as 2½ miles of smaller supply lines. The length of the pipelines belonging to the water company which ran through the streets

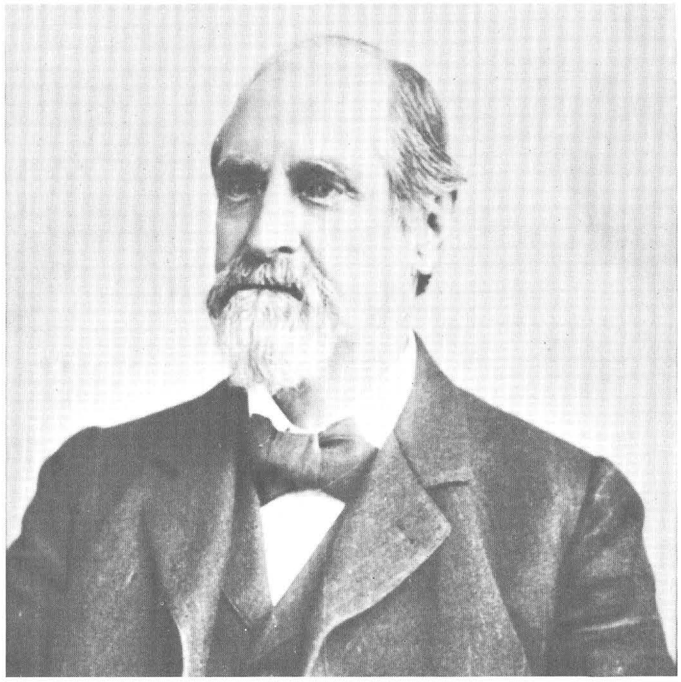


FIGURE 17.—Captain John Bear Overton, Superintendent of the Virginia and Gold Hill Water Company from 1873 to 1906. Courtesy of Hobart Leonard.

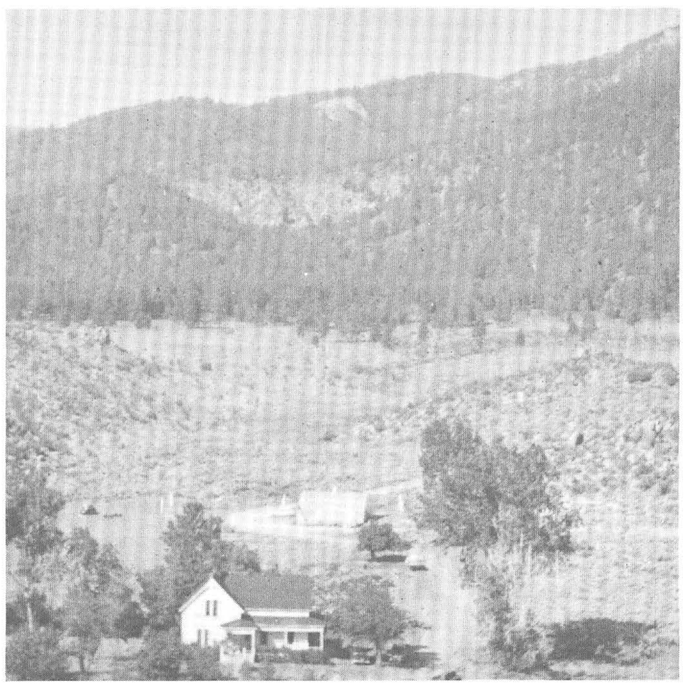


FIGURE 18.—The white house at Lakeview, built about 1873. The Sierra Nevada looms in the background.

of Virginia City, Gold Hill and Silver City was 14 miles, and through this system of pipes and flumes 4,200,000 gallons of water was distributed daily through the towns on the lode, the mine works consuming two-thirds of the supply. Galloway mentions that three large wooden tanks, each holding 30,000 gallons, were built on the line of the flume above the cities, and in addition, there were large storage tanks at the numerous mines. Also on the high ground of the "Divide" between Gold Hill and Virginia City, a distribution reservoir was built with a capacity of 2,500,000 gallons. The water rates in 1880 were 20 cents per 1,000 gallons to the mining companies and $4 per month to families of six or eight persons. Eliot Lord, quoting from a statement by J. B. Overton, gave the total cost of the water company's plant, including flumes, dams, reservoirs, pipes, water rights, litigation, etc., as $2.2 million.

## RECAPITULATION OF WATER WORKS, 1873–1887

The extent of the water-supply system is shown in the following recapitulation. The writer can only echo the statement made by Galloway that "as built, the water supply was a notable addition to the art of water supply engineering."

| Supply line and year | Flumes to inlet of pressure pipe (miles) | Pressure pipe inside diameter and length (inches and miles) | Flume from outlet of pipe to Five Mile Reservoir (miles) | Flume from Five Mile Reservoir to Virginia City (miles) | Divide tunnel (feet) |
|---|---|---|---|---|---|
| First, 1873 | 4.62 | 11½, 7.0 | 4.04 | 5.66 | ------- |
| Second, 1875 | [1] 2.77<br>[2] 4.72<br>[3] 4.38 | 10, 7.32 | 3.98 | 7.31 | 3,994 |
| Third, 1887 | [4] 8.25 | 11½, 7.15 | ------- | ------- | ------- |
| Total | 24.74 | 21.47 | 8.02 | 12.97 | 3,994 |

[1] Flume from east portal of tunnel to Hobart Creek.
[2] Flume from Hobart Creek to inlet pipe.
[3] Flume (14"×30") from Marlette Lake to west portal of tunnel.
[4] North flume, starting at Third Creek north of Incline, to west portal of tunnel.

| | |
|---|---|
| Total length of pipelines | 21.47 miles. |
| Total length of flumes | 45.73 miles. |
| Tunnel length | 3,994 feet. |
| Marlette Lake capacity | 6,154 acre-feet. |
| Hobart Creek Reservoir | 100 acre-feet. |
| Five Mile Reservoir | 15 acre-feet. |

## WATER-RELATED EVENTS, 1861–1894

While this is intended to be a factual history of the development of the water supply from the Sierra for the Virginia City area, there were other events taking place in which these waters were utilized. These events were of importance to the early development of the Comstock and are worthy of being briefly related here:

1. The use of the water from the north flume to float lumber via a V flume from the incline tramway on Mill Creek through the tunnel to Lakeview.
2. The Sutro Tunnel.
3. The use of water from the Virginia and Gold Hill Water Company's system for the development of power at the C & C shaft and the Chollar shaft at Virginia City by means of Pelton Wheels.
4. Development of electricity for town use by the Virginia City Electric Light Company.
5. Pumping water from the deep mine shafts on the Comstock.

## The Sierra Nevada Wood and Lumber Company

The history of this company has been rather well documented by E. B. Scott in his *The Saga of Lake Tahoe*, 1957; in David F. Myrick's *Railroads of Nevada and Eastern California*, 1962; and in John D. Galloway's *Early Engineering Works Contributory to the Comstock*, 1947. The author will borrow heavily from these three authorities in recounting briefly the details pertaining to this lumber company.

The Sierra Nevada Wood and Lumber Company was organized by W. S. Hobart and Seneca H. Marlette in 1878. Captain John Bear Overton, the Superintendent of the Virginia and Gold Hill Water Company, was appointed General Manager, and until the cessation of the lumber company's operations at Lake Tahoe in 1896, he served in this dual capacity.

This company was one of the three major lumber companies supplying the Comstock during the period of greatest demand for cordwood and lumber. By 1880 a steam-powered sawmill was completed about half a mile from the shore of Lake Tahoe, on Mill Creek, and about 1 mile easterly of what is now known as Incline. Galloway states that the tunnel and water flumes of the Virginia and Gold Hill Water Company furnished the basis for the plant of the Sierra Nevada Wood and Lumber Company.[33] At a point on the north flume about 1½ miles from the western portal of the tunnel the mountainside is very steep. It was here that the company built a double-track tramway from near the mill, up the mountainside to the vicinity of the water flume. Scott terms it the Great Incline of the Sierra Nevada. He describes this structure as follows:

> A double track narrow gauge-tramline, 18 feet in over-all width, was engineered by Captain Overton to run straight up the side of the mountain east of the mill. Cross ties spiked to a solid log bed carried the rails on which the lumber and cordwood cars were to operate, with the cars canted at at angle so that a near level inclination could be

maintained on the steep grade. From the staging yard adjoining the mill, a spur track feeder line ran southeast one-eighth of a mile to join the tramline near its base. Here the carriers were loaded for the trip up the 4,000 foot-long, 1,400-foot vertical lift to the V-flume running below the granite outcropping that anchored the top of the structure. Three-quarters of the way up the mountain, an eight-foot rise in every twelve was encountered, giving a 67 percent track gradient.

The machinery and equipment consisted of more than 8,000 feet of 1⅛-inch endless wire cable fed around two massive 12-foot diameter, eight-spoked bull wheels. The wheel at the summit was driven by a gigantic sprocket and gear turned with a 40-horsepower steam engine embedded into a granite-walled powerhouse. Ten- by twenty-inch timbers were bolted to solid rock and secured with iron rods and ring bolts to support the weight of the terminal wheels, with the cable ambiguously described as "running near the tops of the cars and hitched on top of the hind ends."

The V lumber flume paralleled the water company's flume and the latter furnished water for the transportation of the lumber and cordwood. The V flume extended through the 3,994-foot water company tunnel and thence descended about 2,500 feet to a lumberyard at Lakeview. In passing through the tunnel the lumber flume was located directly above the water-supply box flume to Hobart Creek.

Red McGovern told this writer that, according to reports he had heard, when the V lumber flume was in operation, the water from the north flume (Third Creek) was used during the day to transport lumber, and during the night the water was commingled with Marlette Lake water and went to Hobart Creek and thence to the Virginia City area.

The lumberyard at Lakeview was located just south of the Lakeview house. The Virginia & Truckee Railroad main line passed a few feet west and south of the house, and spurs were built to the lumberyard.

About the only evidence left of the Sierra Nevada Wood and Lumber Company's operations at Lake Tahoe is the path of the Incline Great Tramway, and at the top there still remains one of the massive bull wheels which carried the endless cable.

Myrick states that initial timber cutting by the Sierra Nevada Wood and Lumber Company was made about a mile north of Crystal Bay. To service the area, a 1½-mile narrow-gauge railroad was constructed in the spring of 1881. Later the rails were extended several miles both northerly and southerly, the southerly terminus being at Sand Harbor. Logs were assembled in V-booms at Hobart, at the south end of Lake Tahoe, and rafted nearly 20 miles to Sand Harbor, where they were loaded on the narrow-gauge cars and conveyed to the sawmill.[34]

The V lumber flume was continuous from its start at the top of the Incline Tramway through the tunnel and thence to Lakeview, a distance of about 10 miles.

