

PACIFIC RAILROAD.

MEMORIAL

OF THE

CENTRAL PACIFIC RAILROAD COMPANY OF CALIFORNIA.

DECEMBER 9, 1861.—Referred to the Select Committee on the Pacific Railroad, and ordered to be printed, with report of Chief Engineer.

MEMORIAL OF THE CENTRAL RAILROAD COMPANY OF CALIFORNIA.

*To the honorable Senate and House of Representatives of the United States of America:*

The undersigned memorialists hereby beg leave to represent to your honorable body the fact that they have recently acquired new, interesting, and important information with regard to the location of the western end of the Pacific railroad across the Sierra Nevada mountains; having discovered a new railroad route across the same, whereby there is effected a saving in distance of 184 miles, and in cost about ten millions of dollars, over the route upon which all the estimates of distance and cost have heretofore been made for the central route, while upon their newly-discovered line the heaviest grades and sharpest curves do not exceed the maximum grades and curves of the Baltimore and Ohio railroad.

The undersigned would further represent that the information thus gained is not of a vague or indefinite character, but is the result of a scientific exploration and reconnoissance upon three routes across the Sierra Nevada mountains, in central California, and of an actual instrumental survey upon this route made by railroad engineers, in the manner usual upon railroads, at a considerable amount of cost and labor. And that they have forwarded to Washington all the maps, profiles, details, &c., for the inspection of those interested in the matter, for the purpose of corroborating these statements.

The following is a brief enumeration of the advantages of this line :

1. It crosses the Sierra Nevadas and reaches the Truckee river in 123, and State line in 140 miles from Sacramento.
2. Big Bend of Truckee river, or Humboldt desert, is reached in 178 miles.

3. It crosses the State at nearly its narrowest width.

4. It pursues nearly a direct course from Sacramento to Big Bend of Truckee.

5. It reaches and forms an outlet for the business of Nevada Territory, the new silver mineral regions of Washoe, and the newly-discovered mineral regions of the Humboldt river, also of the Pyramid lake and Esmeralda mining districts.

6. It crosses the Truckee meadows at the head of Steamboat valley, which, with Washoe and Eagle valleys, connects with Carson valley, enabling a branch road with light grades to be built to any point on the Carson river.

7. It reaches the summit of Sierra Nevadas (or an elevation of 7,000 feet above Sacramento) in 81 miles from base of mountains.

8. It reaches eastern base of Sierra Nevadas in  $11\frac{1}{2}$  miles from the summit.

9. It follows the valley of Truckee river without obstacle to Big Bend, or Humboldt desert.

10. It entirely avoids the second summit of the Sierra Nevadas.

11. Its maximum grades and shortest curves do not exceed those of the Baltimore and Ohio railroad.

12. The elevation of line is maintained continuously to the summit, there being no down grade running easterly to the summit.

13. Encounters no elevated plateau of table-land at summit.

14. Running to and from the single summit with maximum grades, has no extensive snow line.

15. Runs through extensive forests of timber suitable for ties, &c., for Pacific railroad.

16. Crosses no deep river cañons or gorges.

17. Its longest tunnel will not exceed 1,350 feet in length, and no shafting will be required.

18. Navigable waters of the Sacramento river at all seasons of the year its western terminus; Washoe and the Great Basin its eastern terminus.

19. Its eastern terminus is in proper position to connect with a railroad line through the Territories by either the Humboldt or Simpson routes.

20. Saving in distance over the route *via* Madelin Pass, as surveyed by Lieut. Beckwith, from Lassen's Meadows or Humboldt Crossing to California, 184 miles.

21. Saving in cost over ten millions of dollars.

22. Is advantageously located for a branch to Oregon.

23. Overcomes the greatest difficulties of the Pacific railroad.

Esteeming a knowledge of these facts of importance to your honorable body, in connexion with Pacific railroad matters, your memorialists respectfully present the same, with the report of their engineer, containing the details of such survey.

And, as in duty bound, we will ever pray.

CENTRAL PACIFIC R. R. CO. OF CALIFORNIA,  
By THEODORE D. JUDAH,

*Their accredited Agent.*

## REPORT.

ENGINEER'S OFFICE,  
*Central Pacific Railroad of California,*  
*Sacramento, October 1, 1861.*

*To the president and directors of the Central Pacific Railroad Company of California :*

GENTLEMEN : Agreeably to your instructions, I have completed the preliminary survey of a railroad across the Sierra Nevada mountains, from the city of Sacramento to a point on the Truckee river, at the eastern base of mountains ; the results of which confirm the facts established by the barometrical reconnoissance made last fall.

A preliminary examination was made, and barometrical observations taken last fall upon three routes—one through Eldorado county *via* Georgetown, another *via* the present route, (Illinoistown and Dutch Flat,) and the third *via* Nevada and Henness Pass.

These observations demonstrated the existence of a route from Sacramento across the Sierra Nevadas, by which the summit could be attained with grades of 105 feet per mile; accordingly, field parties were organized early in the spring, and a thorough railroad survey made, the results of which are embodied in the following report, developing a line with lighter grades, less distance, and encountering fewer obstacles than found upon any other route or line hitherto examined across the Sierra Nevada mountains; and proving, by actual survey, that the difficulties and formidable features of this range can be successfully overcome for railroad purposes.

Among the objectionable features which render the Sierra Nevada mountains formidable for railroad operations are found—

First. *The great elevation to be overcome in crossing its summit, and the want of uniformity in its western slopes.*

It will be observed that in crossing a summit of 7,000 feet in height an average grade of 100 feet per mile can only be attained, with a distance or base of 70 miles. Should any irregularity of surface occur in this distance, the grade would be correspondingly lessened or increased, in conformity with such irregularity of surface.

When it is considered that the average length of the western slope of Sierra Nevada mountains, from summit to base, is only about 70 miles, and the general height of its lowest passes about 7,000 feet, the difficulty of locating a railroad line with 100-foot grades is correspondingly increased, as it becomes absolutely necessary to find ground upon which to preserve a general uniformity of grade.

In the present instance, the distance from base to summit, by railroad line, is 81 miles; the elevation of summit 7,000 feet above Sac-

ramento, and the maximum grade 105 feet per mile; showing a remarkable regularity of surface, without which the ascent could not have been accomplished with our maximum grades.

Secondly. *From the impracticability of river crossings in the mountains.*

To those unacquainted with the mountain topography of the western slope of the Sierra Nevadas, and accustomed to the lesser elevations and gentler slopes of the Atlantic States, it would be difficult to convey an adequate idea of the extensive proportions of the irregularities of surface which attach to these mountains.

The general course of the Sierras is northwesterly, and parallel to the line of Pacific coast.

This western slope being at right angles, extends therefore in a southwesterly direction, which is the general course or direction of the rivers and streams upon its western slopes.

Between a point opposite the city of Sacramento (about latitude  $38\frac{1}{2}$ ) and Shasta (about 41 degrees,) this western slope is intersected by numerous rivers, having their sources near the summit of the Sierras. They are as follows: The South Fork of American, Middle Fork and North Fork, Bear river, Deer creek, South Fork of Yuba, Middle Fork, North Fork, the South, Middle, and North Forks of Feather river.

These rivers run through gorges or cañons, in many places from 1,000 to 2,000 feet in depth, with side slopes varying from perpendicular to an angle of forty-five degrees.

The ridges formed by these rivers are sharp, well defined, and in many places so narrow on top as to leave barely room for a wagon road to be made without excavating the surface of ridge.

The branches, also, of many of these rivers have worn out gorges as deep as those of the rivers, and present physical barriers to a line of communication, either crossing them, or extending in a northerly and southerly direction.

These rivers are generally made the dividing lines between mountain counties, which are of oblong shape, long and narrow—the counties of Eldorado, Placer, and Nevada, extending from base to summit of Sierra. The thoroughfares of travel extend into these counties along these ridges; the focus of travel for the large counties of Eldorado, Placer, Nevada, and Sierra, being Sacramento, (a portion of this travel, however, concentrating at Marysville.)

No wagon road exists across the Middle Fork of the American. The inhabitants of Eldorado county, in order to reach the divide between Middle and North Fork of the American by wagon, are obliged to proceed down to within eight or ten miles of the Sacramento valley, in order to obtain a crossing.

The towns of Forest Hill, Yankee Jim's, Todd's Valley, Michigan Bluff's, Bird's Flat, Sarahsville, &c., lying in the divide between the North and Middle Forks of the American, are reached by crossing the North Fork, about four miles above Auburn, at which point the road is excavated on the face of a steep side-hill above the river



cañon, which is about 1,000 feet high, closely following its bends and sinuosities; the hill upon each side being about four miles in length, or a total of eight miles in length; the grade for wagon road varying from 250 to 300 feet per mile.

Iowa Hill and Wisconsin Hill, although upon this same divide, are separated from the above-mentioned towns by two or three cañons or branches of the North Fork, running nearly parallel.

One of these cañons is deeper and more precipitous than the crossing of North Fork, above Auburn; the descent into the cañon being about one thousand five hundred perpendicular feet. A wagon road, wide enough for a single team, with occasional turning-out places, has been built across, but a distance of ten miles of road is rendered necessary in order to reach across a direct line of about three miles, the grades being between three hundred and four hundred feet per mile.

From Iowa Hill to Illinoistown and Nevada the cañons of Bear river, of Steep Hollow, Greenhorn, Wolf creek, and Deer creek intervene

Above Nevada, the South, Middle, and Main Yuba also intervene.

