The locations and amounts of work most needed are—

| | Cubic yards. |
|---|---|
| At Bonanza Rock, to widen the channel | 250 |
| At Dove's Rock, to widen the channel | 500 |
| At Tualatin Rocks, ¾ mile below Dove's Rock, to widen and straighten the channel | 300 |
| Total | 1 050 |

Tualatin Rocks are visible during daylight, and as there is very little current here accidents have been avoided heretofore by running slowly. The improvement of the two points above will, by enabling boats to run past Rock Island at night, render necessary corresponding improvement here.

No dams were built during the year. Although this plan of work has been eminently successful in opening channels through bars formed of loose gravel at certain points, the improvement has not proved permanent, owing to the peculiar form of the river bed in the vicinity, new bars forming a short distance below the dams. The two worst shoals on the river below Corvallis, Buena Vista and Lone Tree Bars, are of this class, and are almost identical in form. A deep and narrow channel for half a mile or more above the bar maintains a speed of current str ong enough, even at lowest stage, to bring down large pebbles, which are carried over the bar and dropped where the channel widens and the velocity is reduced, producing the shape of a fan with the broad end downstream. Dams built at these points have cut out good channels within a few days after completion, but the next low stage has disclosed new bars several hundred feet below. The extension of the dams year by year has produced no other result than to force the shoals further downstream. To continue to prolong the dams until deep water should be reached would involve great expense, not only in the construction of new but the maintenance of existing work. It was apparent that some other method would have to be resorted to at these points, and, scraping having been tried with good results at Matheney's Bar, 12 miles below Salem, some years since, it was decided to make such alterations in the snagboat as would enable it to do all work which might be necessary on the Upper Willamette. To this end plans were prepared for supplying the boat with motive power, a rake, and an attachable pile-driver, the latter to be used in building dams where required. The funds available not being sufficient to carry out the whole of this plan and operate the boat for the rest of the year, it was decided to omit the pile-driver for the time being. During the winter the other alterations were made, and the boat put into working condition by the 1st of April, 1879.

Stores and other material were then placed on board and the snagboat sent to Centennial Chute, 125 miles above Portland, with orders to remove a large pile of drift accumulated during the past winter, which obstructed the channel, threatening also to divert a large body of water from the present channel through Hogue's Creek into an arm of the river, to the injury of the former; and afterwards to clear out Hogue's Creek down to its junction with the west channel 6 miles below Centennial Chute. This was done, leaving the river open and, in the existing stage of water, navigable from Portland to Eugene City, a distance of 172 miles.

The snagboat was then, May 1, moved up the west channel, removing all obstructions as far up as Booneville, 6 miles above Corvallis, a shipping point of importance. From Booneville the boat dropped downstream, working where required at various points as far as Carey's Bend, 43 miles above Portland. Here, the river having risen 4 feet, work was suspended for a week. About the end of May the boat returned to McCloskey's Chute, 9 miles below Salem, with orders to fell such trees along the east bank as seemed likely to fall into the river and obstruct the channel, and to remove all projecting stumps and snags from the east bank, and to deposit them along the upper slope of the dam, built in 1877 across the west channel, for the purpose of assisting in forming the east channel, now used.

During the month of June the boat has been employed, with interruptions from minor rises in the river, at McCloskey's Chute, and at Lone Tree Bar, 1 mile below.

The operations of the boat during the present year have been much delayed and interrupted by the unusually high and muddy water. Notwithstanding these difficulties the work accomplished has been satisfactory. The expense of towage, which has been heretofore $8 per hour, has been avoided entirely; and the power to proceed from point to point, when desired, at any stage of the water, has saved, as shown by comparison with the record of last year, 23 working days during the present season so far. All things considered, the efficiency of the boat has been nearly doubled. Some alterations in the after rake of the hull, to facilitate backing when raking the bars, are required. These may be made the first time the boat is brought to Portland. For the present the additional power required to drag a full load of pebbles and cobblestones across a bar can be supplied by two timbers, 20 feet long, attached to the hull, one on each side, immersed in the water, to be opened out at any desired angle, like wings, so as to catch the current and assist in propelling the boat downstream. This has been tried with good results. In the event of building another



snagboat, as has been proposed, I respectfully recommend that its power, in proportion to its dimensions, be made equal to that of the ordinary river steamboats. The gain in efficiency will more than compensate for the small additional cost.