According to McGovern, and apparently for inspection purposes, a special type of float was constructed to convey a person or persons in the V flume through the tunnel and thence down to Lakeview. The speed of the float would depend on the amount of water used in the flume. This, no doubt, was a thrilling adventure for those who dared brave such a ride—especially if a full charge of water was used.

Myrick wrote that the last major season of the lumber company's operations at Lake Tahoe appears to have ended in the fall of 1894 and that the railroad was abandoned shortly thereafter. However, Scott indicates that 1896 was the last year of Sierra Nevada Wood and Lumber Company activity there.[35]

The *Territorial Enterprise* of December 2, 1887, quoting Captain Overton, stated that during the 8-month period from April to November 1887, the mill produced 12 million feet of lumber, all of which was flumed to Lakeview. E. B. Scott gives a total production figure for the Sierra Nevada Wood and Lumber Company's Tahoe operation, starting with 1879, as approximately 200 million feet of lumber and more than a million cords of wood. Most of this went underground to shore up the galleries of the Comstock Lode, or vanished into the fire boxes of the hoisting works at the mines, and the Cornish steam pumps that cleared the mine sumps of water at Virginia City. Thousands of cords of wood also disappeared through the balloon and diamond stacks of the Central Pacific and Virginia & Truckee Railroads' locomotives.

The V flume of the Sierra Nevada Wood and Lumber Company is mentioned here because of its relation to the Virginia and Gold Hill Water Company's facilities. However, the reader should remember that there were at least 10 V lumber flumes in operation on the eastern slopes of the Sierra Nevada. Galloway, quoting from an early Surveyor General's report, stated that in 1869–70 there were 25 miles of flume in Ormsby County. During the period 1879–80, there were 10 flumes in Douglas, Ormsby, and Washoe Counties, totaling more than 80 miles in length, which annually transported 171,000 cords of wood and 33 million board feet of lumber.

## The Sutro Tunnel

In discussing the Sutro Tunnel it is not intended to record the full history of this undertaking as it has been well documented in many publications.[36] The author will only outline enough of the facts pertaining to this great undertaking to enable the reader to understand the tunnel's primary function—namely, the drainage of water from the deep shafts on the Comstock Lode, and their better ventilation. The tunnel was also utilized as a means of getting rid of the water pumped from below the tunnel level, thus eliminating the extra pumping distance from the tunnel level to the surface, a distance of about 1,600 feet.

Up until 1861 little difficulty was experienced with water in the sinking of shafts on the Comstock; however, with the increased depths, water became a great problem. Not only did the water problem increase with depth, but adequate ventilation of the mines was the most difficult of all problems from the very beginning. It was not until the Root blowers were introduced in 1865 that there was some relief from the air problem. Both the air and water increased in heat and foulness with depth, and in this early period more men died from extreme heat and foul air than from any other cause.[37]

In order to drain the shafts, several tunnels were constructed prior to the Sutro Tunnel. In 1861 the Latrobe Tunnel and Mining Company constructed a tunnel under contract with the mining companies whose ground it would penetrate. These companies agreed to segregate a portion of their claims adjacent to it in compensation for drainage and prospecting. The tunnel started at a point a little more than half a mile east of Virginia City, and it was estimated that it would strike the Comstock at a horizontal distance of somewhere near 3,000 feet and at a depth of about 600 feet below the outcropping.[38] In 1864 this tunnel, 2,800 feet in length, tapped the Sides and the White & Murphy (which later became the Consolidated Virginia Company) lode on its dip at 700 feet. A drift was run to drain the nearby Central and Ophir mines.[39]

In 1862 the Cedar Hill Tunnel and Mining Company undertook a similar work, but after tunneling about 2,000 feet, the project was given up. However a more important enterprise was inaugurated by the Gold Hill and Virginia Tunnel and Mining Company in 1863. The plan was to begin at a point in Gold Canyon near Silver City and run a tunnel the entire length of the lode to the Ophir mine, which it would intercept at a depth of about 1,000 feet, and a horizontal distance of 15,000 feet. Work on this tunnel had been in progress nearly a year when the exhaustion of all the upper ore bodies on the lode and the failure to discover any new ones rendered the outlook for the mining industry so disheartening that capitalists refused to put more money into the scheme. Accordingly, the work was suspended, and was never resumed.[40]

The October 25, 1925, issue of the *Carson Daily Appeal* contains a letter addressed to the editor from Alfred Chartz, in which some of the early Comstock water tunnels were discussed. Mr. Chartz stated that the first tunnel excavated was the Mint Tunnel, which tapped springs at a depth of 500 feet below the collar of the Hale & Norcross mine, and which was run about 1863. Then he mentioned a tunnel that was excavated in the early days, located at the mouth of Daney Canyon, which was driven a length of about 1,100 feet. This may be the same tunnel mentioned previously which was started by the Gold Hill and Virginia Tunnel and Mining Company, as Daney Canyon lies below Silver City. Recently the author was shown the portal of the Daney Tunnel by F. N. Dondero, of Carson City, who has mining property in that area and who probably hauled in the last ore milled at the Sutro Mill prior to shutting down its operation. The ceiling of the portal is crushed down and overgrown with brush; a small stream of water was coming out at the time of our visit.

Any history of the Sutro Tunnel would be incomplete without at least a short discussion of colorful Adolph Sutro, the tunnel's instigator and builder. Adolph Heinrich Joseph Sutro was born in Aachen, Prussia, April 29, 1830. At the age of 20, he, along with his family, sailed for New York. After a few months he left his family in New York and sailed for San Francisco, arriving there November 21, 1850. Within 4 years he owned several stores in San Francisco, dealing primarily in imported tobaccos. In 1859 he made his first trip to the "Washoe country" and was greatly impressed by the Comstock, then in its infancy. While there, he came to the conclusion that he could invent a better way to treat quartz ore. With the help of a chemist, he developed a process which they were confident would work.[41]

In about 1862 Sutro again went to Washoe (Virginia City) to look for a place to establish a reducing mill. He found a good mill site at Dayton, and by 1863 he had a substantial establishment there, with eight stamps and 20 amalgamating pans.[42] It was during this period that his thoughts developed pertaining to a long tunnel to drain the mines on the Comstock.

The matter of running a long tunnel to the Comstock Lode at a lower depth with an outlet near the Carson River was the subject of a great deal of discussion and editorial comment during the early days of the Comstock. Adolph Sutro, while probably not the originator of the idea, supported a plan and immediately proceeded to promote it. The obstacles confronting Sutro appeared to be almost insurmountable, but not to him. He was a combination of many things: a dynamo of energy, a great promoter, a great speaker (although he spoke broken English), and a fighter. He was hated by many, and loved by others.

His proposed project involved the drilling of a tunnel 20,000 feet long starting near the toe of the range of hills westerly from Dayton, and with the mouth of the tunnel about 150 feet in elevation above the Carson River. The plans called for the tunnel to cut the Comstock Lode about 1,600 feet below the surface.

The Sutro Tunnel Company was incorporated by an act of the Nevada State Legislature, approved February 4, 1865. This act granted an exclusive franchise to construct and operate the tunnel for a period of 50 years. Other provisions were that the mouth of the tunnel was to be located between Corral Canyon and Webber Canyon, that shafts were to be sunk along the course of the tunnel, and that the tunnel was to be started within 1 year from the passage of the act and completed within 8 years. Neither of the latter two provisions were met.

At that time the title, or fee, to the land was in the United States Government, and an act of Congress was necessary to enable Sutro to obtain the necessary easements. Sutro visited Washington and obtained the support of Senator Stewart, and on July 25, 1866, a bill, commonly known as the Sutro Tunnel Act, was approved, which became the first Federal law to provide for a location and patenting of mining claims on public lands. The Act, in addition to other provisions, empowered Mr. Sutro to purchase 4,357 acres of land at the tunnel mouth and to claim ownership of the mines within 2,000 feet on either side of the tunnel, excepting, of course, the mines on the Comstock Lode.[43]

Mr. Sutro was able to secure contracts in April 1866 from 23 of the principal mining companies, which represented 95 percent of the stock-market value of the Comstock Lode at the time. By these contracts the companies which signed the articles of agreement bound themselves to pay the sum of $2 for every ton of ore extracted after the extension of the tunnel and its lateral drifts had reached designated points.[44] A survey of the tunnel was made by our old friend Schussler, and work commenced on the tunnel October 19, 1869.[45]

The surface survey was marked with cast iron posts. Each post was firmly placed in the ground and its top was weighted. A circular hole was machined in each top and a brass plug 1½ inches in diameter inserted. The posts marked the course of the tunnel and were referred to as "The Line." [46]

The tunnel was completed July 8, 1878, a construction period of 8 years, 8 months and 19 days. On that day a connection was made with a short east drift from the Savage mine at a depth of 1,640 feet. The length of the tunnel as finally completed was 20,498 feet and for the greater part of the distance the tunnel, inside the timbering, was 7 to 7½ feet in height, 8 feet wide across the top, and 9 to 9½ feet across the bottom.

Lateral tunnels to drain the various mines along the Lode were then started; in the course of several years the north lateral, 4,403 feet in length, reached the Union shaft, and the south lateral was extended 8,423 feet to the Alta shaft.