The present travelled stage road from Nevada to Eureka, &c., crosses South Yuba about eight miles from Nevada, the road descending in about two miles one thousand feet, and in the next five miles ascending two thousand feet to the top of ridge.

Thus it will be seen that, in order to reach the summit of Sierra Nevada, a railroad line must avoid the crossings of any of the cañons; for were it even practicable to follow down into them with a grade of one hundred feet per mile, it would still be necessary to retrace the line upon the opposite side, which would involve (in a cañon of, say, one thousand feet in depth) the additional length and cost of twenty miles of line of maximum grade, with the crossings of side ravines and tributaries.

The *present line* pursues its course along an *unbroken ridge, from base to summit, of Sierras*, the only river crossing in the mountains being Little Bear river (a tributary of Main Bear river, about three miles above Dutch flat,) which is crossed at an elevation of fifty feet, and will require only about fifty feet span of bridge.

Thirdly. *In its entirely avoiding the second summit of the Sierra Nevada mountains.*

A cross section of the main range of Sierra Nevada presents a profile showing two summits, with a range of elevated table-land lying between; thus, upon the profile of Lieutenant Beckwith's survey across the Sierra Nevada, *via* Madelin Pass, are shown two distinct summits, thirty-five miles apart, with a range of elevated table-land between them.

The present Placerville wagon road to Washoe also crosses these two summits; passing the first range *via* Johnson's Pass it descends into Bigler Lake valley, and ascending again crosses the second summit, *via* Daggett's Pass, into Carson valley.

Lake Bigler lies in this valley between the two summits—is about 35 miles long, and from 12 to 15 miles in width; is entirely surrounded by mountains and lofty peaks, excepting at one point on its western shore, where the Truckee river forms its outlet.

Running at first northwesterly about eight miles, then northerly about ten, thence northeasterly about twelve miles, the Truckee passes down between these two summits with a nearly uniform fall of about thirty-five feet per mile; thence sweeping round to the eastward, it passes through the second range or summit, at a depression where it seems to be entirely worn away down to the level of the river, thence pursuing its way through an extensive plain known as the Truckee Meadows; thence through the Washoe mountains to the Big Bend; thence northerly about twenty miles, finds its way into Pyramid lake.

At the Donner Lake Pass, where our line crosses the first summit of Sierra Nevada, the altitude of line is about 1,200 feet above the Truckee river. Donner lake lies immediately beneath, at a depth of 1,000 feet.

Two long side ranges or spurs enclose the lake and its valley, declining in height gradually to the Truckee river, about eight miles below.

Our line is carried down along the side-hill of the spur or range immediately above the lake, and upon its south side to the Truckee river, which point it reaches in a distance of eleven and a half miles of line, with a uniformly descending grade of 105 feet per mile from the summit.

The Truckee thus reached, all further difficulty of location ceases, as it pierces its way through all obstructions with a uniform descent, not exceeding forty feet per mile, to the Humboldt desert, which forms the sink of the Humboldt and Carson rivers.

Thus the second summit of Sierra Nevada and the crossing of the Washoe mountains are entirely avoided; and from the western base to the summit of Sierra Nevada the grade is uniformly ascending or level, there being no descending grade going eastward, while from the summit to Big Bend of Truckee, or Humboldt desert, a uniform grade is likewise maintained.

The prominent features of this line may be briefly enumerated as follows :

1. It crosses the Sierra Nevada mountains and reaches the Truckee river in 123, and State line in 140 miles from Sacramento.

2. Big Bend of Truckee, or Humboldt desert, is reached in 178 miles.

3. It crosses the State at nearly its narrowest width.

4. It pursues nearly a direct course from Sacramento to Big Bend of Truckee.

5. It forms a local road for the counties of Sacramento, Placer, and Nevada.

6. It commands and will perform the entire business of Nevada Territory, Washoe, and the silver mineral region.

7. It will also command the business of newly-discovered Hum-

boldt mineral district, Pyramid lake, Esmeralda, and Mono mineral districts.

8. It crosses the Truckee Meadows at the head of Steamboat valley, which, with Washoe valley and Eagle valley, connects with Carson valley, enabling a branch road, with light grades, to be built to any point on Carson river.

9. It reaches the summit (or an altitude of 7,000 feet above Sacramento) in 81 miles from base of mountain.

10. It reaches eastern base of Sierra Nevada in  $11\frac{1}{2}$  miles from summit.

11. It follows the valley of Truckee river, without obstacle, to Big Bend or Humboldt desert.

12. It entirely avoids the second summit of Sierra Nevada.

13. Its maximum grades is 105 feet per mile, or less than those of the Baltimore and Ohio railroad.

14. The grades down the Truckee will not exceed 40 feet per mile.

15. The elevation of line is maintained continuously to the summit, there being no down grade running easterly to summit.

16. A uniformly descending grade is maintained from the summit easterly to the Truckee or eastern base.

17. Encounters no elevated plateau of table-land at summit.

18. Running to and from summit with maximum grades cannot have an extensive snow line.

19. Runs through extensive forests of pitch and sugar pine, fir, cedar, and tamarack, which latter two species of timber are abundant, and will furnish excellent cross-ties.

20. Crosses no deep river cañons or gorges.

21. Its longest tunnel will not exceed 1,350 feet in length, and no shafting will be required.

22. Shortest radius of curvature 573 feet.

23. Navigable waters of the Sacramento river at all seasons of the year its western terminus; Washoe and the Great Basin its eastern terminus.

24. At Big Bend of Truckee the line is in position to proceed *via* the Humboldt to Salt Lake, or follow the Simpson route to some point.

25. *Saving in distance over route via Madelin Pass and headwaters of Sacramento*, as surveyed by Lieutenant Beckwith, from Lassen's Meadows or Humboldt Crossing, 184 miles.

26. *Saving in cost of Pacific railroad line*, taking Lieutenant Beckwith's estimate from Lassen's Meadows or Humboldt Crossing, as compared with cost of present proposed line, in thirteen and one-half millions of dollars.

27. Reduces the time of passenger transit to and from Washoe to  $8\frac{1}{2}$  hours. Passengers leaving Virginia Station at 5 a. m. will reach San Francisco the same evening.

28. *Saving in cost of transportation of freight to citizens of Washoe or Nevada Territory* one million of dollars per year.

29. Affords a market for low-class silver ores, (now thrown aside,) for shipment to Europe, from over 3,000 mining claims.

30. Is advantageously located for an extension to Oregon.

31. Completes first western link of Pacific railroad, overcoming its greatest difficulties.

GENERAL REMARKS CONCERNING LOCATION AND DESCRIPTION OF RIDGE OR DIVIDE.

This divide is the strip of land lying between the American river and its north fork, (on the south,) and Bear river and the South Yuba, (on the north.)

The American river unites with the Sacramento river at the city of Sacramento; Bear river unites with Feather river (a tributary of the Sacramento) about 30 miles north of the city of Sacramento.

The direction of the divide is northeasterly and southwesterly. Its width opposite Sacramento is about 30 miles.

The foot-hills of Sierra Nevada begin at Folsom, on the American, and at Johnson's ranch, on Bear river; the line of foot-hills running through or near Lincoln, (about 15 miles northerly from Folsom, and 10 miles southerly from Johnson's ranch,) forming a piece of land in Sacramento valley, between the foot-hills and Sacramento river, of about 30 miles in length and 20 in width. The ravine of Bear river, from Johnson's ranch to English bridge, (a distance of about 15 miles,) pursues nearly an easterly course, while the course of the ravine of American river, from Folsom, is nearly north, to a point within about 8 miles, (southeasterly,) from English bridge. Here the American river branches, and the ravine of its north fork, as well as that of Bear river, pursue a northeasterly course, but gradually approach each other to a point about 4 miles above Illinoistown, called Long ravine, where the two rivers are less than three miles apart.

At this point occurs the greatest depression on the ridge, and the greatest difficulties in location were found.

From Long ravine, the ravines of these rivers diverge somewhat, but are scarcely further than six miles apart at any point—the ravine of North Fork and its tributaries and branches continuing up to the summit.

Numerous branches and ravines extend northerly from the North Fork, rendering a location on that side extremely difficult, if indeed practicable, our line at Long ravine being about 1,200 feet above the bed of North Fork. The ravine of Bear river extends up about fourteen miles above Dutch flat, widening out near the source of Bear river into a beautiful valley, called Bear valley, about two miles long and one mile wide. Diminished in size to a small creek, Bear river passes through this valley, and a mile above is lost among the benches to the right. The ridge between Bear valley and North Fork of American is about 800 feet high.

Here occurs a singular freak of nature. The South Yuba, augmented by numerous large branches along its course, is seen emerging from impassable rocky cañons, and sweeping down through the head of Bear valley, it turns suddenly to the north, and pierces the ridge or divide lying north of Bear valley, forcing its way out to the

northward, between rocky walls, surmounted by peaks from 2,000 to 3,000 feet high.

There is little doubt that, at some former period, the waters of South Yuba flowed through Bear valley, and down the ravine of Bear river; and, indeed, it would be no difficult matter to turn the whole volume of South Yuba into Bear river at the present time.

The South Yuba Canal Company, who supply the Nevada divide with water for mining purposes, take their water from the South Yuba, at the head of Bear valley, bringing it down through Bear valley by the side of Bear river, with a grade of about ten feet per mile, being, at points, as near as 200 feet to Bear river, and not over fifteen or twenty feet above it. Thus it will be seen that the cañon of Bear river becomes and is the same as that of the South Yuba, which latter river now takes its place, the divide or ridge being now bounded by North Fork of American on the south, and South Yuba on the north.

