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REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE SECOND SESSION OF THE FORTY-SEVENTH CONGRESS.

IN FOUR VOLUMES.

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PART 3.

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APPENDIX O O.

IMPROVEMENT OF RIVERS AND HARBORS IN OREGON AND IN WASHINGTON TERRITORY—IMPROVEMENT OF LOWER CLEARWATER RIVER, IDAHO—CONSTRUCTION OF CASCADE CANAL, COLUMBIA RIVER.

REPORT OF CAPTAIN CHARLES F. POWELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1882, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Lower Willamette and Columbia rivers, from Portland, Oregon, to the sea.
2. Upper Willamette River, Oregon.
3. Upper Columbia River, including Snake River.
4. Constructing Canal around Cascades of the Columbia River, Oregon.
5. Coos Bay Harbor, Oregon.
6. Lower Clearwater River, Idaho.
7. Entrance to Yaquina Bay, Oregon.
8. Mouth of Coquille River, Oregon.
9. Cowlitz River, Washington Territory.
10. Skagit River, Washington Territory.
11. Chehalis River, Washington Territory.

EXAMINATIONS AND SURVEYS.

12. Columbia River at the Dalles, Oregon, including plan and specifications for locks and canal around said point.
13. Young's, Lewis and Clarke's, and Skipanon rivers entering into Young's Bay, in the county of Clatsop, near mouth of Columbia River, Oregon.
14. Snake River, from Lewiston to the mouth of Salmon River, Idaho.
15. Entrance to Gray's Harbor, Washington Territory.
16. Between Baker's Bay and Shoalwater Bay, Washington Territory, for canal for light-draught vessels.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., September 9, 1882.

GENERAL: I have the honor to submit herewith my annual report upon works of river and harbor improvements and of surveys and examinations under my charge since July 27, 1881, for the fiscal year ending June 30, 1882.

Very respectfully, your obedient servant,

CHARLES F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

O O 1.

IMPROVEMENT OF LOWER WILLAMETTE AND COLUMBIA RIVERS, FROM PORTLAND, OREGON, TO THE SEA, INCLUDING BAR AT MOUTH OF COLUMBIA RIVER, OREGON.

The project for this improvement from Portland as far as Saint Helens consists in the permanent contraction of water-way at four places where bars exist. The object is to give a navigable ship-channel 20 feet deep at low-water. The plan was adopted in 1877 and modified in 1879.

A change in the location of works designed for the right bank of the Willamette at its mouth and a return to the class of structures required by the original project on account of a question of land damage and a decrease of cost were approved March 29, 1882.

The estimate for completion of project is derived as follows:

Saint Helens work, not commenced, orginal and present estimate	$97,440 00
Swan Island work, not commenced, modified project (1879), proportionate cost of whole to contract awarded (1879) for partial length	54,950 00
Ten per cent. thereon for contingencies and inspection	5,495 00
Works on right bank mouth of Willamette, not commenced, modified project (1882)	12,454 75
Head of Willamette Slough, revetment of bottom and raising present dam 2 feet	4,000 00
Coon Island, left bank mouth of Willamette, extension of revetment	5,000 00
Total	179,339 75

No project is in force for improvement of the sea-bar.

During construction of permanent works and for the river below Saint Helen's annual dredging or scraping was intended. Snagging operations and local surveys also have been found necessary. The cost of temporary improvement and service naturally varies according to exigencies; for next year it is estimated as follows:

Operating dredge-boat with tender for six months	$9,600
Constructing three dump-scows	6,750
Constructing one wood-scow	650
Steam capstan for dredge-boat	1,900
Repairs to snag-boat Corvallis	6,000
Operating snag-boat four months	4,800
Hire of tug for scraping on lower river for fifty days	3,000
Local river surveys	3,000
Annual survey of sea-bar	6,000
	41,700
Contingencies	4,170
Total	45,870

OPERATIONS DURING YEAR AT MOUTH OF WILLAMETTE.

The pile-dam across Coon Island Slough, and which is one of the structures designed for permanent improvement of the bar at this locality, was under contract with Messrs. Holmes and Sweeny. After the high-water of summer, work on the dam was resumed and the contract part promptly completed by October 1, the date of expiration of contract. The filling and revetment of the dam was then made without any delay by the crew of the snag-boat Corvallis. The same force was used to extend the revetment on the island bank. Materials were purchased in lots and the brush transported by the snag-boat, while stone was generally delivered under purchase agreement.