It was planned to construct four vertical shafts along the line of the tunnel, so that the excavation of the tunnel could be carried on at eight different faces. These shafts were located in November 1871. The first was 4,915 feet from the mouth of the tunnel, at a vertical distance of 522 feet above the tunnel level; the second was 4,150 feet farther along, and its depth to the tunnel level was 1,041 feet; the third shaft was 4,490 feet from the second one, and its depth to the tunnel level was 1,361 feet. The fourth shaft was 17,695 feet from the tunnel entrance. In addition to the four shafts, a small air shaft was completed in the summer of 1872. It was situated 2,250 feet from the tunnel mouth, and had a depth of 211 feet to the tunnel level.[47]

Difficulties with water in both the third and fourth shafts caused them to be abandoned. In the first shaft, after 18 months of labor the tunnel level was reached, and drifts both east and west were started, the former in due time connecting with the tunnel header. At the second shaft, water was encountered, and pumps had to be placed in position. The tunnel level was reached in the spring of 1874. East and west drifts were then started, and when the former had reached a distance of 171 feet and the latter 170 feet a large body of water was encountered, filling the tunnel and shaft with water. This caused a delay of several months, but eventually work was resumed on the headings.[48]

During the first 5 years progress on the tunnel was slow. The monthly distance completed averaged 105⅕ feet in 1873; in 1874 223⅓ feet per month. At the close of 1874 some 8,079 feet of the tunnel had been completed. In 1874 Burleigh Drills, operated by compressed air, were put in use, and this greatly speeded up the work. In 1875 the tunnel advanced 3,728 feet, and the average footage completed per month increased to 310⅔ feet. As heretofore stated, the tunnel made a connection with the east drift of the Savage mine on the 1,640-foot level. On July 8, 1878, the Savage mine water, which heretofore had to be raised 2,200 feet to the surface, had then only to be raised 600 feet to the tunnel level.[49]

It is interesting to note that during the early history of the tunnel horses were tried for pulling the cars

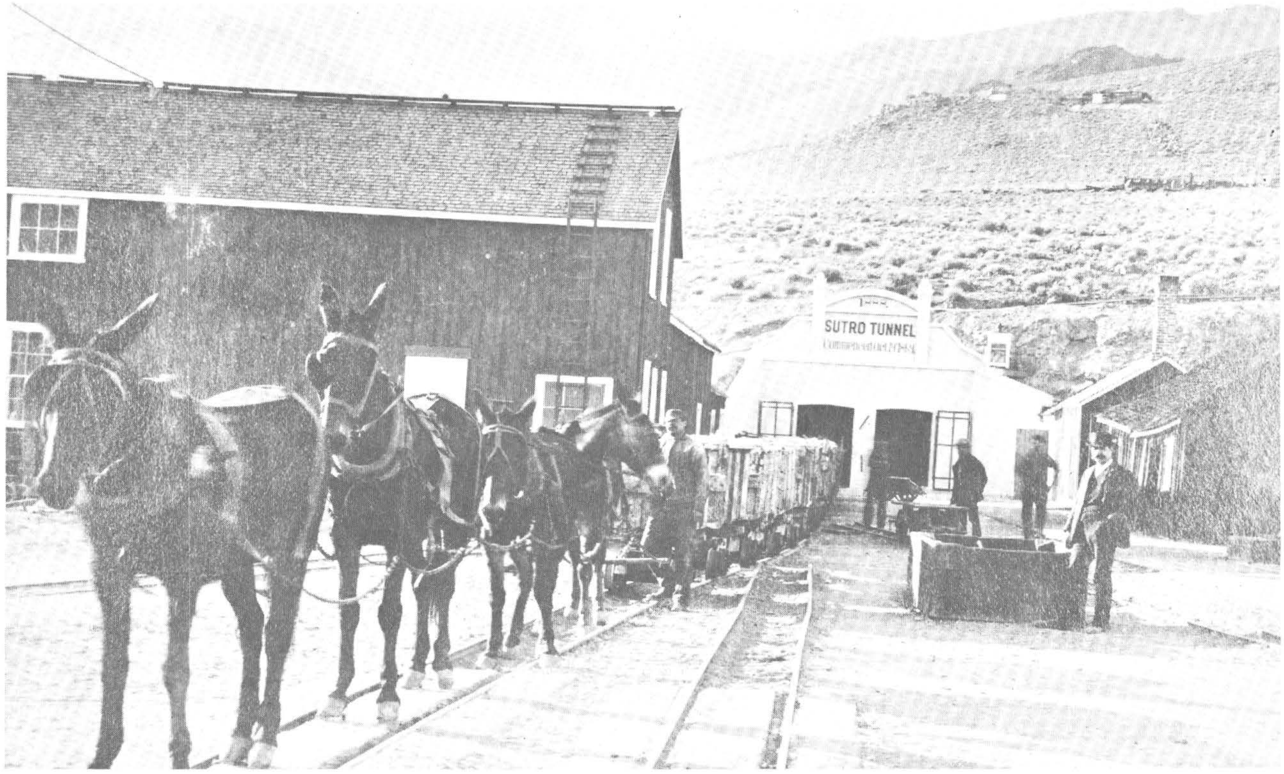



FIGURE 19.—Mules used in the construction of Sutro Tunnel. Courtesy of Nevada Historical Society.

loaded with waste rock. However when anything touched a horse's ears, the horse would throw up his head, hitting the overhanging rock and hurting his skull. Mules, on the other hand, would drop their heads and avoid injury (fig. 19).[50]

The cost of the tunnel was $2,096,566, not including the cost of the laterals or expenses of management of the company.[51] The laterals, amounting to about 12,800 feet of tunnel 8 feet in width by 7 feet in height, probably cost another million dollars.

Thompson & West state that the cost of the tunnel itself was about $4,500,000 and the total cost, including lateral branches up to and including March 1, 1881, was $5,069,801.16.[52]

Sutro had many supporters among the mine owners, including William Sharon, during the early construction period; however, later on disputes arose, and a bitter fight broke out between the two. The mine owners refused to pay the royalty of $2 per ton of ore mined, and Sutro was forced to reduce the royalty to $1 a ton. Shortly after this he sold out and retired to more pleasant activities at San Francisco.

Eliot Lord states that in 1880 the tunnel drained some 3,500,000 gallons of water daily and that during the year 1,277,500,000 gallons of water, or 4,752,605 tons, drained through the tunnel. Much more was expected after the laterals were fully completed.[53]

During the 50 years following the completion of the tunnel and its various laterals, the Gold Hill mines, with hot waters of 150°, were automatically drained through the Sutro Tunnel. In the Virginia City mines, the water stood about 100 feet below the tunnel after 1884, except for a brief period after 1900, when the north end mines were pumped out to the 2,500-foot level.[54]

In 1872 Sutro laid out a townsite near the mouth of the tunnel, which he named Sutro. It was to be a model town, with the main east and west thoroughfare, named Tunnel Street, lining up with the tunnel. This street was to be 200 feet wide; the other east-west streets were 80 feet in width. The avenues, which ran from north to south, were named for women, from Adele through Jeanne, and were 100 feet wide, except for Florence Avenue, which had a width of 150 feet. Four 11-acre parks were laid out, and the plans called for board sidewalks. A large steamboat Gothic style house was built for Sutro at company expense near the mouth of the tunnel; the structure cost $40,000 to build and furnish (fig. 20).[55]

When the author first came to Carson City in 1935, this great mansion still stood, as well as the mill which had been constructed to process ores coming through the tunnel. The mansion burned in the 1940's, and the mill was destroyed by fire in 1967 (fig. 21).

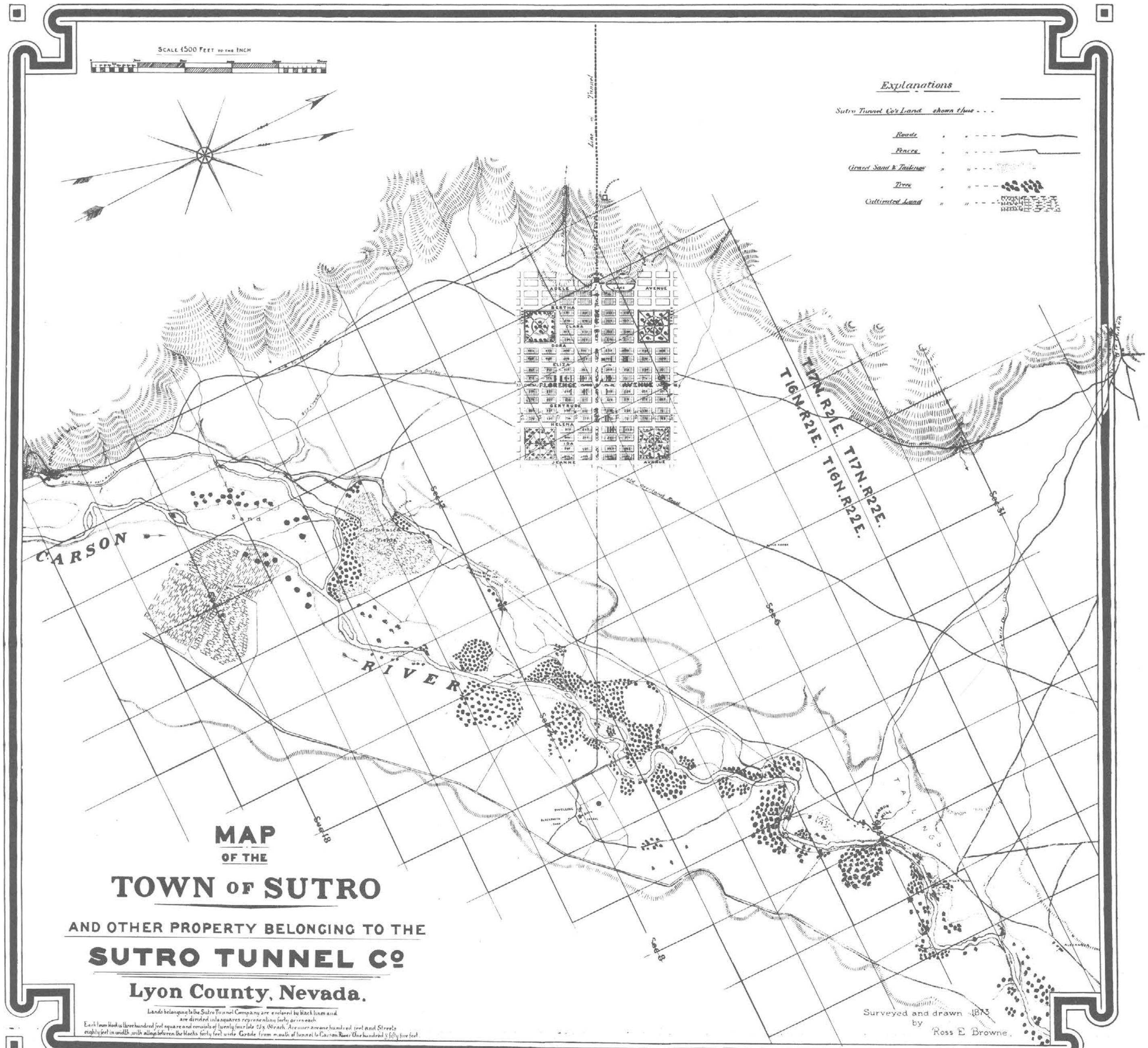



FIGURE 20.—Map of the town of Sutro, 1873. The description reads: "Lands belonging to the Sutro Tunnel Company are enclosed by black lines and are divided into squares representing forty acres each. Each town block is three hundred feet square and consists of twenty-four lots 25 x 130 each. Avenues are one hundred feet and Streets eighty feet in width, with alleys between the blocks forty feet wide. Grade from mouth of tunnel to Carson River one-hundred & fifty-five feet." Scale of the reproduction above is approximately 1 inch=10,000 feet.