The ravine or valley of South Yuba continues on to the summit of Sierra Nevada, and in Summit valley, within two miles of Summit, the river is a larger stream than is Bear river in Bear valley.

A barometrical examination of this route indicated that the top of ridge or divide could be reached at Clipper gap, near the head of Dry creek,  $48\frac{1}{2}$  miles from Sacramento. From this point to Reservoir gap, (about  $11\frac{1}{2}$  miles above Dutch flat, and 25 miles from Clipper gap,) it was found that the line must be carried on the top of ridge.

The line of top or crest of ridge being far from uniform, of course the lowest points or gaps in ridge become commanding points, and it was found necessary to carry the line from gap to gap, passing around the intervening hills upon their side slopes.

It was also found, upon reaching New England gap, (near the New England mills, about six miles from Clipper gap,) that to Long ravine, a distance of eight miles, the ridge was nearly level, the elevation of grade at Long ravine being only about 100 feet higher than at New England gap.

Also, that the ridge rose rapidly from Long ravine, eastward to the next gap, (called Secret Ravine gap.)

It was also found that from Reservoir gap ( $11\frac{1}{2}$  miles above Dutch flat) the ridge rose too rapidly for one maximum grade, and that for the next 20 miles, to the bottom or valley of Yuba, the line must be carried on the main slope of Bear and Yuba rivers. It was thought, however, that the line could be carried up Cañon creek (a tributary of North Fork, with tolerably smooth side slopes,) to Dutchman's gap, about eight miles above, and there cutting through the gaps brought out on to Bear river side-hill.

Subsequent examination proved this to be impracticable. Cañon creek rising too rapidly for our grades, we were therefore compelled to carry the line immediately on to Bear river side-hill, and were fortunate enough to be able to avail ourselves of the side-hill of Little Bear river for that purpose.

Being on the top of ridge at Reservoir gap, we were enabled to



cross Little Bear river near its head, and to use its side-hill for an approach to Main Bear river.

The barometrical elevations also indicated that the Yuba could be reached about twenty miles above Dutch flat, at the head of its cañons, and the line carried along up its smooth, uniform bottoms for some distance; then, by taking to its south side-hill, Summit valley and summit reached with maximum grades.

The South Yuba, from this point (twenty miles above Dutch Flat,) called Yuba bottom, extends to the summit, a distance of sixteen miles, most of the way through a valley in some places 500 or 600 feet wide. The old Truckee emigrant trail follows down through the valley a portion of this distance, generally over a smooth natural road.

Were the fall of this river evenly distributed it would afford a uniform grade of a little less than 100 feet per mile to the summit.

Rising, however, from Yuba bottom (say half a mile at a grade of fifty feet per mile) the river cañons for half a mile at a steeper grade; thence for four miles its grade is about sixty feet per mile; it then cañons, rising about 250 feet in a mile, at a point called Slippery Rock cañon.

The river then rises gently for about three miles, and again rapidly for three miles, to Summit valley.

Through Summit valley (a distance of two and a half miles) its grade is scarcely twenty-five feet per mile, then rises rapidly again to the summit.

Inasmuch as the indications of altitude of the aneroid barometer proved lower than those of the true level, after continuing our line for six miles along Yuba bottom, we were obliged to retrace our steps and commence again near Yuba bottom, running up on south side-hill of Yuba, with maximum grade, into Summit valley, in order to attain a sufficient elevation to reach the summit.

Summit valley is a beautiful valley near the source of the Yuba, about two and a half miles long and three-quarters of a mile wide, yielding excellent pasturage for cattle, hundreds of which are driven there each summer.

From the summit, looking easterly, you appear standing upon a nearly perpendicular rocky wall of 1,000 feet in height.

Immediately below is seen a valley, from one to two miles wide, extending up from the Truckee river to nearly beneath your feet. Donner lake (about three and a half miles long by one mile in width,) occupies the upper portion of this valley, and its outlet is seen pursuing its course down to a junction with the Truckee. Two long ranges or spurs are seen on either side, parallel with and enclosing the lake, reaching from the summit to Truckee river. Immediately beyond the river is seen the second summit of Sierra Nevada, while still further in the distance the Washoe mountains are plainly visible.

Passing the summit our line is carried down upon the side-bill of the range, on south side of Donner lake, descending with the maximum grade for about eleven miles.

The distance, in a direct line, from summit to Truckee river, does

not exceed eight miles; but we fortunately encountered two long ravines, with smooth side slopes, which, with the sinuosities of side-hill, gave about three additional miles of distance, enabling us to reach the Truckee with maximum descending grades.

#### PARTICULAR DESCRIPTION OF LINE.

Commencing at the city of Sacramento, the line will cross the American river about half a mile above Lisle's bridge; thence pursuing a northeasterly course, for twenty-five miles, across the Sacramento valley, it reaches the town of Lincoln, or intersection with the California Central railroad, which point is at an elevation of 140 feet above the top of the levee at Sacramento.

From Lincoln the line follows up an indentation or bay, in the foot-hills, with grades not exceeding 50 feet per mile (passing half a mile north of Virginia) to Barmore's, thirty-one miles from Sacramento, (elevation 340 feet above Sacramento,) from which point grades of 84 feet per mile are first used.

Continuing up on the southerly bank of Doty's ravine, (passing about one mile north of Gold hill,) the line crosses Doty's ravine, running down the north side of same for about one-quarter of a mile, with ascending grades; thence, turning to the right, it crosses the travelled road near Dutch Colonel's House, and passes up the upper portion of what is known as Shipley ravine.

Thence crossing northeastly corner of the old Boyen ranch, it follows northerly, (near the line of what is known as Sailor's Ravine ditch,) at the base of the foot-hills, to Sailor's ravine.

Running up Sailor's ravine about one-third of a mile, the line crosses the same, and, turning to the left, it passes about 300 feet east of Moore's house, continuing on, up a branch of Sailor's ravine, to a point called Bar summit, having attained an elevation of 660 feet above Sacramento.

Thence, winding about between the heads of small ravines, it crosses near the head of Taylor's and Sedergest ravines, and passing about two-thirds of a mile north of Taylor's house, reaches the side-hill of Dry creek.

Passing up the south side-hill of Dry creek, the line follows up two tributary ravines a short distance to a favorable crossing, and in a short distance further strikes another tributary called Deadman's ravine.

This ravine presenting a smooth side-hill, the line continues up the same about half a mile, to a favorable point, where it crosses, at a height of about 45 feet.

Pursuing its course down the east side-hill of Deadman's ravine, it strikes again the main side-hill of Dry creek, following the same to the point where it breaks from its smooth, uniform valley into rocky cañon; thence up Dry creek, about two and a half miles, to the Auburn and Nevada stage road.

From the Nevada stage road to Clipper gap (a distance of six miles) the line follows up the valley of Dry creek, with grades vary-

ing from 50 feet to 105 feet per mile. At one point on the profile a grade of 116 feet per mile will be observed. This is the grade upon the line as run; but a slight alteration of line will reduce it to 105 feet.

From point where Dry creek cañons to Clipper gap, the line passes up and near to Oert's house, Page's Redwines, passing under the flume of Bear River ditch, and crossing Wyman's turnpike and Auburn and Nevada stage road at Hawes's store.

Thence, passing over lands and near dwellings of Welles, Gilbert, Cook, Kingsley, Cogswell, Watson, Buckley, and Neil, it reaches Gasorway's, or Golden Gate Hotel, passing about 25 feet in front of Gasorway's house.

Here the stage road forks, one branch following up a side ravine to the left, over Tunnell hill, and *via* Empire Mills to Illinoistown, while our line continues to the right, up Dry creek, about a mile further, passing about 200 feet in front of Predmore's house.

Here, instead of following Dry creek further, (it rising too rapidly for our grades,) we cross a gap to the right, called Clipper gap, and run up the north side-hill of Clipper ravine, a tributary of North Fork of American, to Wild Cat summit, crossing several short, steep side ravines.

Passing through Wild Cat summit, about one-quarter mile south of Widow Hawes's house, we pass around Hawes's hill, and, curving to the left, cross the main road and pass up a smooth ravine to the top of the ridge, at a point called Applegate summit.

A short distance further on the line passes through Evergreen gap, crossing the divide again at Baney's gap, from which point it curves round on side-hill (on North Fork side) to Star House gap, near the Star House.

Here the line crosses Star House gap (and the travelled road) about 50 feet high, passing up very nearly on the top of divide to the head of Applegate ravine, which runs into Bear river, this point being called New England gap.

From New England gap the line passes out upon north side-hill of North Fork.

Crossing the travelled or stage road, it runs along above the same, and about 500 feet above New England mills, through peach orchard of Murphy, through Manzineta and Chaparrel gaps, and over Sugar Loaf summit to Lower Illinoistown gap, at the point where upper stage road crosses the gap, about one and a quarter mile below Illinoistown.

Crossing this gap, about 30 feet high, the line continues on about half a mile further, over a broken country, to a point called Bear River gap, where it turns abruptly to the left, with maximum curve, and crosses the ridge with a tunnel of 500 feet in length, emerging on the south side-hill of Bear river, along which it pursues its course to Storm's gap and Long Ravine gap, leaving Illinoistown about one mile to the right.