By the middle of September the bar had become troublesome. The shipping season had commenced and only 19 feet could be carried over, and then in an inconvenient direction. This result caused vexatious delays and expensive lighterage. As the dredge-boat, under construction, was not likely to be ready for several weeks, scraping of the bar was commenced October 1.

The large, heavy harrow which had been successfully used on the sand-bars of the lower part of the Columbia, was pulled across the Willamette bar 41 times. No impression was made on the hard, compacted silt of the bottom; the current, even at ebb, was feeble. It was then recommended that the steamship George W. Elder, at the time unemployed, should be used to cut out a channel with her screw. The appropriation did not warrant the charter of so expensive a craft, but her owners offered the ship for the service named to the Portland Board of Trade if that body would pay the expense of operation. The offer was declined.

Towards the middle of the month there were indications of a rise. It was determined to blast the bar, and, when the current increased, to resume scraping. Warnings to prevent accidents were given to navigators; and nine surface charges in 13 and 14 feet of water, of No. 1 giant (dynamite) powder, were fired on October 16 and 17. One charge was of 100 pounds, and the remaining charges of 50 pounds each. The blast gave a line of craters across the bar 3 to 5 feet central depth, and about 10 feet diameter. Scraping was commenced on the 19th instant and continued until November 10, giving an increased depth of nearly 6 feet, in a straighter channel than the former one, of sufficient width and with a central depth of 19 feet reduced to low-water. This result was due to four forces—blasting, scraping, current produced by river rise, and a better concentration of water-way by completion of Coon Island Dam. The scraper used this time was one patterned after Long's. It was handled by the snag-boat, which was towed by a tug lashed to her side. There was no more trouble at this bar during the remainder of the season. Subsequent rises of the Willamette by scour, increased the depth to 22 feet at low-water.

SAINT HELEN'S BAR.

Commencing in September, deep-draught vessels frequently lightened for crossing this bar. As the river was likely to continue on a falling stage, and as the dredge-boat was not completed, methods of artificially stirring up the bottom were resorted to. The bar was 1,500 feet across; its material is fine, hard sand. As the snag-boat was not available for service as at the Willamette bar, the harrow was used, aided by sluicing with hydraulic jets. The latter appliances were crude. The river surface current, on the stronger ebbs, was 2 miles an hour. Operations were conducted between November 11 and 29; one-half foot only was gained in ruling depth of the channel. The available depths during the month were from $20\frac{3}{4}$ to 17 feet on day tides. The depth after scraping, reduced to mean low-water, zero of gauge, was a scant $14\frac{1}{2}$ feet.

The new dredge-boat was towed to Saint Helen's on December 1, and put fairly to work on the 7th. Operations were stopped on January 27. A channel, in depth of 17 feet full, reduced to zero, and a width of 50 feet, had been excavated; 4,310 cubic yards of material were removed on a length of cut of 1,177 feet.

While the dredge was disabled for a few days, a tug with the snag-boat and its scraper was used to plane down the crest of the bar.

The day-time gauge readings at Saint Helens, during the months of work, varied from 6.1 to 0.2 feet. Some detention was caused to shipping in March by the part filling up of the channel.

WILLAMETTE SLOUGH DAM.

This structure was built in 1879, for the amelioration of Post-Office Bar, where the natural depth had been 14 to $15\frac{1}{2}$ feet, reduced to mean low-water, and during a period when dredging was done on about alternate years. Since the completion of the dam the channel has deepened to 17 and 18 feet, and become straighter. The following other changes of channel were noted from an examination made during low-water of 1881. A movement of the bar one-half mile down stream; shifting of channel from one mile above head of Sauvie's Island towards right bank, and corresponding shoaling on left side; average of 4 feet increased depth along right bank from the bar to Three Tree Island.

Not a vessel last year grounded upon the bar; neither has a pilot complained of it.

The navigation opening in the dam prevents a full contraction of the water-way. To obtain the 20 feet depth required by the project of improvement, and which will be demanded by commerce, it seems that it will be necessary to raise the dam at least 2 feet, and to raise and revet the bottom of the pass.