Where the mansion once stood, only the foundation remains. The reservoir, in front of the mansion, is now just an ugly depression, with fallen trees, tin cans, and other debris. The writer on a recent visit was saddened by the conditions of the tunnel portal. Trees and brush almost obscure the portal, and back of the concrete facings, the tunnel is caved in for about 50 feet. Only a small stream of water flows out of the tunnel now; this water comes from a spring in the tunnel itself. The mine drainage waters are dammed off by slides deep in the tunnel. Glancing back of the tunnel portal and following the alignment of the tunnel up the hillside, the heavy cast iron posts heretofore mentioned are still in place. On the ones observed, the brass plugs are gone.

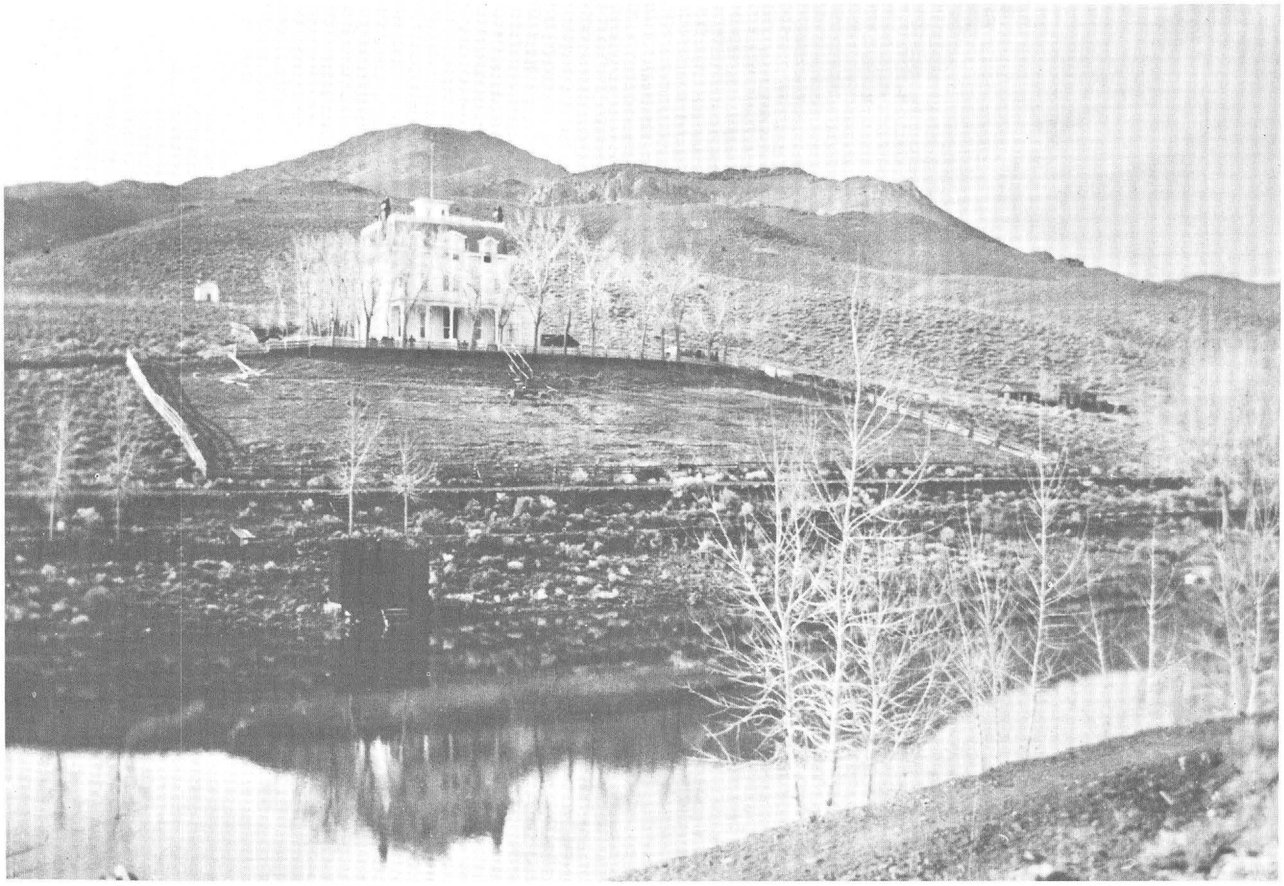


FIGURE 21.—Sutro's mansion about 1874 near tunnel portal. Courtesy of Nevada Historical Society.

In 1879 Adolph Sutro resigned his position as Superintendent of the Company and moved his activities to the San Francisco Bay Area, where he remained until his death in 1898. He sold his stock in the Sutro Tunnel Company for $709,012.[56] By so doing he became the only man who ever made any appreciable amount of money from that project. He invested his money in property in San Francisco, and became a very wealthy man. Although he was unsuccessful in his attempts to become United States Senator from Nevada, he was elected Mayor of San Francisco in 1894 (fig. 22).

An article concerning the Sutro Tunnel which appeared in the December 4, 1909, issue of the *Goldfield News* stated that—

> Yesterday was marked by an important event in connection with the repairs under way in the Sutro tunnel. The steam-tight, stovepipe drain which has been underway for the past three or four years, was practically completed. The finishing of this pipe has been one of the main features of the new work in the tunnel, and the latter is now cool in its entire length, making rapid progress possible for the balance of the work to be done in the tunnel.
>
> The Savage Mining Company is now running the Comstock Tunnel Company's mill at the mouth of the tunnel to full capacity and ore is being shipped daily through the tunnel to the mill. A new track has been built practically throughout the tunnel and a large amount of transportation is being handled early and without delay.
>
> The drainage facilities of the tunnel are now perfect to take care of the large increase of water being sent through from the C & C shaft. The pumping is being steadily increased every day and more water is now being raised from the lower levels than at any time since pumping was resumed some years ago.

Mrs. Jack Greenhalgh of Virginia City, who is the daughter of Tom Higgins, foreman for the Virginia and Gold Hill Water Company from 1906 to 1937, remembers being told by her father that many Dayton and Sutro people would go to Virginia City for Saturday night dances by means of the Sutro Tunnel, reaching the surface at Virginia City by riding up the C & C shaft. Mrs. Greenhalgh also recalled that as a small girl she would ride on the four-horse wagons hauling ice from the storage house at Five Mile Reservoir to the mines. She would then be allowed to ride down the shafts in the hoist cars loaded with ice for the use of the miners working in the unbearably hot atmosphere of the deep tunnels.

Jack Greenhalgh, who has been with the Nevada State Department of Highways for more than 35 years, told the author that in the 1930's he took a leave of absence from the Highway Department and, with a partner, operated the Comstock Mill located at the mouth of the Sutro Tunnel, milling mostly custom ore.

The Comstock Tunnel and Drainage Company and the Sutro Tunnel Company have their offices in San Francisco. The latter company still owns the property adjacent to the portal of the tunnel, and so far as is known still owns the easement for the tunnel granted by Congress in 1866, as well as other properties in the general area.

## Water Power and Electric Power

"Nowhere else on the face of the globe is there anything of the kind that approaches it." Thus the water-power development scheme at the C & C shaft was described by the *Territorial Enterprise* of September 30, 1887. The article referred to the development of water power in the California and Consolidated Virginia companies' joint shaft to operate the large stamp and pan mills.

Water for the project was obtained from the Virginia and Gold Hill Water Company. A large tank was constructed near the flume line, capable of holding 80,000 gallons of water. Water was conducted through an iron pipe which varied in diameter from 20 inches at the tank to about 12 inches where it went down the C & C shaft. Both the tank and pipeline, which was about 3,000 feet long, were designed and constructed by Captain Overton. At the ground surface near the C & C shaft, the water, under considerable pressure, hit a 11-foot Pelton Wheel, which by means of pulleys and cable, ran the 80 stamps of the battery mill and also 12 Boss grinding pans.

A Pelton Wheel is similar to a water wheel used to raise water a few feet from a ditch or stream. The difference in this instance is that the Pelton Wheel was used to develop power. As will be seen, the Pelton Wheels at the Chollar shaft ran dynamos which produced electricity to operate the mill, whereas at the C & C shaft they produced mechanical power. Water under pressure was forced against the cups of the Pelton Wheel, causing them to revolve. The speed of the wheel was governed by the amount of water and pressure. The amount of water used at the C & C shaft was about 1,700 gallons per minute under a pressure head of about 580 feet.

After the water was used on the Consolidated Virginia's surface Pelton Wheel, it was dropped down the

FIGURE 22.—Adolph Sutro. Courtesy of Nevada Historical Society.

C & C shaft, where it was passed through three other Pelton Wheels of the same size, spaced 500 feet apart vertically.

The *Territorial Enterprise* of September 30, 1887, described the workings in the shaft as follows:

> There is a great deal more of machinery in the shaft to conduct the power to the surface than there is on the surface to conduct it to the mill. It is an entirely different system of transmission. It is the only system of perpendicular transmission of power upon the face of the earth, and the men who planned it and carried it out are the inventors of it—they are the argonauts. The stations are numbered "A," "B," "C," "D,": the last being at the Sutro tunnel level, and the first on the surface—all being 500 feet apart, and there is a Pelton wheel on each station. From A to B there are three wires or cables from B to C two wires, and from C to D, one wire. The stations are forty feet in depth, and the face is fully twenty feet high to make room for the

> bearing wheels. At each station there are grooved wheels upon which the wires run. There is a system of water gauges at the surface and at each station. There are six small water pipes that run from A to B, four to C and two to D. By turning the water on or off at the surface in these small pipes, gates are either opened or shut which gauges the water that is played on the Pelton wheels at any station desired—that is to say, that any of the Pelton wheels or all of them can be stopped or regulated at will from the surface. . . . The water was first played from an inch nozzle, and strikes the cups of the Pelton wheel underneath it and flows back into a tank. . . . Any size nozzle can be put on from one to two and a half inches, according to the power desired to be played upon the wheels. The stream that comes out of an inch nozzle is nearly as rigid as a bar of iron. From the first tank the water is conducted down the shaft, makes a curve at the station and is played under the wheel in the same manner as the first, and so on to the Sutro tunnel where it escapes.