Here was found the greatest difficulty in location; Long Ravine

gap being an unusually low depression, the ridge beyond rising quite rapidly to attain its average elevation.

Here the line crosses gap, about 70 feet high, and curving to the right follows the-side hill of Rice's ravine (leading to North Fork) for about one mile, encountering a succession of short, steep, abrupt side ravines, to Cape Horn, which is a bold, rocky bluff, nearly perpendicular, and 1,200 feet high, above the North Fork of American.

Passing round the face of this bluff, about 200 feet below the table above, we strike the side-hill of Robber's ravine, which runs parallel to Rice's ravine, and continues up along the side-hill of same for about  $1\frac{1}{2}$  mile, crossing Oak summit, and passing about three-quarters south of Madden's toll-house, through Trail summit.

From this point the line follows along the face of side-hill above North Fork, striking Secret ravine, along which it runs for about one mile, when, turning to the left, it passes up a tributary side ravine to its head, the line striking a point about two hundred feet south of stage road, one mile south of Secret town.

Running thence, alongside of road nearly a mile, it crosses the same, and passing between Everhart's house and barn, at Secret town, it reaches the head of Secret ravine, or Secret Town gap, crossing it with trestling, about 50 feet in height.

Turning to the left, the line now passes north of Cold Spring mountain, (on Bear river side,) and for two miles encounters a succession of steep side ravines, where some of the heaviest work on the line will be found. Two tunnels will be necessary on this piece of line, each about 600 feet in length.

Leaving the side-hill again, the line strikes a long and nearly level bench, about two miles in length, extending up nearly to Dutch flat.

This bench is the well-known gravel ridge which extends along the slopes of the Sierras at about this elevation, and on which are situated the mines worked by the hydraulic mining process.

Extending up this ridge to within about one mile of Dutch flat, the line again takes to side-hill to the left, running near to Strong's cabin, Brickell's steam saw-mill, Dutch Flat steam saw-mill, to the Dutch Flat Water Company's large reservoir, about one  $1\frac{1}{2}$  mile above Dutch flat.

The town of Dutch Flat lies on Bear River side-hill, about half-way down to Bear river, the line passing about half a mile in the rear, and about 300 feet higher than the town.

At this last-named reservoir, which is upon the top of ridge, called Reservoir gap, we leave the crest of ridge for the last time, it rising too rapidly to be available for a railroad line at our maximum grades.

Turning to the left, the line now runs at nearly a level grade, about  $1\frac{1}{2}$  mile further to Little Bear river, which stream it crosses just above the saw-mill, near Widow Homer's ranch.

Pursuing its course down the north side-hill of Little Bear river, it departs at Elmore hill, passing round the same, and enters upon the side-hill of Bear river.

The river gorge at this point is about 1,500 feet deep; our line being about 500 feet below the top of ridge, and from 1,000 to 1,200

feet above the river. Its side-hill is steep, rocky, and marked by many abrupt indentations and corresponding salient points.

The line was carried *round* most of these points ; but, upon a final location, it will probably be found advisable to run through the sharp points with short tunnels—the longest of which will be 1,350 feet—none of them, however, requiring shafting.

The line passes up this side-hill of Bear river, (the grade line being nearly parallel with the crest or top of ridge, and from 500 to 700 feet below the same,) crossing through Zerr's ranch, (about 600 feet north of his buildings,) striking the lower end of Bear valley, about 200 feet high, on its south side-hill.

Continuing on for two miles, it leaves the head of Bear valley, at an elevation of about 350 feet on side-hill above the same, crossing the head of Bear river, (which is here but a small creek,) following it up to its source, which is in a marshy lake, about  $1\frac{1}{2}$  mile above Bear valley.

It will be observed on the profile that from Zerr's ranch to head of Bear river a grade line is indicated, running about 100 feet higher on the side-hill.

In locating the line as run, the intention was to cross Bear river, and continue on the side-hill of the main gorge to Yuba river, (near head of South Yuba Water Company's canal,) keeping up on main side-hill of South Yuba to Yuba bottom; but, upon examination, this proved to be impracticable, the Yuba above Bear valley running in deep rocky cañons, with perpendicular rocky walls of granite, too rugged in their character to admit of the location of a line over them.

It therefore became necessary to carry the line on to a bench above and south of the Yuba river, and nearly at the base of a main ridge—a line from Zerr's ranch to this point being practicable at our maximum grade, the only change necessary being to make the location a little higher on side-hill.

Our present line passes about 100 feet to the left of Jew David's cabin. On the location, as changed, it will pass a short distance in the rear of the same.

Continuing on, the line pursues the general course of Yuba river, about six miles further, to the point where old Truckee emigrant trail leaves Yuba bottom to ascend on the main ridge to the south (which point is 19 miles above Dutch flat by trail, and about  $22\frac{1}{2}$  miles by our line), called Yuba bottom.

This point is at the head of the lower cañons and falls, between Yuba bottom and Bear valley.

In a subsequent location, it will be necessary to run the line between these two points, (viz: head of Bear river to Yuba bottom,) a little lower down on side-hill, as indicated on profile, for the following reasons: Fearing that the elevation of the Yuba bottom might prove too high, the line was run from head of Bear river, at our maximum grade, in order to gain as much elevation as possible. But on reaching Yuba bottom, it was found that this gave more elevation than was necessary ; therefore the last half mile of line was run down on to Yuba



bottom. The last elevations show that a grade of 80 feet per mile can be obtained from head of Bear river to Yuba bottom.

From this point (Yuba bottom) the line follows the river for about one mile, passing through a short cañon, and emerging at very near the level of water surface in river (called Hall's cañon.)

From this point the line was first run for about six miles up the river valley, taking to side-hill at the two upper cañons, the line being carried up to the upper ford, at head of Wilson's cut-off; but finding that the summit could not be reached without increasing grade on the remaining distance, our parties proceeded to summit, from which a line was run down on south side-hill of Yuba, at maximum grade, striking into the valley line, at head of first small cañon (about one mile above Yuba bottom) called Hall's cañon.

The location, therefore, is carried from Hall's cañon, on south side-hill of Yuba, at maximum grades, into lower end of Summit valley, (about  $3\frac{1}{2}$  miles below summit of Sierras,) crossing the old Truckee emigrant trail, near Kidd's reservoir, about half-way up to the top of bridge, the line striking the lower end of Summit valley, about the level of Yuba river; running thence straight across Summit valley, about two miles, at a grade of about 25 feet per mile, to a point on the south side of Summit valley, near Cook's old cabin, the line takes to side-hill on the right, and in  $1\frac{1}{2}$  mile further reaches the summit of Sierras, with a cutting of about 50 feet.

By commencing the last-named ascent a little further back in Summit valley, the summit can be reached with maximum grades without any excavation. The elevation of surface at summit is 7,027 feet above top of levee at Sacramento.

#### DESCENT ON EASTERN SIDE OF SIERRA NEVADA.

Pursuing its course from the summit easterly, the line commences its descent with maximum grade, and, passing to the right, is carried for next two miles over a steep, rocky side-hill, on which will be found quite heavy rock cutting; thence, turning abruptly to the right, it enters upon side-hill of Strong's ravine, and, running up the same, about one mile, crosses over, and is carried down over a smooth side-hill, to a point 600 feet higher than the southwest corner of Donner lake; thence pursuing its course along the side-hill for about three miles, it encounters Coldstream ravine, and runs up the same a little over a mile.

Crossing Coldstream, the line follows along down its south side-hill to within about  $\frac{1}{4}$  mile of the Main Truckee, where, turning to left, it crosses the valley of Donner creek, accomplishing the descent in about  $11\frac{1}{2}$  miles of downward maximum grade. Thence the line was carried about five miles down the valley of Truckee river, and the survey terminated at a point 128 miles from Sacramento.

The object of this survey being to accomplish the crossing of the Sierras with a railroad line, it was considered unnecessary, at this time, to extend the survey any further down the Truckee river; barometrical elevations were taken from our line up the Truckee

river to Lake Bigler, and also down the same to the lower end of Truckee meadows, showing its average fall to be only about 35 feet per mile.

I also carried a series of observations down Steamboat valley to Steamboat springs; thence across the Washoe mountains (*via* Virginia, Flowery, and Six Mile cañon) to the Carson river; thence down the same to Fort Churchill—a profile of which is shown on the small general profile of grades.

A continuation of our line down the Truckee to Big Bend follows the same, from terminus to survey, 13 miles to Neil's ranch, or Henness road; thence 7 miles to Stout's crossing of Truckee; thence through the Truckee meadows and across head of Steamboat valley 8 miles to Stone's crossing or western base of Washoe mountains; thence 23 miles, through Washoe mountains to Big Bend of Truckee, or edge of Humboldt desert, making total distance about 178 miles.

No obstacle exists, and a line, with light grades over exceedingly smooth surface, can be carried from Stout's crossing of Truckee, up Steamboat valley, to its head; thence through Washoe valley into Eagle valley, which opens into Carson valley; thence down the Carson river to Fort Churchill, or edge of desert, making, however, a longer line than that down Truckee.

#### GRADES.

The following table of grades extends from Lincoln (25 miles from Sacramento, and 6 miles from westerly base) to terminus of survey, (or four miles beyond eastern base of mountains,) or includes 11 miles beyond base of mountains. The average grade from Sacramento to Lincoln (25 miles) being six feet per mile.