The erosion on the island bank next below the dam which had appeared the previous year, and was then checked by brush revetment, threatened, last season, to cause damage. The revetment held the bank tolerably well, but the strong eddy was boring a deep cavity in the bottom of the slough, which would soon have displaced the revetment, and undermined the wing of the dam on that side. A fascine mat 3 by 86 by 94 feet was sunk, in good shape, to the bottom, over the eroded surface. A spur dike of brush was built from the island, 300 feet below the dam, parallel to it and of a length equal to three-fourths of that of the wing of the dam. The top of the spur for 178 feet is at low-water level; it then inclines at 6 on 1, for 60 feet to the end. A line of piling, braced by iron rods to a parallel row 10 feet further back, was driven from the lower corner of the east crib of the navigation opening to the end of the spur dam. The piles in the outer row were close driven; an interval of 140 feet was left near the middle, where no erosion appeared. Both rows were stiffened by waling timbers, 6 by 12 inches. The bottom along and around the piling was revetted by bolsters of young fir, 30 to 50 feet long.

A mat of fascines 3 by 30 by 160 feet was sunk across the channel, close against the lower faces of the cribs, to prevent their settlement, and decrease the water-way. The current of the pass was so strong that the heavy ballast was swept away, and a section of the mat near the middle buckled up and had to be cut out.

The water has not been sufficiently low since the freshets for an examination of the effect of preservative measures. The piling and revetment of bottom, as commenced, are to be completed next year, and the revetment extended over a larger area.

SWAN ISLAND BAR.

The dredge-boat was in position to work at Swan Island January 29. The low temperature on that and part of the following day prevented the use of her hydraulic apparatus, and made work impracticable. The bar only carried a scant 13 feet, reduced to mean low-water. Day-time gauge readings varied during period of lowest water at this locality—late January and early February—from 1.8 to 4.4 feet.

Dredging was commenced January 30, and suspended on February 10, on account of a rising river, which gave too strong a current for efficient work. One thousand one hundred and seventy-five cubic yards of coarse sand were removed on a length of cut of 349 feet; a depth, at zero of gauge, of 16 feet, and width of 50 feet. The cut was immediately below the crest of the bar, and on a line with existing beacons and buoys.

During suspension of work some changes were made in the dredging appliances for more efficient service.

Work was recommenced March 13, and continued until April 1. This time the cut was laid out from the extreme foot of the bar, for a depth of 18 feet at zero of gauge and average width of 90 feet, and on a line nearer to the right bank than formerly and about parallel to it. This location for the cut was chosen since it gave the shortest distances between both the 16 and 20 feet curves, and was parallel to the current direction. Two thousand two hundred and fifty cubic yards of material, consisting partly of sand and silt, with refuse, and partly of clay, were removed on a length of cut of 337 feet. Of the refuse, cans, boots, matting and like articles are reported. Several large pieces of wood were brought up by the dipper from the bottom, and also three large stumps and one tree. The latter measured 2 and 3 feet diameter by 80 feet long and with one-half of its mass of roots attached.

BAR AT MOUTH OF COLUMBIA RIVER.

During December, 1881, a small force was employed for two weeks in shore protection on the Clatsop spit side of the slough at the end of Point Adams, to supplement similar work done on the opposite side and partly at the mouth of the slough, on account of repairs and preservation of Fort Stevens. The object was to close the natural mouth of the slough and build out the shore line. The method followed was to plant low wings of brush which would catch drifting sand and thus raise the beach level above high-tide. The brush was placed in shallow trenches, at favorable times, and pinned or anchored to the ground. Small results were readily caused as expected. The work is worthy of notice as showing one method of building up Clatsop spit for a required position—a desideratum generally favored in plans for improvement of the bar.

The north channel has remained the ship channel during the year. It has shoaled from 20 to 19 feet at mean low-water. This small depth of channel, while one channel has heretofore existed with from 20 to 27 feet, reduced, causes much uneasiness in the shipping interests of the Columbia River. Vessels have been detained, others have not been loaded to their full capacity, and some have been directed to other ports on account of the shoalness of the channel. One vessel, the Corsica, outward bound, thumped on the bar and sunk outside. She was old and of short length. Her draught was carried out by other craft immediately after. The three other wrecks at the entrance to the river during the year should not be charged to the bar; they were of vessels crossing under sail, and two without a pilot.