The pan mill was located about 1,000 feet from the stamp mill, and between the two there was a depression. Pole lines were erected to the pan mill, and cables or wire ropes were installed above the ground which were a part of the intricate series of Pelton Wheels, pulleys, cables, etc. operated by water power from the water company flume.

To someone seeing such an installation in the present day, it would appear to be a rube goldberg affair. However, in the 1880's it was recognized as a great engineering feat—which it was.

The reader might be confused as to how the shafts could be sunk or worked in with all the equipment which was installed, such as the Cornish Pumps, the hydraulic pumps, and the Pelton Wheels. The C & C shaft was the first of the great third-line shafts. Such shafts had four compartments (except the Forman shaft, which had five) : one for the pumps, another for sinking the shaft, and two for hoisting.[57] Later all the deep shafts were of this type.

The first mill on the Comstock to use electric power was the Nevada Mill, built in 1887, which had 60 stamps, each weighing 800 pounds, 30 amalgamating pans, 15 settling pans, and 10 agitators.[58] The power to operate the mill was run both by water power and by electricity. The *Territorial Enterprise* of September 21, 1887, stated:

> The ten-inch pipe to conduct water for the waterwheel at the mill and the electric plant is nearly complete. The work is under the supervision of Captain Overton and the pipe that is being used is ten inches in diameter and will first be used to run the 11-foot Pelton wheel at the mill and until it is needed down the Chollar shaft will run down Six Mile Canyon.

The electric plant, as described by Grant Smith, consisted of six 40-inch Pelton Wheels set up in a large chamber at the Sutro Tunnel level.[59] After the water, under a 460-foot head from the water company's flume above, was used on the 11-foot Pelton Wheel at the surface, it was flumed a short distance to the Chollar shaft and was dropped vertically through two large iron pipes to six Pelton Wheels. The vertical drop was 1,630 feet. Each wheel drove a dynamo, and the controls were so arranged that any number of the six dynamos could be run at one time. The power was then transmitted up the shaft to the mill. The *Territorial Enterprise* further commented that "never before has any water wheel been operated under a vertical pressure of 1,630 feet."

The type of power used here and at the Yellow Jacket in the Gold Hill section to operate the mills was probably not too widely used on the Comstock, steam power being the mainstay until electric power was brought in from a powerplant on the Truckee River, 40 miles away, about 1900.

The author has briefly described the water power developed at the Nevada Mill to illustrate the resourcefulness of the Comstock miners. This description, coupled with that of the operation of the large Cornish Beam Engines and Pumps, and the hydraulic pumps, should give some idea of the magnitude and complexity of at least some of the outstanding operations on the Comstock.

## Electric Lights

The Virginia Gas Company was organized early, and the Virginia City streets and business houses were lighted with gas. Illumination in the homes was furnished by kerosene lamps, which continued in general use until electric power was brought in from the Truckee River about 1900. However, electric lights were used in many of the mills, business houses and on the streets as early as 1888.

The *Territorial Enterprise* of December 2, 1887, stated that:

> Our light is no longer "hidden under a bushel" in this city set upon a hill. It blazes forth to the illumination of all, and is the light that flashed down from the heavens long before man was on the earth. It is the light that always will be, and can never be improved upon.

The *Enterprise* article went on to say that the Virginia City Electric Light Company was formed and was headed by W. S. Hobart and Alvinza Hayward, with Captain J. B. Overton as Superintendent and Manager.

The works of the electric company were located close to the new water mill of the Nevada Mill & Mining Company, just in front of the Chollar hoisting works.

Water was piped down from a reservoir on the side of Mount Davidson, 460 feet above the hoisting works. The reservoir in turn received its supply from the Virginia and Gold Hill Water Company flume. The dynamos were driven by water power from three small Pelton Wheels, working under a pressure of 200 pounds to the square inch. The Pelton Wheels were 16½ inches in diameter, and each wheel drove one dynamo.

The *Enterprise* article, commenting on the prices charged for electric lights in Virginia City, stated the charges would be the same as those of the California Electric Light Company in San Francisco.

The December 4, 1887, *Territorial Enterprise* stated that for the first time several electric lights were in use along "C" Street. Most of the lights were in business places. The first outside electric light ever installed on "C" Street was that in front of the Vucovich Brothers' Magnolia Saloon and "Mr. Armer's Cigar Store." In commenting on the electric lights, the *Enterprise* reporter had this to say: "The lamps gave a very brilliant and steady light. Beside it, ordinary lights—coal oil or gas—look pale and sickly. The electric light could be observed by persons distant two or three blocks, as a white radiance pervaded the atmosphere for a large surrounding area."

Doubtless some of the homes in Virginia City installed electric lights prior to the power being brought in from the Truckee River. These installations were probably limited, because of the small capacity of the plant and the cost of electricity as compared with that of the kerosene lamp.

It is of interest to note that electricity for the water company's Lakeview house was furnished for many years by a small Pelton Wheel placed in the 1875 pipeline which ran beneath the kitchen. Red McGovern told the writer that the wheel was removed about 1957.

## Pumping Water From Deep Shafts

A number of shafts on the Comstock reached and even exceeded a depth of 3,000 feet from the surface. Among these were the Combination shaft, which reached the greatest depth, 3,250 feet; the Crown Point-Belcher; the Hale and Norcross and the New Yellow Jacket reached depths about 3,000 feet. Several others reached 2,500 feet in vertical depth. It is interesting to note that the bottom of the C & C shaft was more than 1,700 feet lower than Carson City.

As previously mentioned, getting rid of the mine water was one of the great problems confronting the mine operators. Many of the deep shafts of different companies were connected, and additional trouble developed when one or more of the companies was lax in pumping water from their shafts. This threw a greater burden on those who did. However, the water problem could be handled, especially after the Sutro Tunnel laterals reached the various mine shafts, because this reduced the pumping level on an average of about 1,600 feet. The greatest problem, and one which could not be successfully overcome at that time, was the high temperatures in which the miners had to work.

Temperatures increased with depth, and the miners worked in adits and shafts where temperature was as great as 134°F. Springs of hot water were often encountered with temperatures as high as 157°F. In the Crown Point mine, 2,000 feet below the surface, the temperature was 150°F., and it was only 16° less in the open drift.[60]

Large volumes of air were pumped in the mines, but because of impaired air circulation, the problems were still acute. Tons of ice were sent down daily into the mines. Ninety-five pounds of ice were consumed daily by each miner employed in the hottest workings of the California and Consolidated Virginia mines during the summer of 1878.[61]

While the problems of heat and water were the main causes of the cessation of deep mining, there were other factors involved. No bonanzas had been found during the 10 years of deep mining, 1876–1886, and the great expense involved, together with the fact that $40 million had been expended in those 10 years by mines which did not pay any dividends, finally brought an end to large-scale deep mining on the Comstock.[62]

All the deep mines ceased to operate between 1882 and 1886. The New Yellow Jacket shaft in the Gold Hill section, which had reached a depth of 3,000 feet, shut down in March 1882. The north end mines (the Consolidated Virginia, California, Ophir, Mexican, Union, and Sierra Nevada) were the next to stop pumping, near the end of 1884. The Alta shaft below Gold Hill and the Forman shaft followed in December of that year.

The manner in which the mine operators pumped water from the deep shafts in order that they could be driven to even greater depths is interesting; it is certain that the reader will be impressed at the ingenuity of these Comstock mine operators.

At first, and in the shallow shafts, buckets were dropped by means of a windlass and, when filled with water, were hauled out by manpower. Later, as the workings deepened, a larger bucket was fastened on the bottom of the ore bucket, lowered to a water sump, and hauled up with the ore by steam engines. As the amounts of water increased, improved methods had to be used. Plunger pumps run by small steam engines were used between 1861 and about 1874. Probably, as the depth of the shaft increased, more than one plunger pump was used in the same shaft; one pump pumping to a certain level, from which the water was pumped to a higher level by another pump.

As depths increased, the water increased in volume and larger pumps had to be installed. This brought about the advent of the Cornish Beam Engines and their pumps. These pumps served their purpose until about 1881, when the new hydraulic pumps were installed.

The Cornish Beam Engine, or Cornish Pump as it was familiarly known, was so named because it was developed by the Cornish people in Cornwall in the mid-1800's to dewater their deep copper mines. The Cornish miner (commonly known in America as Cousin Jack) played an important role in the early mining development in the Western United States. In essence, the Cornish taught Americans the technique of hard-rock mining. One of their contributions was the introduction of the Cornish Pump to the Comstock and to many other deep mining areas in this country. Victor Goodwin gives a good description of the Cornish Miner, and also the Cornish Beam Engine, in *Nevada's Northeast Frontier*.[63]

Probably the first Cornish Pump was installed on the Comstock in the early 1870's. The last one built was in 1879, at the Union shaft (fig. 23).[64] As it is rather difficult to describe these huge machines, one good contemporary source will be quoted.

> The pump at the New Yellow Jacket vertical shaft, 3,080 feet deep, has a capacity of 1,000 gallons a minute, or 1,440,000 gallons in twenty-four hours, and regularly raised over 1,000,000 gallons. The pump rod was 3,055 feet long, made of lengths of Oregon pine, 16 by 16 inches, strapped together with iron plates. Its weight when in motion was 1,510,400 pounds. Its greatest capacity was seven strokes a minute, each stroke lifting 160 gallons. The weight of the pump rod was equalized by 8 balance bobs placed at intervals in the shaft, carrying a total lifting weight of 240 tons. There were 13 pumps in the shaft placed at intervals of about 250 feet, which lifted water from station to station, all attached to the pumping rod. The two fly wheels weighed 125 tons. [65]

*The Mining and Scientific Press* of July 17, 1880, carried a very vivid article on this Yellow Jacket Cornish Pump. In this article, the reporter stated: "This machinery is regarded as a remarkable triumph of mechanical skill, and we spare space for the following description of it from the Territorial Enterprise."

The article goes on to describe some of the pump's features, which will be briefly covered here. The pump rod, more than 3,000 feet long and made up of 16 x 16-inch lengths of Douglas-fir (then colloquially known as Oregon pine) securely bolted together, passed through "stays" that were placed across the shaft compartment every 30 feet to prevent vibration. There were, in addition, six rod-catchers to prevent the massive wooden pump rod falling down the shaft if it should break at any place. The balance bob was a long beam of wood or iron resting on a fulcrum near its center. On the outer end was a large wooden box capable of holding many tons of iron ballast. At the inner end of the beam, there was a huge iron clevis that was attached to the pump rod. The clevis was so attached that the swinging or rocking motion of the bob, which described part of the circumference of a circle, would impart a vertical movement to the pump rod.