*Table of grades.*

Length of plane, feet.	Grade ascends per mile.	Grade descends per mile.	Length of plane, feet.	Grade ascends per mile.	Grade descends per mile.	Length of plane, feet.	Grade ascends per mile.	Grade descends per mile.
3,000	9	-----	11,000	105	-----	10,500	105	-----
3,000	53	-----	4,000	53	-----	1,000	53	-----
1,000	Level.	-----	6,750	105	-----	500	Level.	-----
3,000	45	-----	18,250	Level.	-----	5,000	79	-----
4,500	Level.	-----	3,000	105	-----	3,000	105	-----
6,500	45	-----	1,000	Level.	-----	3,000	79	-----
4,000	36	-----	6,000	36	-----	38,000	105	-----
4,300	53	-----	13,500	Level.	-----	2,000	Level.	-----
6,300	79	-----	17,500	105	-----	1,000	53	-----
3,200	Level.	-----	1,000	Level.	-----	25,000	79	-----
500	53	-----	3,500	105	-----	2,750	26	-----
12,700	84	-----	1,000	Level.	-----	3,500	105	-----
3,300	Level.	-----	3,500	105	-----	2,000	Level.	-----
5,000	84	-----	1,000	53	-----	57,500	105	-----
6,000	65	-----	2,500	105	-----	1,750	53	-----
7,100	84	-----	2,000	Level.	-----	2,500	Level.	-----
1,300	53	-----	13,000	105	-----	13,750	105	Summit.
2,500	105	-----	1,000	Level.	-----	45,000	-----	105
1,800	26	-----	1,000	53	-----	1,750	-----	Level.
4,000	75	-----	4,000	Level.	-----	15,250	-----	105
1,000	53	-----	172,500	105	-----	2,500	-----	Level.
1,000	75	-----	1,250	Level.	-----	6,500	-----	53
1,700	105	-----	1,000	79	-----	3,200	-----	39
2,500	75	-----	1,000	Level.	-----	2,750	-----	Level.
2,000	105	-----	4,000	53	-----	3,500	-----	39
2,000	65	-----	14,000	105	-----	1,000	-----	53
3,000	105	-----	3,000	53	-----	2,000	-----	39
15,000	116	-----	4,000	79	-----	-----	-----	-----

*Summary of grades.*

	Grade—feet per mile.	Miles ascending.	Miles descending.	
	9	0.56	-----	
	26	0.86	-----	
	36	1.89	-----	
	39	-----	1.04	
	45	1.80	-----	
	53	5.08	1.42	
	65	1.53	-----	
	75	1.38	-----	
	79	8.39	-----	
	84	8.03	-----	
	105	43.08	11.41	
	116	2.84	-----	
	Level.	11.19	1.33	
Total distance from Lincoln to Summit.	87.63	15.20		
Deduct 7 miles beyond base.....	7.00	4.00		Deduct beyond base.
Leaves distance western base to Summit.	80.63	11.20		Summit to eastern base.

From which it appears that upon the western slope :

Total distance from western base to summit is.....	80.63 miles.
Number of miles of ascending grade 116 feet per mile }	2.84 "
Number of miles of ascending grade 105 feet per mile }	43.08 "
Number of miles of ascending grade 34 feet per mile..	8.03 "
Number of miles of ascending grade 79.75 feet per mile	9.77 "
Number of miles of ascending grade 65 feet per mile..	1.53 "
Number of miles of ascending grade 53 feet per mile..	5.08 "
Number of miles of level.....	11.19 "

While upon the eastern side, or descent, there are 11.41 miles of grade of 105 feet per mile.

The total elevation of grade overcome at summit is 7,000 feet.

That the elevation overcome in crossing the summit of Sierra Nevada is greater than that upon any other line of road in the United States is true. But it is no less true that the grades employed in reaching that summit are less than the maximum grade employed on important roads in the United States; the Pennsylvania Central having 10 miles of grade of 95 feet per mile, while the Baltimore and Ohio railroad has one plane, 15 miles in length, on which are 11½ continuous miles of grade of 116 feet per mile, and 3½ of 100 feet per mile. A portion of the Virginia Central railroad was operated successfully a period of five years over two miles of grades of 300 feet

per mile, with curves of 300, and one as small as 238 feet radius, with a 30-ton locomotive engine.

By referring to the above table of grades, it will be seen that the longest piece of continuously ascending maximum grade of 105 feet per mile is about 10 miles; all of these heavy grades being relieved at frequent intervals by lesser grades or levels. So that on no portion of the road will there be so long a piece of continuously ascending grade of 105 feet per mile as upon the 116-foot grades of the Baltimore and Ohio railroad.

It is deemed unnecessary here to enter upon a calculation of the effective power of locomotive engines upon different gradients, General McClellan having given very full notes of the results of his investigations upon the subject in his memoranda on P. R. R., published in the report of the Secretary of War upon P. R. R. surveys. The following extracts from his report are given here:

"On the Pennsylvania Central road are gradients of 95 feet per mile for  $9\frac{3}{4}$  miles. Passenger trains ascend this grade with a velocity of 24 miles per hour, and descend at 20 per hour.

"The working load of the heavy freight engines (weighing 65,000 lbs., on eight drivers) on the 95-foot gradient is 125 tons net, or about 208 tons, including tender and cars."

Of the Baltimore and Ohio railroad he says:

"The most interesting and analogous case, however, to which I can refer is that of the Baltimore and Ohio railroad, one of the great lines in the United States, alluded to in a previous part of this article as connecting the seaboard with the valley of the Mississippi across the Alleghany mountains. In the year 1850, 447,000 tons of merchandise and 180,000 passengers were transported on this road, the receipts amounting to \$1,343,000, the road being only about half completed. When finished to the Ohio river the receipts are expected to amount to \$3,000,000. On this road are heavy gradients, with several curves of 600 feet radius, and some of four hundred feet. It is to the mountain district of the road just opened that I wish particularly to invite attention, and for this purpose an extract is made from the official report of the chief engineer, Mr. Latrobe, one of the most distinguished engineers of North America, in which he describes the route and grades over the Alleghany mountains."

"At about a mile below this point the *high grade of 116 feet per mile begins and continues about  $11\frac{1}{2}$  miles*, crossing the Potomac from Virginia into Maryland near the beginning of the grade, and thence ascending the steep side slopes of Savage river and Crab Tree creek to the summit, at the head of the latter, a total distance of about 15 miles. Upon the last three and a half miles of which the grade is reduced to about 100 feet per mile. From the summit the line passes for about 19 miles through the level and beautiful tract of country so well known as the Glades, and near their western border the route crosses the Maryland boundary, at a point about sixty miles from Cumberland, and passes into the State of Virginia, in whose territory it continues thence to the terminus on the Ohio. From the



Glades the line *descends by a grade of 116 feet per mile for eight and a half miles*, and over very rugged ground, and thence three and a half miles further to Cheat river, which it crosses at the mouth of Salt Lick creek. The route, immediately after crossing this river, ascends along the broken slopes of the Laurel Hill, by a *grade of 105 feet per mile for five miles*, to the next summit, passing the dividing ridge by a tunnel of 4,100 feet in length; and whence, after three miles of light grade, a descent by the *grade of 105 feet per mile for five miles* is made to the valley of Raccoon creek, by which and the valley of the Three Forks creek the Tygarts Valley river is reached in fourteen miles more, at the turnpike bridge above described, and 103½ miles from Cumberland."

*Virginia Central railroad.*

Upon the Virginia Central railroad the Alleghany mountains were crossed with grades of 296 feet per mile, and the road operated successfully a period of over five years.

Reference is had to a pamphlet published by Chas. Ellet, esq., the engineer of the road, who says:

EASTERN SIDE.

"The length of descent from summit to foot of grade, on eastern side, is 2 37-100 miles.

"The road descends in this distance 610 feet.

"The average grade is therefore 257 feet per mile.

"The maximum grade is 296 feet per mile.

WESTERN SIDE.

"Length of descent 2 2-100 miles.

"Road descent in this distance 450 feet.

"Average grade is 223 feet per mile.

"Maximum grade is 280 feet per mile.

"On both sides of mountains the ruling curves are described with a radius of 300 feet, on which the grade is 237 feet per mile."

"The admirable engines relied on to perform the extraordinary duties imposed upon them in the passage of this summit have failed *but once* in this period (2½ years) to make their regular trips. The mountain has been covered with deep snow for many weeks in succession, and the cuts have been filled, for long periods, many feet in depth, with drifted snow; the ground has been covered with sleet and ice, and every impediment due to bad weather and inclement seasons has been encountered, and successfully surmounted in working the tracks.

"The total weight of engines is 55,000 lbs., or 27½ tons, when the boiler and tank are supplied with fuel and water enough for a trip of eight miles."

"Ascending engines stop daily on a grade of 280 feet per mile, and are there held by the brakes while the tanks are being filled, and are started again, at the signal, without difficulty."

With the practical experience afforded by the workings of these roads, it may be safely assumed that a thirty-ton engine with eight drivers will ascend the maximum grades of this road with an ordinary passenger train at a speed of twenty miles per hour.

That an engine of the same class will ascend these grades, with a freight train weighing 150 tons, at a speed of 13 miles per hour.