A drawing of the snagboat, showing also the rake in position, accompanies the present report.

The rake was used successfully on McCloskey's Bar last week, producing, with the aid of the current, a gain in depth of 2 feet in half a day's work. Below this depth was found a layer of concreted gravel which resisted the rake. It will have to be loosened with giant powder before a good low-water channel can be made here. These strata are found at many points on the Willamette, generally near low-water mark, and vary in thickness from 1 to 2 feet.

## STAGES OF WATER.

The daily variations in the height of the river at Albany throughout the year, and at Salem since the 1st of January last, the date on which the gauge at that point was established, are shown on the profile herewith submitted. The bases of the gauges correspond to the low-water mark of 1878, the lowest on record by about 8 inches.

From June 15 to October 12 the height of water varied from + 1.5 to 0.0. During the greater portion of this time navigation was suspended above Buena Vista, 13 miles below Albany. Throughout November and December the average height was 5 feet above low-water mark, a favorable stage for boating. During the first week in January the river fell to 1.3, rising again to 4.0 on the 12th, since which time it has varied from 3.0 to 22.6, the greatest height occurring on March 28, falling to 2.4 on June 30. From all indications, the low stage has fairly commenced.

## PRESENT CONDITION OF THE RIVER AS TO IMPROVEMENTS MADE AND DEPTH OF WATER.

During the last week in June I made, as instructed, an examination of the river from Corvallis, the present head of low-water navigation, to Oregon City, for the purpose of ascertaining the condition of improvements heretofore made, and their results, and the work required to keep the river open to Corvallis through the present low-water season. Soundings were taken on all of the bars, and the following depths found:

| | Feet. |
|---|---|
| On Stewart's Bar, 111 miles from Portland | 3.9 |
| Upper Half Moon Bar, 110 miles from Portland | 4.0 |
| Lower Half Moon Bar, 109½ miles from Portland | 5.3 |
| Bowers's Bar, middle channel, 106 miles from Portland | 3.3 |
| Pine Tree Bar, 101 miles from Portland | 3.8 |
| Upper Fickel's Bar, 96½ miles from Portland | 4.8 |
| Lower Fickel's Bar, 95 miles from Portland | 5.4 |
| Buena Vista Bar, 90 miles from Portland | 4.6 |
| Long Crossing Bar, 87 miles from Portland | 5.5 |
| Eola Bar, 73¼ miles from Portland | 5.4 |
| McCloskey's Bar, 62 miles from Portland | 3.6 |
| Lone Tree Bar, 61 miles from Portland | 3.7 |
| Beaver Bar, 60¾ miles from Portland | 3.7 |
| Polalley Bar, 18 miles from Portland | 6.0 |

The gauge at Salem read 3.2. Observations heretofore made have shown that when the river falls at Salem, where there is very little current, from 3.0 to zero, the loss of depth on the bars varies from 1.0 to 1.2 feet in proportion to the inclination, or the velocity of the current, over each bar. It is safe, therefore, to assume that the depths above given will not be reduced more than 1.2 feet if the water should fall to zero during the present season, except at Buena Vista and Lone Tree Bars, where, as above stated, the form of the river bed is such as to cause a constant deposit of gravel on the bar during the low stage, and where raking will probably be found necessary occasionally.

The dams marked (x) were all built or added to in 1877. They are in good condition, as far as could be seen at the existing height of water. Any repairs which may appear or become necessary as the season advances can be made by the crew of the snagboat.

## WORK FOR THE PRESENT SEASON.

In addition to the removal of obstructions and raking on the bars, it will probably be necessary to build short dams at several points to assist in confining the currents to the desired channel. Such dams have been built of alternate layers of fascines and

bags filled with gravel, the whole covered with loose gravel and raked to a smooth surface, the crest of the dam being from 1 to 2 feet above low-water mark. Rows of gravel sacks are disposed around the free end or toe of the dam, forming an apron, which resists erosion, and, settling down as the channel is deepened by the currents, serves as revetment to the slope which the bottom assumes. Dams built in this way in 1877 in water 5 feet deep, with a current of from 3 to 4 miles per hour, have stood without injury. Their cost is about half that of the ordinary pile and fascine dam, while for shallow water they are equally as good.