The pump column was an iron pipe 14 inches in diameter running the full depth of the shaft. In order to support the column, a number of large collars were supported by the heavy timbers. The article points out that at that time there were six pumps in the Yellow Jacket shaft above where the south lateral of the Sutro Tunnel tapped it. After this connection was made these pumps were no longer necessary. It is hard to visualize a timber shaft 16 inches by 16 inches square and more than a half mile long operating 13 pumps. The article concludes by giving this description:

> The simultaneous starting up of a line of pumps 360 feet over half a mile in length is truly a most remarkable achievement and a feat that has never before been performed or attempted in any part of the world. When the big engine made its first revolution, all this half mile of pumps made a stroke. Not only was the whole pump rod of 300 tons moved but a great weight of water was also lifted. Great credit is due Mr. Pyen, who placed in position all the 13 pumps, 8 bobs and many other parts, for the patience, skill and excellent judgment displayed. A very little thing out of place at any one point would have caused a grand smash-up of everything.

All the deep shafts used the Cornish Beam Engine, and in many cases hydraulic pumps were added to assist. At the Combination shaft, there was a double line of Cornish Pumps, in addition to hydraulic pumps. Altogether the pumps lifted 5,200,000 gallons of water every 24 hours to the Sutro Tunnel level. On October 16, 1886, these pumps ceased to operate.

The last Cornish Pump installed on the Comstock was at the Union shaft in 1879. The flywheel was 45 feet in diameter, and the pumping beam was 48 feet between centers. The pump rod had similar dimensions to that used at the Yellow Jacket, but was 2,500 feet long. Here, as at other shafts, the water was not

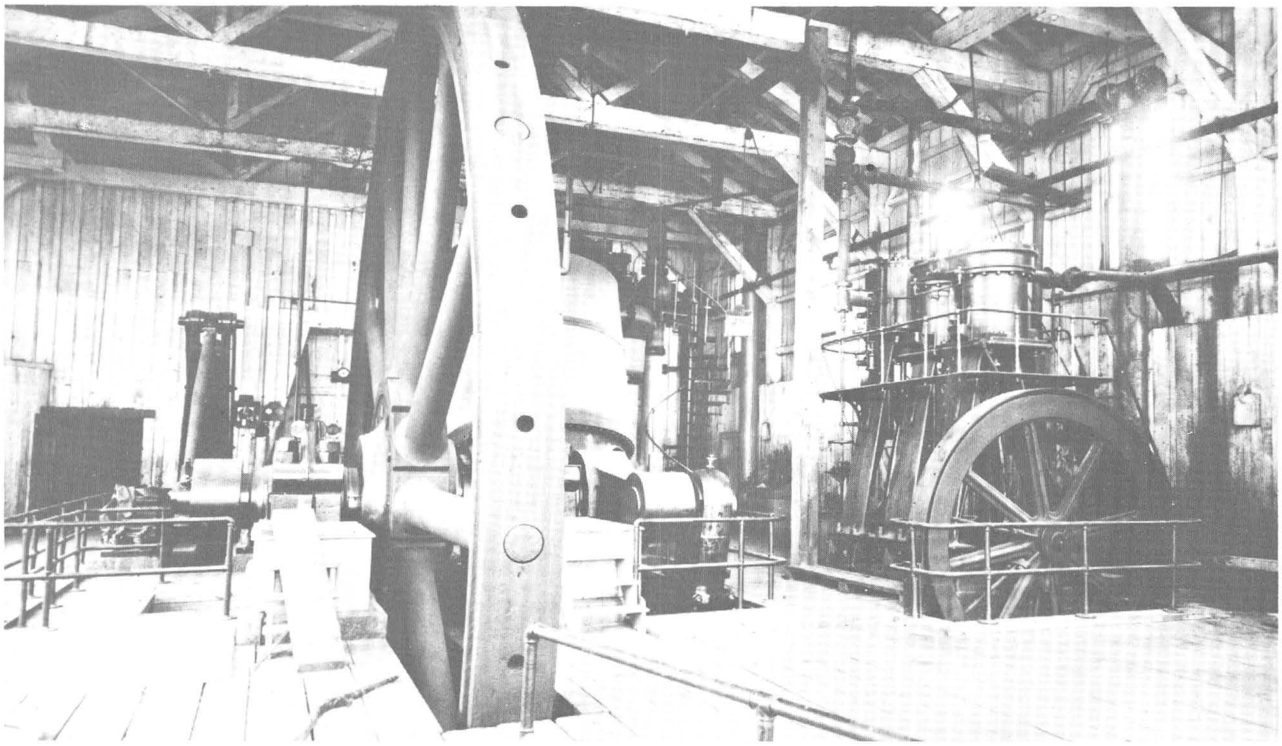


FIGURE 23.—The last Cornish Pump on the Comstock, installed at the Union shaft in 1879. It had a 45-foot flywheel weighing 110 tons. Courtesy of Nevada Historical Society.

pumped directly from the bottom to the top of the shaft, but in stages from one tank to another on different levels. Each tank had a separate pump connection with, and was operated by, the main pump rod.

Some idea of the great size of the Cornish Beam Engines may be formed when it is stated that the stations excavated for them in the shafts were 85 feet long, 28 feet wide, and 12 feet high.[66]

The hydraulic pump was a late innovation on the Comstock to supplement the huge Cornish Pumps. They were first introduced in the early 1880's. The hydraulic pump installation at the Combination Shaft is described by DeQuille.[67] He states that at the 2,400-foot level two Cornish Pumps had been in operation and handled the water until a drift encountered additional water which the Cornish Pumps could not handle. It was at this time that the management installed a hydraulic pump. This pump was operated by the pressure of water from the surface. The pump merely consisted of a 12-inch iron pipe running down the shaft, and in the case of the Combination shaft, to the 3,000-foot level. At the 3,000-foot level the end of the pipe was turned upward 180°, forming a U shape—the last few feet being tapered down and fitted with a nozzle. The water was obtained from the Virginia and Gold Hill Water Company's flume, and was conveyed from the flume by a pipe and then dropped down the shaft in the 12 inch pipe. At the Combination shaft the end of the upturned section was fitted with a one-inch nozzle made of phosphor-bronze, through which the water was ejected into a larger discharge pipe, both being submerged in the water sump. The tremendous pressure developed by the water falling more than 3,000 feet (about 1,300 pounds per square inch) and passing through the small nozzle, together with the suction it created, forced the water in which the pipes were submerged upward to the Sutro Tunnel level where it was discharged into a lateral leading to the Sutro Tunnel. The lift was about 1,400 feet.

DeQuille states that when one stood at the 3,000-foot level and looked up a compartment of the shaft, 5 by 6 feet in size, the little spot of daylight seen at the top appeared to be about 4 inches square.[68]

The installation of the hydraulic pump, or elevator, as it was sometimes called, was rather simple and not too costly. Davis states:

> Using water under such great pressure brought forward problems in hydraulics not yet solved. The advantages of the system were so great as to economy of space and first cost that every feature of the system deserves the most careful study. Before a hundred thousand dollars had been expended in this system, more water was discharged into the drain tunnel at one time by it than had been discharged by the five million dollars worth of pumps formerly in operation on the Comstock Lode.[69]

## THE TWENTIETH CENTURY

Any description of the water-supply system for Virginia City, Gold Hill, and Silver City would not be complete without tracing its history up to the present time. The system reached its greatest magnitude at the time the third pipeline was put in operation in 1887, at that time had a capacity of nearly 10,000,000 gallons of water daily to the Five Mile Reservoir. The main task of the Virginia City Water Company in later years was to keep the system in operating condition, which at times during severe winter weather was a task of considerable magnitude.

In 1906 Mr. J. B. Overton, Superintendent of the water company from its inception, retired. He was at that time over 80 years of age, and had also served as Superintendent of the Sierra Nevada Wood and Lumber Company, as well as being engaged in other activities on the Comstock. His place as Superintendent of the water company was taken over by Mr. James M. Leonard (fig. 24). Mr. Leonard had started working for the company in 1901 and continued in that capacity until 1959. He was related by marriage to W. S. Hobart, who had been one of the principal owners of the water company, as well as the Sierra Nevada Wood and Lumber Company. The author was well acquainted with Mr. Leonard, who was recognized as one of the outstanding citizens of the State. In about 1940 he turned a great portion of the operation of the system over to his son, Hobart Leonard, who became Superintendent and President of the water company following the death of his father in 1959 (fig. 4).

Red McGovern, who started working for the water company in 1934, was first employed as a helper to the attendants at the various stations on the system between Marlette Lake and Five Mile Reservoir (fig. 25). Red recalls that there were stations at Marlette Lake, Hobart Creek, The Tanks, West Tunnel Portal, Lakeview, Five Mile Reservoir, the Divide between Virginia City and Gold Hill, and the pump tanks in Virginia City. In addition, the company maintained its headquarters in Virginia City. The water company had its own telephone line, so that the attendants at the various stations could remain in touch with each other and also with the main office in Virginia City.

Mention should be made of two men who, prior to Red McGovern's service with the water company, played an important role in the operation at the Sierra water system: Tom Higgins and Joe Berger. Mr. Higgins, who was foreman under James Leonard, first served as attendant at Red House, the Station of Hobart Creek (fig. 1). In 1899 he moved with his family to the Lakeview house, and in about 1906, moved to the Divide station between Virginia City and Gold Hill. He finally retired in 1937.[70] Following Mr. Higgins' move to the Divide station, the Lakeview house was occupied by Mr. Joe Berger and his family. Mr. Berger had previously been the attendant at The Tanks (fig. 2).[71]

FIGURE 24.—James M. Leonard, Superintendent of the Virginia and Gold Hill Water Company from 1906 to 1959. Courtesy of Hobart Leonard.

On April 17, 1922, the Virginia and Gold Hill Water Company deeded all its rights in the entire water system to The Virginia and Gold Hill Water Company. On April 21, 1933, the Virginia and Gold Hill Water Company deeded to The Virginia City Water Company.

## Curtis-Wright Corporation

The Curtis-Wright Corporation purchased the Sierra water system, together with all its water rights, lands, easements, etc., up to the meter box a hundred feet or so northerly (toward Virginia City) from the Five Mile Reservoir. The deed was conveyed on August 8, 1957.