The following is taken from memoranda of General McClellan on subject of Pacific railroad:

Calculations for a 30-ton engine on 6 drivers, total adhesive weight.....	67,200 pounds.
By formula 1, maximum load on a level is.....	1,680 tons.
By formula 2, maximum grade up which this engine can draw a load of 76 tons is.....	401 feet.
By formula 4, the maximum grade for same load is.....	281 feet.
By formula 1, the maximum load for grade of 150 feet is.....	186 tons.
By formula 3, the maximum load for same grade is.....	133½ tons.
By formula 1, the maximum load for grade of 200 feet is.....	146 tons.
By formula 3, the maximum load for same grade is.....	104½ tons.

*Comparison of elevations overcome.*

Route.	Length.	Summit elevation.	Total rise and fall.	Maximum grade.
	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>	<i>Feet.</i>
Boston route.....	500	1,440	4,700	83
New York Central.....	400	650	2,100	30
New York and Erie.....	460	1,720	6,500	70
Philadelphia route.....	340	2,400	5,600	95
Baltimore route.....	390	2,700	7,000	116
Charleston route.....	490	1,400	5,000	40
Savannah route.....	440	1,400	5,000	40
Santiago.....	110	2,640	4,340	119
Central Pacific.....	140	7,000	8,800	105

It will thus be seen that the sum of ascents and descents upon this line are but 1,800 feet more than upon the Baltimore and Ohio railroad, our line crossing a summit of 7,000 feet, the elevation of summit on that road being only 2,700 feet.

The small percentage of total rise and fall upon this line, as compared with the altitude of summit, is due to the fact that there are no undulatory grades—the rise and fall is constant, no elevation being lost.

GRADES ON LIEUTENANT BECKWITH'S ROUTE FROM LASSEN'S TO SALT LAKE—  
451 MILES.

The following is a statement of grades from Lassen's to Salt Lake, taken from Lieutenant Beckwith's profile, assuming his projected improvements in location:

	Miles.	Ascending grade, feet per mile.	Descending grade, feet per mile.
Lassen's to Junction Main Forks of Humboldt.....	145	4	-----
Junction Forks to creek.....	35	31	-----
To stream near summit.....	8	89	-----
To summit of Humboldt mountains.....	1	25	-----
Summit to mountain stream.....	3	-----	25
To Camp 16.....	8	-----	58
To Camp 15.....	15	4	-----
To Camp 14.....	28	7	-----
To Camp 13.....	10	-----	21
To Camp 12.....	20	Level.	-----
To Camp 10, Fish creek.....	28	-----	31
To point on Fish creek.....	16	Level.	-----
To Camp 8, Granite mountains.....	40	-----	10
To Camp 6.....	24	0½	-----
To Camp 5.....	15	-----	12
To shore of Salt Lake.....	21	-----	10
To Camp 3.....	13	18	-----
To Oquirrh mountains, or opposite Salt Lake City....	21	8	-----
	451		

The highest grade shown being eight miles of eighty-nine feet grade, which can probably be reduced to fifty or sixty feet per mile.

#### ALIGNMENT.

The first twenty-five miles of line from Sacramento to Lincoln will be generally straight. From Lincoln to Barmore's, or six miles further, the least radius of curvature will be 1,432 feet.

From Barmore's (or western base) to the Truckee river, or eastern base of Sierra Nevada, the line is mostly on side hill; there is, consequently, a preponderance of curved line rendered necessary by the sinuosities of side hill and projecting points.

The least radius of curvature, however, upon the line is 573 feet, or a ten-degree curve.

The Baltimore and Ohio railroad has several curves of 600 and some of 400 feet radius.—(See report of General McClellan.)

The Virginia Central railroad had curves of 300 feet radius, on

which the grade was 237 feet per mile. One curve upon that road had a radius of 238 feet.—(See report of Charles Ellett, esq.)

Curves of 500 feet radius are common upon many of our eastern roads, and are safely traversed at a speed of thirty miles per hour.

For a particular description of the alignment of this road attention is invited to the large map of location, (scale 400 feet per inch,) exhibiting each curve and tangent, with the length and radius marked upon it.

Also, to the tabular arrangement of the same, in which each curve and tangent is laid down, from which it will be seen that between Barmore's and Truckee river, a distance of ninety-two miles, there is of straight line:

Number of curves of 573 feet radius.....	157
Number of curves of 716 feet radius.....	65
Number of curves of 955 feet radius.....	140
Number of curves of 1,432 feet radius.....	65
Number of curves of 1,910 feet radius.....	62
Number of curves of 2,865 feet radius.....	23

From the eastern base of mountains to Big Bend of Truckee the length of curved line will not exceed thirty per cent. of the whole distance, the curves being generally of over 1,500 feet radius.

Thus it will be seen that the alignment of this road compares favorably with that of many of the most important roads of the Atlantic States.

#### SNOWS.

The argument of obstruction from snow having been frequently urged against the central route for Pacific railroad, I have taken much pains to arrive at correct conclusions upon this subject, and feel warranted in the statement *that a railroad line upon this route can be kept open during the entire year* for the transaction of its business.

It is true that snow falls to a greater depth upon the elevated portions of this line than upon the lines of railroads in the Atlantic States.

The depth at which snow lies upon this route is plainly distinguishable at any season.

The trees are generally covered with moss down to the level of the snow, and thousands of them can be seen entirely free from moss up to a certain height, and almost entirely covered with moss from that height.

Frequent marks have also been made by persons who have traversed the route on snow-shoes during the winter by axe marks chopped in the trees at the level of the snow.

The limbs of the small trees also afford indications of the height of snow, those limbs lying beneath the snow maintaining their original or natural position, while those above the snow line are almost universally bent downwards, and not unfrequently broken by the weight of snow.

These observations lead to the conclusion that the greatest depth of undisturbed snow is 13 feet at the summit.

In places where drifts occur the depth is, of course, greater, and at corresponding points less than the average level.

This may at first seem to be a serious obstacle to the passage of railroad trains. But this depth of 13 feet is not the result of a single storm, but the *accumulation of a number of successive storms occurring during the winter.*

Snow does not melt very rapidly at this elevation during the winter.

A storm will occur and snow fall to the depth, perhaps, of three or four feet.

Another storm will, perhaps, add two or three or four feet to this depth.

Successive storms add to its depth, but it is believed that its highest level is not over 13 feet.

The town of Dutch Flat, seventy-two miles from Sacramento, and forty miles from Summit, may be considered the foot of snow line on western side, snow seldom falling more than two feet there, and melting off in a day or two.

The average depth of snow at lower end of Donner lake is about six feet.

At Neil's ranch, on the Truckee river, twenty-eight miles easterly from the summit, I am assured by Mr. Neil that the greatest depth of snow last winter was eighteen inches, and that during the five years he has lived there it has not exceeded three feet in depth.

It may be safely concluded that the line of deep snows terminates where our line strikes the Truckee river, or say twelve miles from the summit, making fifty-two miles of snow line.

It will also be remembered that our line is almost exclusively a *side-hill line*, from which the snow can be more easily removed than from a level surface.

It is only necessary, then, to start an engine with snow-ploughs from the summit each way at the commencement of a storm, clearing the snow as it falls. A similar course of procedure at each successive storm will keep the track open during the entire winter.

It is also stated that a crust soon forms upon the snow, which prevents its drifting badly.

The only point where we shall encounter a level surface of snow is in Summit valley for about two miles.

By elevating the track at this point no trouble need be anticipated.

The great dread and real danger of a storm in the mountains does not arise from the depth of snow, but from the entire absence of shelter and relief in the mountains, there being no houses of accommodation excepting upon the wagon roads across to Washoe.

The Placerville wagon road is kept open for travel during the entire winter, hotels being established every few miles along the route. With a railroad built upon this route this objection would also be entirely obviated.

#### TUNNELS.

Upon the line, as located, but four tunnels appear upon the profile, but upon further examination it has been deemed expedient to cut



through several sharp projecting points, instead of carrying the line around them.

It is estimated that the cost of these tunnels will not exceed the cost of the increased length of line around these points.

It will be observed that the tunnels are comparatively short, the longest being 1,370 feet in length; they can all be worked from either end, reducing the greatest consecutive length of tunnelling to 685 feet.

They are in rock, generally granite, and require no shafting.

The cost of shafting in long tunnels is usually one-third the whole cost of tunnel.

Their lengths are as follows :

1	500 feet long.	1	1,300 feet long.	1	1,200 feet long.
1	600 "	1	1,370 "	1	1,100 "
1	800 "	1	1,250 "	1	400 "
1	1,200 "	1	1,300 "	1	1,070 "
1	1,000 "	1	1,370 "	1	1,100 "
1	1,100 "	1	300 "	1	450 "
				<hr/>	<hr/>
				18	17,410
				<hr/>	<hr/>

Making 18 tunnels, with an aggregate length of 17,410 feet, costing, at \$50 per linear foot, \$870,500.

The longest tunnel can be excavated in 13 months, at the rate of 2 feet per day.

The following statistics were given in report of General McClellan to the Secretary of War, on Pacific railroad :

*Nerthe tunnel, France*—15,153 feet long; 24 shafts; aggregate length of which was 7,589 feet; deepest of which was 610 feet; in very hard limestone; dimensions,  $29\frac{1}{2}$  by  $26\frac{1}{4}$  feet.

Its cost was as follows :

For mining body of tunnel.....	\$705,982 00
For mining shafts.....	109,081 00
Masonry for shafts.....	49,069 00
Lining for body of tunnel .....	423,711 00
Cost of aqueduct.....	10,607 00

Total cost of tunnel..... 

---

1,298,450 00

---

Cost of mining main body of tunnel, \$46 58 per linear foot.