The greatest draught carried over the bar, inward bound, was 22 feet; and outward bound, 22 feet 8 inches. There were several 22-feet vessels, but the greater number were of less draught.

Examinations were made during January and February of the expected new middle channel by the inspector of this light-house district, with a view of placing buoys there if the channel proved to be good. Attention had been first drawn to changes indicating the formation of a middle channel, by the 1879 survey. The depth then found, 14 to 15 feet, reduced, had increased to 15 and 17 feet by the 1881 survey. During last winter pilots reported an improvement at the place of the middle channel and a shoaling to 17 and 18 feet in the north channel.

The notes of soundings by the light-house inspector were kindly furnished me. Their plottings showed, while a greater depth still existed at the middle of the sands than on other portions, that a channel there as good as the north one did not exist.

On the approach of fair weather of summer and the annual river flood, preparations were made for scraping across the middle sands. Lieutenant Price was instructed to make an instrumental examination of the bar, with a view to the selection of a line for scraping, and to mark such line by buoys and ranges. The report by that officer of his examination is appended. It gives a statement of changes since 1881, and an opinion of the injurious effect of bar fishing on the channels; 1,400 boats and nets are reported to have been used last year in salmon fishing on the lower river. I judge that two-thirds of this number, or about 900, ply at the river entrance, one-half of which are in service at one time. The fishing season coincides with that of river floods. The nets are about 30 feet deep by 1,800 feet long. It might be expected that the drifting backward and forward of a large number of immense nets with heavy sinkers would be to check the currents, causing some deposit, and to level the bottom of the sands by smoothing down the ridges and lumps and filling the depressions. It is a fact that shortly after fishing on the outer bar commenced the channels have gradually shoaled, and the shoal areas gradually increased in extent and depth. The well-defined channels and prominent shoals are both disappearing; and now the best channel has a less depth than any shown by surveys extending through a period of ninety years.

Before commencing scraping, the subject of confining the fishing, by mutual consent, to the river inside the mouth, was brought to the attention of some of the principal cannery proprietors. All of them agreed that limiting the fishing ground, in absence of law, would be totally impracticable. The fishermen are irresponsible as a body and independent of each other. The contract between them and the cannerymen covers only payment for fish delivered. The effect of bar fishing on the channels and the question of prohibition by law will be brought to the attention of the Board of Engineers, which, it is understood, are to investigate the improvement of the mouth of the Columbia River.

Scraping with a bar tug and the heavy horizontal harrow, which had been used successfully at the Hog's Back and Cut-off channels, was commenced June 9. On July 5, a second tug with a large revolving scraper was added to the force; 1,056 crossings of the bar were made with a scraper, and generally during ebb-tide. At the beginning the ebb ran directly out on the line marked for scraping, and afterwards became more and more oblique to it, until at the end the ebb spread in a fan-shape over the tail of the middle sands and the old south channel. This change of ebb is referred to a shore current caused by continued northerly weather. The line for scraping was changed somewhat to follow the ebb direction; $2\frac{1}{2}$ feet were gained in depth. Pilots commenced to use the new channel, and then after a few days of heavy swells from the west undoubted shoaling occurred and the project was abandoned July 19.

NEW DREDGE-BOAT.

This is an Osgood's boom dredge, with double cylinder engines 11 by 18 inches, a $2\frac{1}{2}$-yard dipper, and steam power for capstans and spuds. The engines and dredging machinery were manufactured at Troy, N. Y., by the patentee, for $8,700. The wooden hull and house were built by Joseph Paquet, of East Portland, Oreg., for $5,946.46. The boiler and appurtenances were taken from the old dredge, whose hull and frames had become useless from decay.

By agreement with the Troy manufacturer, the machinery was to be delivered on the cars within twelve weeks from receipt of order, April 4. The last shipment was only made on September 20. Transportation required about seven weeks, and even then two pieces were lost on the way, so that more than two months of the low-water season had passed before a dredge was available for work.