The Curtis-Wright Corporation was then planning a large missile-testing program in Storey County, under a Government contract. This company, by exchanges and purchases, acquired title to about 95 percent of the lands in Storey County, which it still owns (1969). About the only lands not acquired were the townsites of Virginia City, which is the Storey County seat, and Gold Hill. The program, as planned by the company, involved the use of a large and stable supply of water. At that time the future of the Virginia City Water Company, as well as its water supply, was somewhat uncertain, as the demand for water in Virginia City and Gold Hill was quite small and the water company was having financial troubles. Curtis-Wright, therefore, felt it necessary to purchase the water company's Sierra water system in order to carry out its anticipated program in Storey County. In addition to the Sierra waters owned by the Virginia City Water Company, the Curtis-Wright Corporation purchased several decreed water rights on the Truckee River. Between the years 1956 and 1959, the corporation filed five applications with the State Engineer to change the points of diversion, manner and place of use of the purchased Truckee River waters. The water was to be conveyed to a reservoir site in sec. 27, T. 19 N., R. 21 E., about 12 miles north of Virginia City, and was to be used for industrial and domestic use.

The corporation also planned to pipe a portion of the Sierra water from Five Mile Reservoir through Virginia City, and thence northward down Long Valley to the reservoir site in said sec. 27.

About 1941, the Virginia City Water Company, under the direction of Hobart Leonard, had started removing the first pipeline (1873) and the third pipeline (1887) in the inverted siphon, and using the pipe to replace the flumeline from Five Mile Reservoir to Virginia City. This operation was not completed until the mid-1950's (fig. 4).

On December 2, 1957, the Curtis-Wright Corporation deeded all its rights in the water system to the Marlette Lake Company, a wholly-owned subsidiary of Curtis-Wright.

Shortly after acquiring title, the Marlette Lake Company started a program of improving the water system. In 1959 Marlette Lake Dam was raised 15 feet, increasing the capacity of the reservoir from 2,000,000 gallons (6,154 acre-feet) to 3,400,000 gallons, or about 10,400 acre-feet. The Hobart Creek Reservoir Dam, which had partially washed out in the December 1955 flood, was repaired in 1956, before the purchase by Curtis-Wright. A new 8-inch pipeline replaced the single remaining box flume from the outlet of the siphon to Five Mile Reservoir. This line was put in by Curtis-Wright in February 1957, just before it purchased the system.

FIGURE 25.—Harry E. "Red" McGovern, Water Master of waterworks between Marlette Lake and Five Mile Reservoir. He has spent 35 years on the Sierra system.

The flumeline from Marlette Lake Dam to the west portal of the tunnel had long been in disrepair, and the company was planning to replace this section with a pipeline and repair the tunnel. Even though no water was coming to the tunnel from Marlette, the tunnel itself actually producing an average of 400 gallons of water per minute. As late as 1964, this water was still being conveyed by the old box flume to Hobart Creek, together with other waters collected along the way.

According to Edward Kruse, former Superintendent of the Department of Buildings and Grounds for the State of Nevada, and the Carson City Water Company entered into a contract in 1959 with the Marlette Lake Company to purchase up to 3 million gallons of water per day. The contract with the State of Nevada had a maximum of 1 million gallons per day, and the Carson

City Water Company could purchase up to 2,000,000 gallons daily. Also, the Virginia City Water Company had a contract to purchase water not to exceed 300,000 gallons per day. In 1961 the water used in Virginia City, as recorded by the meter at Five Mile Reservoir, was 50,864,000 gallons, or an average of 140,000 gallons per day. In 1962, the use was 63 million gallons, or an average of 175,000 gallons per day.

Mr. Jac Shaw, in 1968 the Superintendent of the Department of Buildings and Grounds, informed the author that the present use by the Virginia City Water Company varied between 220,000 gallons per day during the winter months and 750,000 gallons per day during the summer months, and that the State used about 100 million gallons during the peak summer months of 1968.

## Franktown Irrigation Company

Another chain of events, starting in 1946, concern the water conveyed by the old Virginia and Gold Hill Water Company's north flume from Third Creek and the Franktown Irrigation Company; it should be told.

The Franktown Irrigation Company is composed of a group of ranchers on the west side of Washoe Valley and southerly from Bowers Mansion, whose lands have been irrigated by the waters of Franktown Creek since the late 1850's. Oftentimes the streamflow was not sufficient to irrigate all their lands. In order to increase their water supply, a dam was constructed at the lower end of Little Valley. This was probably during 1879. The *Nevada State Journal* of February 2, 1881, noted that the day before a huge flood had occurred on Franktown Creek as the result of the dam failing. The flood waters, reaching crests of 25 feet, washed out all but six buildings in Franktown. The property loss was estimated to be $50,000.

The Franktown Irrigation Company and the Virginia City Water Company entered into an agreement for the purchase by the Irrigation Company of the water rights held by the water company on North Creek (Third Creek) and tributaries. Accordingly, on June 27, 1946, the Virginia City Water Company filed an application (No. 11624) with the State Engineer to change the point of diversion, manner and place of use of 5.5 cfs of the waters of North Creek. This was the major portion of the waters that the north flume conveyed to the west portal of the water company's tunnel.

The proposed point of diversion was about 1½ miles uphill from the point where the water company's flume diverted water from Third Creek, and approximately 1,000 feet higher.

Because of a protest filed against the application, a hearing was held on October 29, 1946. The writer, then Assistant State Engineer, held the hearing. The main witness was James M. Leonard, Superintendent of the Virginia City Water Company, who had acted in that capacity since 1906. He testified that from 1901, when he first went to work for the water company, up to 1944, the north flume to the west portal of the tunnel was in yearly operation, but no use was made of the flume in 1944 and 1945 because of the washing out of the diversion works. He added that when in operation the flume picked up water from other tributaries on its way to the tunnel.

Mr. Leonard further testified that the water company had been decreed 75 inches of water under a head of 6 inches in 1892, and that W. E. Price was decreed 150 inches. Later, the water company purchased Price's decreed rights of 150 inches, giving the company 225 inches of water. (This would represent a flow of 2,524 gallons per minute, or about 5.5 cubic feet per second.) The records of the State Engineer's office show that in 1939 the water company deeded 5 inches of water to Norman Biltz at Incline Lake, leaving them with 220 inches of water.

Under the application the works of diversion would divert the water from North Creek (Third Creek) at points within the S½S½, sec. 26, T. 17 N., R. 18 E., and then would convey the water through a ditch to be constructed approximately one-half mile to a point on Ophir Creek in Tahoe Meadows, a short distance northwesterly of the Mount Rose Highway. The water would then be conveyed by Ophir Creek to Price Lake, and rediverted by a ditch approximately 1 mile long to a tributary of Franktown Creek in Little Valley, where it would be comingled with the natural flow of Franktown Creek and used for irrigation purposes by the Franktown Irrigation Company.

As a condition to having the application approved, the irrigation company stipulated that it would place a Parshall measuring flume at the point of diversion, and also one where the diversion ditch emptied into Ophir Creek and still another one where the water was rediverted from Price Lake. It was agreed that the Irrigation Company would assume a 10 percent loss of water in Ophir Creek and Price Lake, and that a water commissioner, approved by the State Engineer, would be engaged each season.

On June 10, 1946, the Virginia City Water Company deeded application No. 11624 together with 5.5 cfs of the waters of North Creek to Henry E., Roy F. and Edwin Heidenreich, representing the Franktown Irrigation Company. On July 24, 1947, the Heidenreich's deeded Permit No. 11624, together with the water rights, to the irrigation company. Subsequently, on February 14, 1955, the State Engineer issued Certificate No. 4217 under Permit No. 11624 in the amount of 5.5 cfs of water to the Franktown Irrigation Company. The certificate provided that the irrigation company could divert 1.875 cfs of water during the months of June through December and 3.625 cfs during the months of January, February and May for the irrigation of 1969.39 acres of land.

Because of snow conditions in the winter and spring at the higher elevations, the irrigation company very seldom is able to get the water from North Creek to Ophir Creek and from Price Lake to Franktown Creek until late in the spring of each year. As the company's diversion point is about 1,000 feet higher and 1½ miles distant from the old water company diversion, it was not able to obtain the total water rights it purchased. However, this added supply of water, short as it may be at times, has been of great value to the Franktown ranchers.

On September 14, 1951, the Franktown Irrigation Company, feeling that it should protect its vested rights to the waters of Franktown Creek, petitioned the State Engineer to make a determination of the relative rights to the waters of Franktown Creek and tributaries. The petition was granted, and the State Engineer proceeded with the adjudication. On July 11, 1960, a decree was issued by the Second Judicial District Court of Washoe County. The decree granted the Marlette Lake Company 10 cfs of the water of Hobart Creek and tributaries above the Red House diversion and to the Franktown Irrigation Company 37.09 cfs of the water of Franktown Creek below the Red House diversion.[72] A certificate of water rights in the amount of 10 cfs was issued on June 5, 1967, to the Marlette Lake Company.

It should again be pointed out that Hobart Creek and Franktown Creek are one and the same. The stream is generally called Hobart Creek above Red House, and Franktown Creek below.

## Purchase of the Sierra Water System by the State

The next episode in the long and interesting history of the Sierra water supply for the Comstock involved the purchase by the State of Nevada of practically all the assets of the Marlette Lake Company. The Federal Government contract for the missile-testing program having failed to materialize, the Curtis-Wright people were no longer interested in their water-supply program, and desired to dispose of the Sierra water-supply system and its watershed lands. The sequence of events was as follows:

On February 8, 1963, Mr. H. J. Knell, President, Marlette Lake Company, by letter addressed to Edward Kruse, Superintendent of Buildings and Grounds for the State of Nevada, offered to sell the assets of the Marlette Lake Company to the State for a price of $2 million.

Mr. Kruse, in a letter to Governor Grant Sawyer dated March 15, 1963, recommended the purchase by the State. He pointed out that in 1959 the State of Nevada and the Carson City Water Company had entered into a 20-year contract with the Marlette Lake Company for 3,000,000 gallons of water per day, which provided that the State could purchase a maximum of 1,000,000 gallons per day and the Carson City Water Company could purchase 2,000,000 gallons daily. The water would be conveyed by the State's pipeline from The Tanks. The Virginia City Water Company likewise had a contract to purchase water from the Marlette Lake Company not to exceed 300,000 gallons per day.

In his letter to Governor Sawyer, Mr. Kruse went on to say that Mr. Walter Reid, a licensed engineer for Marlette Lake Company, stated that under normal operation conditions, the system had a capacity of 7,000,000 gallons per day, and that with certain improvements the production could be 10,000,000 gallons daily during highest demand.