It may not be out of place here to describe the dam built in 1877 across the west channel at McCloskey's Chute for the purpose of confining the current to the east shore. The length required was 730 feet, with an average depth of 2½ feet, in a current running at the rate of 4½ miles per hour. Fir piles 1 foot in diameter were driven in the axis of the dam, 10 feet apart, throughout its length, to a depth of 8 feet into the bottom, which was of loose gravel. A course of fascines made of fir boughs 12 feet long was laid on the bottom between the piles, the butts "tailing" downstream, and covered with sacks two-thirds full of gravel, the object in only partially filling the sacks being to allow them to flatten out, leaving no spaces, and offering the least possible resistance to the current, which flowed over the weir thus formed in a smooth sheet. On this a second course of fascines was laid, then a course of gravel-sacks, bringing the general level of the dam up to the water surface. Low places, corresponding to hollows in the river bed, were then filled with fascines and gravel-sacks, bringing the crest of the dam to a level. Up to this stage of the work all had gone well; but before the stringers or bolsters, preparatory to finishing the work, could be placed on the dam and bolted to the piles the water forced its way through under the bottom course of fascines, near the center of the dam, in a small stream, at first only a few inches thick, but increasing so rapidly by cutting away the fine gravel that it soon got beyond control. Bags of gravel, thrown in as fast as possible in the endeavor to close the breach, were swept many yards downstream; and within an hour the breach had attained a width of 76 feet and a depth of 11 feet. By the time that it could be repaired the renewed pressure of the water broke through the dam at two other points, although without causing so much injury as in the first case.

The breaches were repaired in the following way: Piles from 25 to 35 feet long were driven across them in the axis of the dam, 5 feet apart, down to hard bottom, or until they would enter no farther; young fir trees, from 30 to 50 feet long, weighted by sacks full of gravel tied to them, were sunk to the bottom, and arranged, by means of pike-hooks, parallel to the axis of the dam, above the piles, until an artificial bottom was formed, and the holes filled to the level of the bed of the river. Courses of fascines and gravel-sacks were then added, bringing the dam to a uniform level throughout, except where the first breach had been made, where it was left 2 feet lower, and a stringer laid along the top and spiked to the piles 1 foot below water surface, forming a weir over which the water could flow without injuring the dam. This gap was left in order to relieve the dam from a portion of the pressure until the diverted current should have cut out a sufficient channel along the east bank of the river. The desired result was obtained, the new channel having proven a great improvement on the old.

The bed of the river for some distance above and below the dam has been raised by recent deposits of gravel to within 1 foot of low-water level.

It is gratifying to state the Upper Willamette pilots agree that the river has never been so free from obstructions during low-water as at present.

Yamhill River, which enters the Willamette 40 miles above Portland, is reported as being much obstructed between its mouth and Dayton, its head of low-water navigation, a distance of 6 miles. As the only steamboats which run on the Upper Willamette throughout the year without interruption from low-water are those plying between Portland and Dayton, the depot of a thickly populated and fertile grain district, the maintenance of free navigation on this river is almost as important as in the Willamette proper.

Respectfully submitted.

ROBT. A. HABERSHAM,
*Assistant Engineer.*

Col. G. L. GILLESPIE,
*Major of Engineers, U. S. A.*



## KK 15.

### IMPROVEMENT OF THE UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON TERRITORY.

By act of Congress approved June 18, 1878, the sum of $20,000 was appropriated for the improvement, which has been applied in removing solid rock from the channel through Five Mile, Fish Hook, and Pine Tree Rapids, Snake River.

After inviting proposals in the usual way, by public advertisement, a contract was entered into with George J. Ainsworth, of Portland, Oreg., August 23, 1878, for blasting and removing 1,300 cubic yards of rock, at $13 per cubic yard, the lowest known price for that class of work in this district.

#### PINE TREE RAPIDS.

These rapids are 33 miles above the mouth of the Snake River. Work under contract commenced September 6, 1878, and was closed December 14, 1878, at which time the plant was transferred to Fish Hook Rapids; Coe's Rock, Ring Bolt Rock, and many other large rocks lying just above and below Ring Bolt Rock, besides 27 smaller rocks distributed throughout the channel over Pine Tree Rapids, and aggregating 664.28 cubic yards of solid rock, were removed, giving 5 feet at low-water in the channel. The rapids are still difficult to navigate at low-water on account of the swiftness of the current and narrowness of the channel, but as an evidence of the great practical benefit of the improvement already made, it may be stated that the *North West*, a small steamer plying to Lewiston, Idaho, during low-water passed through the rapids on the 16th November, 1878, in 26 minutes, whereas the time required for the passage before the improvement of this year would have been extended to 5 hours at least, and before any improvement the passage would have been impossible.