*Woodhead tunnel, England*— $3\frac{1}{2}$  miles long; 5 shafts; 400 to 600 feet deep; rock, granite, or mill-stone rock; entire cost, \$1,026,705; cost of tunnel, including shafting, \$55 per linear foot. Excavated at the rate of 8 feet per day.

*Uppingham tunnel*—1,320 feet long; cost, \$40 per linear foot.

*Black Rock tunnel, Pennsylvania*—1,932 feet long; rock, greywacke; 6 shafts; cost, \$77 per linear foot.

The cost per cubic yard of excavating tunnels in the United States has been:

Lehigh, very hard granite.....	\$4 36 per linear foot.
Schuylkill State.....	2 00 " "
Union State.....	2 09 " "
Blue Ridge tunnel.....	4 00 " "

A section of tunnel, averaging 20 by 17 feet, contains  $12\frac{2}{3}$  cubic yards per linear foot.

*Time consumed in making the trip with passenger trains from Sacramento to Virginia Station.*

	Distance.	Speed per hour.	Time.
	<i>Miles.</i>	<i>Miles.</i>	<i>Hours.</i>
Sacramento to Barmore's .....	31	31	1. 00
Stoppage at Barmore's .....			.30
Barmore's to Summit.....	81	20	4. 00
Four stoppages, fifteen minutes each .....			1. 00
Summit to Truckee river.....	11	15	.45
Stoppage .....			.15
Truckee to Neil's.....	17	34	.30
Neil's to Stone's, or Virginia Station.....	15	34	.30
Total.....	155		8. 30

A train leaving Sacramento at 6 a. m. would arrive at Virginia Station (13 miles north of Virginia) at 2.30 p. m., passengers reaching Virginia City at 4.30 p. m.; Gold Hill, 4.50 p. m.; Silver City, 5.15; Chinatown, 6.10; and Carson City, 7.15 p. m.

Freight trains leaving Sacramento at 6 a. m. would reach Virginia Station at 7 p. m., including all stoppages.

Returning, the passengers leaving Virginia depot at 5 p. m. would arrive in Sacramento in time to take the 2 o'clock boat, and arrive in San Francisco the same evening.

#### ESTIMATE OF COST.

The estimated cost of this road will be found to exceed the average cost of railroads in the Atlantic States, but is nevertheless a cheaper line than has been heretofore estimated for the crossing of the Sierra Nevada mountains.

The rugged nature of the country over which the line passes, the character of the excavations, (which for ninety miles are almost exclusively rock cuttings,) the high cost of labor in California, the extra weight of rail, (estimated at seventy-five pounds per yard,) with its cost of transportation to California, all tend to swell the cost of road beyond the average cost of railroads in the Atlantic States.

But when it is considered that this line accomplishes the crossing of Sierra Nevadas, (by far the most difficult and expensive portion

of the great line across our continent,) is carried over an elevation of 7,000 feet in height, entirely avoids the second summit of Sierra Nevada, saves 184 miles in distance, and \$13,500,000 in cost to the Pacific railroad, its cost of \$88,000 per mile can scarcely be deemed high.

The Boston and Providence railroad cost..... \$81,273 00 per mile.  
 The Boston and Lowell railroad cost..... 78,636 00 “  
 The New York and Erie railroad, about..... 80,000 00 “  
 The Hudson River railroad, about..... 80,000 00 “

*Cost of road from Sacramento to State line, or Neil's, 140 miles.*

	Miles.	Cost per mile.	Total.
Sacramento to Lincoln .....	25	\$50,000	\$1,250,000
Lincoln to Barmore's.....	6	60,000	360,000
Barmore's to Nevada road .....	12	90,000	1,080,000
Nevada Road to Clipper Gap.....	6	50,000	300,000
Clipper Gap to Long Ravine .....	12	80,000	960,000
Long Ravine to Gravel Ridge .....	9	110,000	990,000
Gravel Ridge to Bear River.....	5	85,000	425,000
Bear River to South Yuba .....	21	100,000	2,100,000
Yuba to Hall's Cañon.....	1	75,000	75,000
Hall's Cañon to Summit valley .....	11	100,000	1,100,000
In Summit valley .....	2	75,000	150,000
To Summit Sierras .....	2	150,000	300,000
Summit to Strong's Cañon.....	2	150,000	300,000
Strong's Cañon to Truckee.....	10	100,000	1,000,000
Truckee to Neil's, or State line.....	16	70,000	1,120,000
Add 18 tunnels .....			870,000
Total cost to State line .....	140		12,380,000

Or an average cost of \$88,428 per mile.

*Additional cost to Stone's crossing of Truckee, or Virginia Station, 15 miles.*

	Miles.	Cost per mile.	Total.
Neil's to Stout's.....	7	\$70,000	\$490,000
Stout's to Stone's.....	8	50,000	400,000
Total cost .....	15		890,000
Making total cost of 155 miles .....			13,270,000

*Additional cost to Big Bend of Truckee, or Humboldt Desert, 23 miles.*

	Miles.	Cost per mile.	Total.
Stone's Crossing or Big Bend.....	23	\$70,000	\$1,610,000
Making total cost of 178 miles .....			14,880,000
Or an average cost of \$83,600 per mile.			

*Additional cost of a railroad line from Big Bend of Truckee to Lassen's Meadows, or to a connexion with Lieutenant Beckwith's line on Humboldt river, 104 miles.*

	Miles.	Cost per mile.	Total.
From Big Bend of Truckee to Lassen's Meadows.....	104	\$60,000	\$6,240,000
Making total cost to Lassen's Meadows 282 miles.....	-----	-----	21,120,000
Or an average cost of \$74,900 per mile.			

*Additional cost of line from Lassen's Meadows to Salt Lake, taken from estimates of Lieutenant Beckwith, Pacific Railroad Reports, 451 miles.*

	Miles.	Cost per mile.	Total.
Lassen's Meadows to Salt Lake.....	451	\$45,000	\$20,295,000
Making total cost of line from Sacramento to Salt Lake, 733 miles.....	-----	-----	41,415,000
Or an average cost of \$56,500 per mile.			

*Estimated cost of line from Salt Lake to Council Bluffs, by Lieutenant Beckwith, Pacific Railroad Reports, 1,125 miles.*

	Miles.	Cost per mile.	Total.
Council Bluffs to Salt Lake.....	1,125	-----	\$58,485,000
Making total cost from Council Bluffs to Sacramento.....	1,858	-----	99,870,000
For purpose of comparison, add cost Sac. to Benicia.	58	-----	2,630,000

	Miles.		Total.
Gives total length, Council Bluffs to Benicia.....	1,916	Total cost.....	\$102,500,000
Estimate by Beckwith's route...	2,100	Total cost.....	116,000,000
Saving, in distance.....	184	In cost.....	13,500,000

*Recapitulation and estimate of entire cost of Pacific railroad line, taking Lieutenant Beckwith's estimates, from Council Bluffs to Lassen's Meadows, and thence via this route to Sacramento—total distance 1,858 miles.*

	Miles.	Cost per mile.	Total.
Council Bluffs to Black Hills.....	520	\$35,000	\$18,200,000
Black Hills to South Pass.....	291	75,000	21,825,000
South Pass to Fort Bridger.....	131	50,000	6,550,000
Fort Bridger to Salt Lake.....	173	60,000	10,380,000
Timpanogos Cañon.....	10	150,000	1,500,000
Salt Lake to Lassen's Meadows.....	451	45,000	20,295,000
Lassen's to Big Bend, Truckee.....	104	60,000	6,240,000
Big Bend to California State line.....	38	66,000	2,500,000
State line to Sacramento.....	140	88,428	12,380,000
Total length.....	1,858	-----	99,870,000

The importance of this route to the great enterprise of which it is destined to form a link cannot be more clearly manifested than in the reduction of cost in constructing the Pacific railroad.

In all the previous comparisons of cost and distance, the central route has labored under great disadvantage, and has not taken the rank among routes to which, by its merits, it was entitled.

A reduction in cost of \$13,500,000, and a saving in distance of 184 miles of line, present features which may well invite consideration from the friends of that project.

#### *General Remarks.*

It will be observed that the estimates of cost and distances from Big Bend of Truckee to Salt Lake are made upon the Beckwith or Humboldt route, a distance of 733 miles.

While it is possible that a more southerly line can be found along or near the Simpson route, in the absence of surveys or data for estimate, no reliable opinion can be found of its feasibility or probable cost.

Our line at Big Bend of Truckee is in position to join an extension on either route.

According to the itinerary of Captain Simpson, it does not appear that the more southerly route presents any advantage in distance to Salt Lake City.

The distance given by Captain Simpson from Carson City to Camp Floyd is 554 miles. Adding to this the distance from Sacramento to Carson City, 142 miles, and the distance from Camp Floyd to Salt Lake City, say 35 miles, it gives the total distance from Sacramento to Salt Lake City as 731 miles.

From our line at Big Bend of Truckee, *via* Simpson route, to Salt



Lake, the distance would be about the same as to Salt Lake City on the Humboldt route; but should the main line of lower road be carried around the head of Utah lake and up the Timpanogos, it would make the lower line about 50 miles the shortest.

If a line can be found from the sink of Humboldt across to Gravelly Ford, (on that river,) it will shorten the Humboldt route about fifty miles.

There are three important considerations, however, which give the route up the Humboldt river a manifest advantage over any other route for a railroad line.

*First.* Its availability for a connexion with Oregon and Washington.