In a letter to Ed Kruse from the Southwest Gas Corporation, which had purchased the Carson Water Company in 1960, it was stated that the Carson Water Company had been approached by the Marlette Lake Company with an offer to sell its properties. The letter stated that since Marlette Lake is the principal water source for the State building complex at Carson City, and is also a source of supplementary water for the Carson Water Company, it would seem prudent that either the Carson Water Company or the State of Nevada should purchase this very vital asset. Mr. Kruse had previously asked the Southwest Gas Corporation for an expression of interest in possibly purchasing the Marlette Lake Company assets from the State of Nevada, in the event the State should purchase the properties and later decide to sell. In answering, Mr. Laub of the Southwest Gas Corporation stated the company definitely would be interested in such an arrangement, with the qualification that should the State, at some time later, decide to sell, the price which the Southwest Gas Corporation might offer must necessarily be based upon the asset value of the water rights. Laub further stated that his company would not necessarily be bound either contractually or morally to offer a price equal to the price that might have been paid by the State, should investigation disclose such price to have been excessive.

FIGURE 26.—Signing of the agreement between the State of Nevada and Marlette Lake Company for the purchase of the Sierra water system June 12, 1963. Standing from left to right are Robert L. McDonald and Donald L. Carano, representing the Marlette Lake Company. Seated (left to right) are William L. Paul, Deputy Attorney General, Hugh A. Shamberger, ex-officio State Land Register, and the late D. W. Priest, Deputy Attorney General. Photograph by John Nulty.

After further negotiations, primarily between Mr. Kruse, representing the State, and the Marlette Lake Company, the company agreed to accept a price of $1,650,000.

The Nevada State Legislature was then in session. After fully studying the assets of the Marlette Lake Company and the necessity of preserving the watershed and the water rights and facilities for the State, the Legislature approved an act authorizing the issuance of $1,650,000 of the State's negotiable coupon general obligation bonds and their delivery to the Marlette Lake Company, a Nevada corporation. The act authorized the State Land Register to execute a contract of purchase for such properties with the Marlette Lake Company; the bonds were to bear 3 percent interest, and were to be redeemed in 20 years. The same act created a State Bond Commission, composed of the Governor, Secretary of State, and State Treasurer.

As ex-officio State Land Register, by virtue of being Director of the Department of Conservation and Natural Resources, the author executed the agreement with the Marlette Lake Company on June 12, 1963 (fig. 26). The property consisted, in addition to all water rights held by the company, of some 5,378 acres, of land, including 80 acres at Five Mile Reservoir and 3.1 acres at Lakeview saddle upon which the caretaker's old house, built by the Virginia City and Gold Hill Water Company about 1873, is situated. In addition, there were included all road easements, flume and pipe easements, and the easement from Five Mile Reservoir to a point 100 feet east of the reservoir, where a water meter has been installed. The Marlette Lake Company retained about 300 acres of land located immediately southerly from the Lakeview house (fig. 18).

In order to test the legality of the agreement to purchase, the State Bond Commission, by resolution dated June 12, 1963, refused to issue and deliver the State's general obligation bonds on the grounds that it had doubts as to whether the purchase of Marlette Lake Company properties came within the authority contained in the second paragraph of Section 3 of Article 9 of the Constitution of the State of Nevada. They further stated in the resolution that it would create a public debt in excess of the debt limitation provided by the same Section 3, Article 9 of the Constitution.

Thereupon the Marlette Lake Company sought a writ of mandamus to compel the State Bond Commission to issue said bonds. The Supreme Court of Nevada held that the agreement for the purchase of the properties was valid.[73] Following this, the Marlette Lake Company executed a deed conveying the assets of the company to the State of Nevada, excepting the 300 acres of land heretofore mentioned, south of the old house at Lakeview.

## CONCLUSION

Following acquisition of the Sierra water system by the State, considerable work was done by the Division of Buildings and Grounds in improving the water-collecting facilities. In 1966 there was not enough water in the Hobart Creek watershed to supply the water needs of Carson City. To augment the supply, a pumping station was installed on the east shore of Marlette Lake, and water was pumped over the divide to Hobart Creek. Again in 1967 the pump was utilized to convey water from Marlette Lake to meet the water demands. The old wooden flume from the east portal of the tunnel was replaced with a steel pipeline. Although the tunnel had caved in in 1957, about 400 gallons per minute of water continues to flow from a spring area within the tunnel. This water, together with the water from some of the side canyons, is conveyed by the pipeline to Hobart Creek. In 1968 The Tanks were torn down, presumably because they had become a fire hazard. (See fig. 3.)

In 1967 the State Legislature authorized the Legislative Commission (Senate Concurrent Resolution No. 21) to make a study of the Marlette Lake water system, its present and future requirements, and report the results of such study, together with specific recommendations, to the 1969 Legislature. The Legislative Commission appointed a subcommittee to make the study. This study, Bulletin No. 79, was prepared under the general supervision of Russell W. McDonald, Director of the Legislative Counsel Bureau, and was submitted to the 1969 Legislature in February 1969. This report is an excellent presentation of the available facilities of the Sierra water system, and contains some of the early history of this system, together with numerous pictures, along with recommendations to the Legislature. The 1969 Legislature authorized the Legislative Commission to continue its study, and to advise the next session of the Legislature (1971) with regard to the administration or disposition of the several elements of the Marlette Lake water system.

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4. Galloway, John Debo. 1947. *Early Engineering Works Contributing to the Comstock*, p. 57.
5. Lincoln, *op. cit.*, p. 226.
6. The Nevada Bureau of Mines lists the total production of the Comstock up to 1957 as being $393,963,725, with the production from 1920 to 1957 as being $28 million. Using Lincoln's 1921 production figure of $558,758 there is a difference of $19,794,448 between the two estimates, Lincoln's being the larger.
7. The census report of 1875 gives a population of 17,528 for Storey County. The year of peak production was 1877 and the population could well be doubled. DeQuille stated that according to the directory of 1875, the population of Virginia City was over 20,000, and that of Gold Hill about 10,000. These two towns made up the bulk of the population for Storey County then as they do now.
8. Department of Economic Development. 1967. *Nevada Community Profile*, p. 129.
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11. Bancroft, Hubert Howe. 1890. *History of Nevada*, Colorado and Wyoming, p. 22; DeQuille, Dan. 1876. *The Big Bonanza*, p. 33; and Shinn, Charles Howard, 1896. *The Story of the Mine*, p. 226.
12. DeQuille, Dan, *op. cit.*
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14. Lord, Eliot. 1883. *Comstock Mining and Miners*, p. 259.
15. *Ibid.*, p. 259.
16. *Ibid.*, p. 260. In this description the writer is drawing to some extent on the account given by Lord.
17. See Buck's letter following page 4.
18. DeQuille, Dan. 1889. *A History of the Comstock Silver Lode and Mines*, p. 69.
19. Galloway, *op. cit.*, p. 57.
20. DeQuille, *The Big Bonanza*, pp. 233–237.
21. Lord, *op. cit.*, p. 322.
22. Reid, Walter G., is a professional engineer now residing at Virginia City.
23. Davis, Sam P. 1913. *The History of Nevada*, p. 407.
24. DeQuille, *op. cit.*, p. 235.
25. Galloway, *op. cit.*, p. 70. Lord stated that the pipeline was 600 feet shorter. It would appear that the Galloway figure is most likely correct.
26. *Ibid.*, p. 71. The dam height was raised again in 1957, increasing the storage capacity to 35 million gallons, or about 800 acre-feet.
27. DeQuille, *op. cit.*, p. 237.
28. Thompson and West, *op. cit.*, p. 601.
29. Lord, *op. cit.*, p. 332.
30. Galloway, *op. cit.*, p. 73.
31. *Ibid.*, p. 71.
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33. Galloway, *op. cit.*, p. 99.
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38. Davis, *op. cit.*, p. 400.
39. Smith, *op. cit.*, p. 46.
40. Davis, *op. cit.*, p. 400.
41. Stewart and Stewart, *op. cit.*, p. 36.
42. *Ibid.*, p. 37.
43. Thompson and West, *op. cit.*, p. 506; and Smith, *op. cit.*, p. 109. According to Smith, the original plan was to extend tunnel westward under Mount Davidson far beyond the Comstock Lode.
44. Lord, Eliot, *op. cit.*, p. 234.
45. DeQuille, Dan. 1889. *A History of the Comstock Silver Lode and Mines*, p. 69.
46. Stewart and Stewart, *op. cit.*, p. 108.
47. Thompson and West, *op. cit.*, p. 509.
48. *Ibid.*, p. 509.
49. *Ibid.*, p. 510.
50. Stewart and Stewart, *op. cit.*, p. 109.
51. Lord, *op. cit.*, p. 342.
52. Thompson and West, *op. cit.*, p. 504–505.
53. Lord, *op. cit.*, p. 342.
54. Smith, Grant H., *op. cit.*, pp. 113–115.
55. Stewart and Stewart, *op. cit.*, p. 112.
56. *Ibid*, p. 168.
57. Smith, *op. cit.*, p. 279.
58. *Ibid*, p. 256.
59. *Ibid.*, p. 256.
60. Lord, *op. cit.*, p. 396.
61. *Ibid.*, p. 393.
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64. Smith, *op. cit.*, p. 278.
65. *Ibid.*, p. 280.
66. DeQuille, *op. cit.*, p. 88.
67. *Ibid.*, p. 87.
68. *Ibid.*, p. 88.
69. Davis, *op. cit.*, p. 375.
70. As related by Mrs. Jack Greenhalgh, of Virginia City, daughter of Tom Higgins, who told the author several interesting stories about Virginia City and the Sutro Tunnel.
71. Mr. Harold Berger, of Carson City, son of Joe Berger, told the writer that he was born at The Tanks and his brothers, Frank, George, and Clarence and his sister Emma were born at the Lakeview house.
72. Franktown Creek Irrigation Company, Inc., v. Marlette Lake Company, 77 Nev. 348, 374 P 2d 1069 (1961).
73. Marlette Lake Company, a Nevada Corporation, petitioner, v. Grant Sawyer, Governor of the State of Nevada, John Koontz, Secretary of the State of Nevada, and Michael Mirabelli, Treasurer of the State of Nevada, members of and constituting the State Bond Commission of the State of Nevada, respondents, 79 Nev. 334, 383 P. 2d 369 (1963).

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