#### FIVE MILE RAPIDS.

These rapids are 5 miles above the mouth of Snake River. Work under contract commenced September 9, 1878, and closed December 21, 1878. Two large rocks lying directly in the channel, measuring respectively 180 and 125 cubic yards, together with several other smaller ones, were removed. The total amount removed during the season was 401.32 cubic yards.

The captains of the steamers all report that the rapids have been much improved, and it is believed that but little trouble will be experienced in the future in passing them even at the lowest stage of water.

#### FISH HOOK RAPIDS.

These rapids are 16 miles from the mouth of Snake River.

On the 15th December, after the work of improvement at Pine Tree Rapids had closed, the plant of that improvement was transferred to Fish Hook Rapids, and operations were commenced at once, but the floating ice which soon began to accumulate in large quantities necessitated a suspense of work on the 22d December. Three small rocks were removed, one at the head and two at the lower end of the rapids, aggregating 27.45 cubic yards. Although insignificant in size, the removal of

these rocks has been a great benefit; the original depth of water over them was about 1½ feet, and the improvement has carried this depth to 5 feet at lowest navigable stage. There are two other rocks standing in the channel which have less than 4 feet at low stage over them which will require to be removed. The channel is now from 75 to 85 feet wide at the narrowest point, and after the contemplated improvement has been made there will be full 5 feet at low stage.

These three separate improvements were carried on under one contract which expired March 15, 1879. When the season's work closed, December 22, 1878, there had been removed 1,093.05 cubic yards, about 200 cubic yards less than the contract called for, but as the contractor was compelled to withdraw to Wallula on account of ice, and no more favorable weather for resuming work occurring later during the winter, the contract was closed and the contractor paid off in January, 1879.

Mr. R. H. Tabor, assistant engineer, was in immediate charge of these improvements, and deserves great credit for his zeal, industry, and most efficient service.

By act of Congress, approved March 3, 1879, $20,000 were appropriated for "improving Upper Columbia River, including Snake River." It is expected that this amount will be applied in widening the upper and lower end of the improved channel through the Upper Umatilla Rapids, Columbia River, by blasting rock, and by blasting and removing rock from the channel in Snake River at Fish Hook, Monumental, Texas, Palouse, and probably Long Crossing Rapids. All of these rapids are of difficult navigation at low stage, but by a judicious application of the present appropriation it is believed that many of the dangerous obstacles lying in the channel can be permanently removed, so that boats may be able to make safer and quicker passages to Lewiston. It will be possible hereafter, even with present improvements, for boats to reach the Upper Snake River at Lewiston at low-water, thereby enabling the farmers in this new country to get their produce to market.

The valleys of the Columbia and Snake Rivers and their several tributaries and the high table-land between are rapidly filling up with an active and industrious agricultural prople, and the acreage under cultivation this year is fully one-fifth more than last year. The sheep, cattle, and fruit interests are commanding the attention of the farmers, and we may confidently expect, in the near future, a vast increase in the material wealth of all this part of the country. The well-directed improvements of the government on the Columbia and Snake Rivers have given great encouragement to the farmers, and they are now putting forth their best efforts, assured that they can send their products to market immediately after sending them to the river, where they can be reached by boats. The government works of improvement should keep pace with the rapid growth of the great Northwest. At the present time nothing is so much talked of as the early railroad connection with the East, by which much of the land heretofore lying dormant, on account of its inaccessibility, will be brought into the market and cultivated; surveying parties are in the field examining the most suitable route for the western extension of the North Pacific Railroad. The Union Pacific Railroad is likewise surveying a route for the extension of the Utah Northern Railroad from Fort Hall, Idaho, to Boise City, and thence to the Columbia River at Umatilla, with a possible extension down the left bank of the Columbia to Portland and the sound. The Central Pacific Railroad is said also to be looking for a connection with the Willamette Valley by way of the Winnemucca Pass. Many narrow-gauge railroads are also projected for making connection with the great trunk roads and for permeating the



small rich valleys communicating with the Columbia River and its tributaries, as well as with the coast. These great works will rapidly develop all this western country and create a commerce along the main arteries, which the present condition of navigation will not satisfy.