Lassen's Meadows are only about eighty miles south of the forty-second parallel of latitude, which parallel is the southern boundary of Oregon, there being a good emigrant road from that point to Jacksonville and Fort Lane, in Oregon, the line following around the northerly end of Mud lake, up Black Rock creek, southerly end of Goose lake, and between the Klamath lakes to Jacksonville, from which point a good railroad line with light grades was found (see Report of Lieutenants Williamson and Abbott) to Portland, on the Columbia river; the distance from Lassen's Meadows to Jacksonville being about 280 miles.

*Second.* The recent discoveries of silver on the Humboldt river in the vicinity of Lassen's Meadows.

The well-known discoveries of silver ore in the Washoe mountains has drawn thither in the last two years a population of about 17,000 souls, most of whom are hardy, able-bodied miners. Numerous flourishing towns and villages have sprung into existence, permanent improvements have been made, and but a few years will elapse before a new State will be formed out of that portion of Nevada Territory.

Within the last few months discoveries of silver have been made on the Humboldt, which are said to rival those of Washoe. Already a new city is in existence, and hundreds of miners have gone there. There will, of course, be but a small emigration there this winter, but next spring and summer will undoubtedly witness an influx of population hardly second to that of Washoe.

The mines are stated to be of great extent and richness, many of the out-croppings assaying over \$1,000 per ton. A number of tons of ore have been sent to Sacramento and San Francisco for trial, the results of which have proved them to be of extraordinary richness.

Cinnabar and coal have also been discovered in this locality.

Several mills are in the course of erection, and permanent improvements are being rapidly made.

Being on the main emigrant route to California, and accessible from both Oregon and California, the accessions to its population cannot fail to be large; and it will not be many years before the new State of *Humboldt* will apply for admission into the Union.

*Thirdly.* From the feasibility of this as a railroad route, and the character of soil, &c., along its route.

After striking the Humboldt at Lassen's there are 190 miles of unobstructed valley, on which the grade for 145 miles is only four feet

per mile; 36 miles are level; 24 miles has a grade of  $\frac{1}{2}$  a foot per mile; 160 miles has a grade 4 feet; 50 miles has a grade of 7 and 8 feet; 53 miles of grade of 8 and 10 feet; 43 miles a grade of 18 to 21 feet; 40 miles of from 25 to 31 feet; 18 miles of grade of 58 feet, there being only 8 miles of a higher grade in 89 feet, which can undoubtedly be reduced.

The elevation at Lassen's is only about 250 feet lower than the Big Bend of Truckee, the distance 104 miles.

There will be then 539 miles of light grades, not exceeding 31 feet per mile on a line 555 miles long, a feature of no little importance in determining the location of the Pacific railroad.

The valley of the Humboldt has been traversed by many thousands of emigrants to Oregon and California, and is well known to embrace many valleys of alluvial fertile soil.

The general character of the soil in the great basin is barren and sterile, except where intersected by rivers. The valley of the Humboldt has received the largest share of the emigrant travel, for the reason that it afforded good grass and water in abundance.

Being more inviting to emigrants, it will settle up more rapidly, and thereby greatly facilitate the construction of a railroad line on this route.

Accompanying this report will be found the following maps, profiles, &c.:

*A.* Large map, on a scale of 400 feet per inch, (90 feet long,) showing the curves and tangents from Dutch Flat to Truckee river, for filing in Secretary of State's office.

*B.* 17 sheets of location, numbered 1 to 17, inclusive, scale 400 feet per inch, showing curves and tangents from Barmore's (or western base) to Dutch Flat, for filing, as above. (Also copies of same.)

*C.* 5 large maps, (20 feet long,) scale 400 feet per inch, showing curves and tangents, as follows:

No. 1. Barmore's to Clipper Gap.

No. 2. Clipper Gap to Dutch Flat.

No. 3. Dutch Flat to Rattlesnake Bluffs.

No. 4. Rattlesnake Bluffs to Summit.

No. 5. Summit to eastern terminus of survey.

*D.* 32 sheets, numbered 1 to 32, scale 400 feet per inch, exhibiting the angular line as run with projected curves and tangents thereon.

*E.* Map, (16 feet long,) scale 5,000 feet per inch, exhibiting the country from San Francisco to terminus of survey, showing our line, with adjoining towns and rivers, for 10 miles on either side, and connecting railroads.

*F.* Traced copy of the same.

*G.* Smaller map, prepared for lithographing, showing whole country from San Francisco to Big Bend of Truckee.

*H.* Britton and Rey's map of California.

*I.* United States surveyor general's map of State.

*J.* Elliott's map of a portion of the State.

*K.* Ransom's map of San Francisco and 40 miles around.

*L.* Map of Sacramento Valley railroad, Sacramento to Folsom, scale 5,000.

*M.* Map of California Central railroad location, Folsom to Marysville.

*N.* Map of California Northern railroad, Marysville to Oroville.

*O.* Map of survey, Sacramento to Benicia.

*P.* Map of survey, Marysville to Benicia.

*Q.* Map of survey, Folsom to Placerville.

*R.* Smith's map of survey for canal up North fork of American river to Lake Bigler.

*S.* Connected map of Lieutenant Beckwith's surveys, showing the topography, &c., from Benicia to Salt Lake.

*T.* Map of Captain Simpson's route to Camp Floyd.

*U.* Large map, compiled in office of Secretary of War, showing country west of the Mississippi river, with all the surveys for Pacific railroad laid down thereon.

*V.* Smaller map of routes, as above.

*W.* Map of Rancho del Paso, through which our line passes.

*X.* Map of city of Sacramento.

*Y.* Map of survey across Sacramento valley.

*Z.* Degroot's map of Washoe mines, also Pierce's map of Washoe.

#### PROFILES.

*a.* Sheets, 1 to 34, inclusive, working profile of line as run, (horizontal scale 400 feet; vertical scale 30 feet per inch.)

*b.* Profile of line to Dutch Flat, (horizontal scale 500 feet per inch; vertical scale 50 feet per inch.)

*c.* Two profiles of line reaching from Lincoln to Truckee river, (horizontal scale 1,000 feet; vertical scale 100 feet per inch.)

*d.* 1 profile, extending from Sacramento to Big Bend of Truckee; also showing a section of Washoe mountains, on a line from Stout's to Fort Churchill, (horizontal scale 11,000 feet; vertical scale 600 feet per inch.)

*e.* Copy of same, for filing in Secretary of State's office.

*f.* Profile of Lieutenant Beckwith's line, Salt Lake to Fort Reading, containing profile of Noble's Pass.

*g.* 2 sheets of profiles of various southern passes across Sierra Nevada, (published in Secretary of War's office.)

*h.* Barometric profile of reconnoissances in Sierra Nevada mountains, viz: Georgetown route; Dutch Flat route; Henness Pass route via Nevada.

Also a set of Pacific Railroad Reports, and all the maps, profiles, &c., relating thereto, published by United States government.

Our levels indicate that many of the passes in the Sierra Nevada mountains will be found, upon actual survey, much higher than they have been represented.

The estimates of business and revenue of road will be deferred to another time, in consequence of delay in procuring the statistics of the Washoe trade and business.

In conclusion, I take this opportunity of expressing my obligations

to Messrs. Edward Judah, assistant in charge of party ; John R. Brown, in charge of levels ; H. T. Hall, topographer, for the able and satisfactory manner in which they performed the arduous duties assigned them ; also to Wm. S. Watson, esq., chief engineer of California Northern railroad, for valuable assistance in office ; to Dr. D. W. Strong, of Dutch Flat, who accompanied me in my reconnoissance last fall, who was with me during the entire survey, and whose experience in and knowledge of the mountains was of the greatest assistance, and contributed to the success of the survey ; also to S. B. Wyman, esq., of Virginia ; Mr. Neil, of Neilsburgh ; Mr. Applegate, of Empire Mills ; Messrs. Egbert and Brickell, of Illinoistown, who were with me on portions of the route ; to Charles Marsh, esq., of Nevada, who accompanied me on the reconnoissance *via* Nevada and Henness Pass ; also to Messrs. John Shaw, of Mormon Island, and D. W. McKinney, of Georgetown, who accompanied me on Georgetown reconnoissance ; also to Mr. Stout, of Stout's Crossing, Nevada Territory, F. Moore, esq., of Dutch Flat, and R. P. Robinson, esq., of Sacramento, for courtesies extended.

Very respectfully,

THEODORE D. JUDAH,  
*Chief Engineer Central Pacific Railroad of California.*

---

## OFFICERS OF CENTRAL PACIFIC RAILROAD COMPANY, OF CALIFORNIA.

---

PRESIDENT,

LELAND STANFORD, *Sacramento.*

VICE-PRESIDENT,

C. P. HUNTINGTON, *Sacramento.*

TREASURER,

MARK HOPKINS, *Sacramento.*

CHIEF ENGINEER,

THEO. D. JUDAH, *Sacramento.*

---

DIRECTORS :

LELAND STANFORD, <i>Sacramento.</i>	JAMES BAILEY, <i>Sacramento.</i>
C. P. HUNTINGTON, <i>Sacramento.</i>	MARK HOPKINS, <i>Sacramento.</i>
LUCIUS A. BOOTH, <i>Sacramento.</i>	THEO. D. JUDAH, <i>Sacramento.</i>
CHARLES CROCKER, <i>Sacramento.</i>	D. W. STRONG, <i>Dutch Flat.</i>

CHARLES MARSH, *Nevada.*