The rapids of the Columbia and Snake Rivers, from Umatilla to Lewiston, should all be improved so that the least depth over them at low stage should be 6 feet. Former improvements have been judicious and the appropriations therefor have been equal with the demands of commerce, and it is of the highest importance that the work should go on in the future under liberal appropriations.

The present project calls for the removal of about 1,500 cubic yards of rock from the Columbia River above Celilo, and about 2,000 cubic yards from the Snake River between its mouth and Lewiston, at a total estimated cost of about $92,000. Of this amount $75,000 can profitably be employed during the next fiscal year, June 30, 1881, in continuing the improvements of the Columbia River at Homely Rapids, and of the Snake River at Palouse, Texas, Monumental, and Long Crossing Rapids, by blasting and removing rock.

For the present I would recommend no improvement in the Columbia above the mouth of the Snake, nor in the Snake above Lewiston.

Referring to the annual report of Maj. J. M. Wilson for 1878, the amounts appropriated for this work from act of June 10, 1872, to act of June 18, 1878, both inclusive, were $140,000. By act approved March 3, 1879, $20,000 were appropriated to continue the improvement.

Aggregate appropriations to date, $160,000.

Of this amount $136,693.18 have been expended to date, $106,777.95 having been applied to the Columbia River, and $29,915.23 to the Snake River. The residue, $23,306.82, will be applied in part to the Columbia River at Umatilla and Homely Rapids, and in part to the Snake River at Monumental, Palouse, and Texas Rapids.

These rivers are in the collection district of the Willamette. Portland, Oreg., is the nearest port of entry. The nearest light-houses and forts are at the mouth of the Columbia River, but troops garrison the posts of Walla Walla, in the interior, about 32 miles from Wallula, on the Columbia, and of Fort Lapwai, near the Clearwater, 12 miles from Lewiston.

| | |
|---|---|
| The amount of revenue collected at Portland, Oreg., during the 11 months ending June 1, 1879, was | $139,149 40 |
| Value of imports | $399,440 00 |
| And that of exports | $3,157,575 00 |
| The number of vessels entering was | 201 |
| With an aggregate tonnage of | 274,682 |
| The number of vessels clearing was | 201 |
| With an aggregate tonnage of | 285,650 |

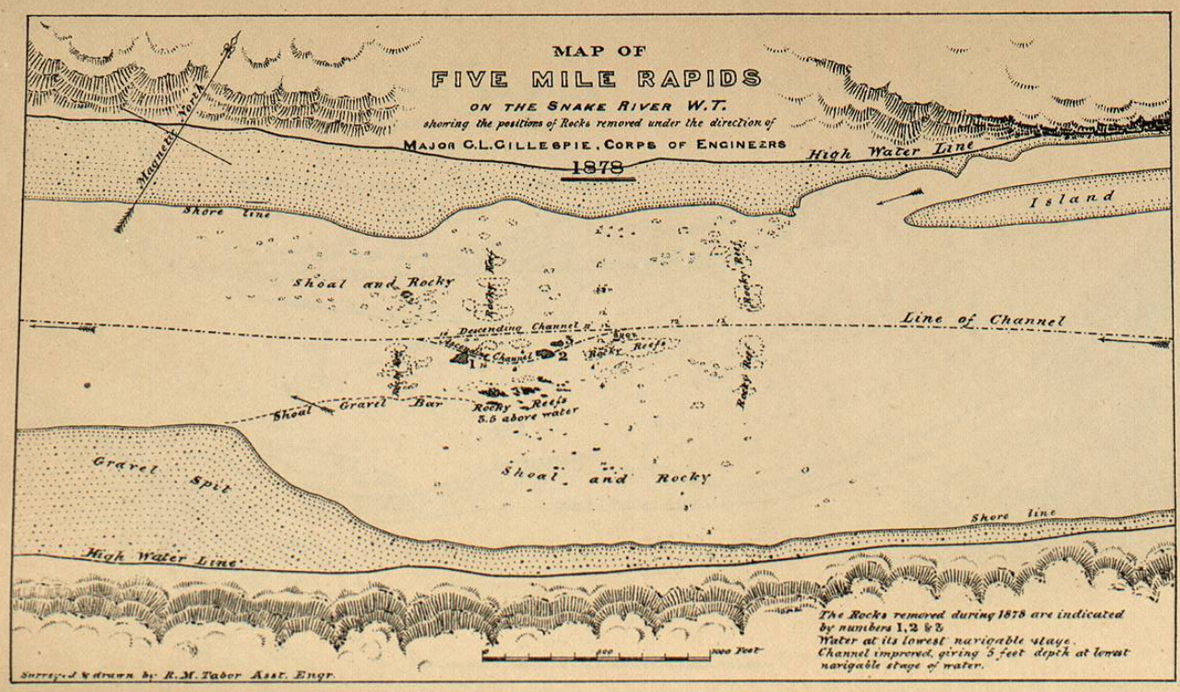
An estimate may be formed of the increasing trade of the Upper Columbia and Snake Rivers by the consideration of the following statistics for the year, which are considered approximately accurate:

| | Tons. |
|---|---|
| Up freight from Portland to the Upper Columbia | 31,800 |
| Down freight to Portland | 34,175 |

The down freight may be classified as follows:

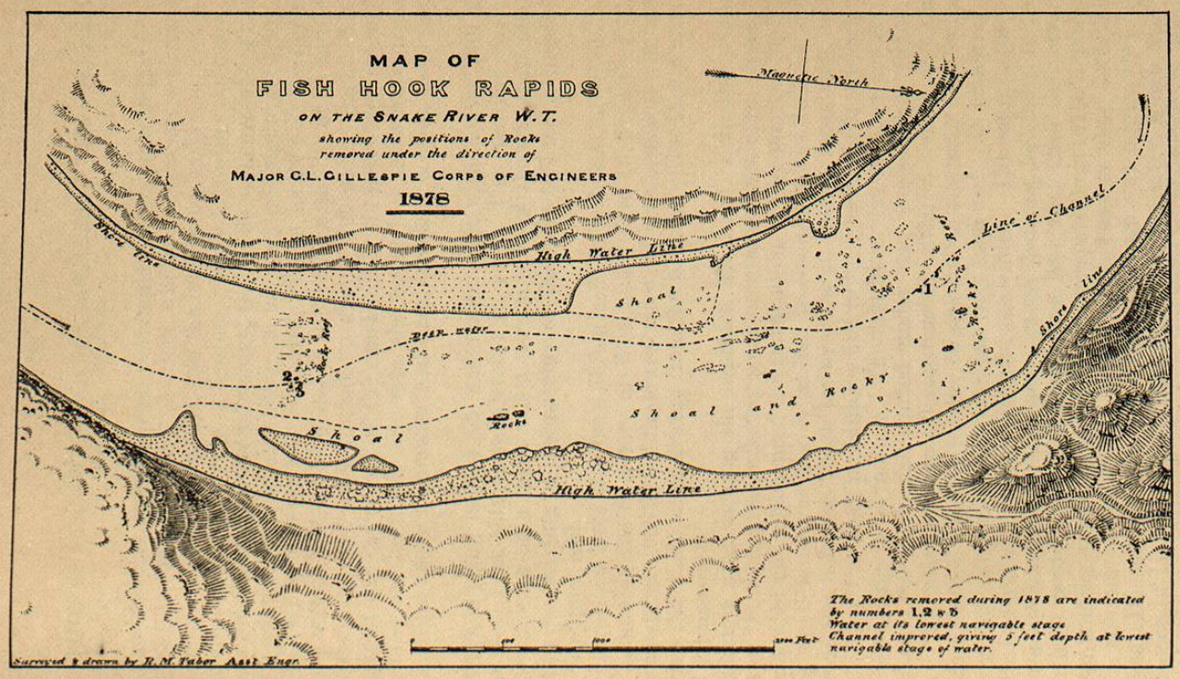
| | Tons. | | Tons. |
|---|---|---|---|
| Wheat | 22,717 | Barley | 15 |
| Flour | 5,687 | Hoops | 38 |
| Lard and bacon | 444 | Animals | 2,298 |
| Wool | 1,972 | Sundries | 707 |
| Hides | 297 | | |

Owing to a partial failure of crops in Eastern Oregon and low price




U.S. ENGINEER OFFICE, PORTLAND, OREGON.
To accompany annual report. June 30th 1879.

G. L. Gillespie
Major of Engineers, Bvt. Lt. Col., U. S. A

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