The spuds of the new dredge would not hold on the hard sand bottom of Saint Helens bar, on account of the shoes furnished with the machinery. These were square pieces of cast iron, whose bottom surfaces were nearly flat. This defect much decreased the capacity of the dredge. It was hoped that the spuds would do better on the softer bottom at Swan Island, which was the only other place likely to require dredging during the season, and that the expense of new points, on account of small balance of funds remaining, would be unnecessary until the following year. The same trouble, however, existed at Swan Island, when the dipper was forced against a bank for a full load. New shoes were consequently procured at a cost of $530. These are made of heavy boiler iron. They are nearly 9 feet in full length, and terminate in an edge; the spud timber rests in a cast-iron socket. The new shoes answer the purpose admirably. The capstans are too small and weak for working the dredge out of the channel quickly, as sometimes necessary in order to give passing ships a safe clearance. It is expected to change the capstans this year.

The old dump scows are worthless and are already condemned. New scows are absolutely required and will be constructed as soon as funds are available.

The old dredge machinery is of the clam-shell pattern, and not well adapted for Columbia River bars, where most of the future dredging will be required, on account of permanent improvements on the Willamette, and for which river this dredging machinery was principally obtained.

It is proposed now to use the machinery in a bowlder dredge for river work below the Cascades Canal, and still have the craft available, by a small change of parts, as an earth dredger.

SNAGGING OPERATIONS.

A snag-boat is required to patrol the lower rivers after freshets, not only to remove snags from the channel, but to promptly dispose of immense trees which may lodge on the Willamette dams or against guide piles and beacons, and thus prevent destruction of these works by pressure from accumulated drift. There is plenty of work for one boat and crew below the Willamette Falls, and on the Cowlitz, where the government has entered on a project of improvement, consisting mainly of snagging operations.

The Corvallis, belonging on the Upper Willamette, is the only snag-boat in the district. She works, however, all around where her services are most necessary; these occur simultaneously for the different localities. Postponement and curtailing of work and expense of long trips are the results of this arrangement. It is hoped that the next appropriation will permit the construction of a new boat to remain above the falls, in order that the Corvallis may be mainly used below. Her hull is much decayed and almost past repair; on account of its weakness the boat is liable to be wrecked at any time. Estimates pertaining to the Lower Willamette and Columbia provide for a new hull.

The Corvallis was used last year three and a half months on these rivers. She removed thirty-four snags from the ship channel besides drift and one wreck, and the work performed on Coon Island and Willamette Slough improvements, and assistance rendered in scraping operations. After the boat was first laid up for the season she was put in commission and worked for a short time in the service and at the expense of the Oregon Railway and Navigation Company, in removing drift and sunken logs at its Albina water front.

RIVER SURVEYS AND OBSERVATIONS.

Assistant Engineer Habersham made a survey in October of the Columbia River from the head of Hayden's or Vancouver Island to the mouth of the Willamette, a distance of 7 miles. This survey was plotted on a map of the latter river from the head of Willamette Slough down, in order to show on a single sheet the junction of the two rivers, their connecting channels, and Post Office and Willamette bars and Vancouver crossing. The latter bar, 2 miles below Vancouver, had been shoaling in late years and causing trouble to the larger river-boats. Its channel was found to carry 9½ feet at low-water, but on an inconvenient direction. Additional works authorized for the Willamette mouth are designed for the improvement of the three bars named.

Examinations were made of the bars from Portland to Saint Helens and around the permanent works after prominent changes of river stage, and facilities were furnished pilots to search for new channels or sound out old ones.

Day-time tidal readings at Vancouver were discontinued December 31, and at Portland May 13, from the lack of funds. Readings at Saint Helens station were kept up during the year. After the discontinuance at Portland, the Signal Service reading was used for the records of this office, which could be done during the high stage then following. This reading is made daily at a stated hour, and consequently omits the tidal changes occurring at lower stages of river.

The tidal records for Saint Helens and Portland were compared with the tide tables for Astoria of the Coast and Geodetic Survey, in order to deduce the corrections to the Astoria establishment for those stations. The corrections appear to be constant for a rising, falling, or standing stage, but different for different heights of river. Results of deduction are given in the following table. Computations were made by Otto Von Gelden and J. S. Polhemus, assistant engineer.

The mean interval of a water is the time required for it to reach the station from Astoria; the difference of tidal range is the constant to be applied to the range of Astoria consecutive waters to give the range of corresponding waters at the station; thus, if a station's low-water is given, and it is desired to know the probable reading of high-water following, take from the tide tables the difference in height of the Astoria low-water next preceding and its following high-water; subtract the constant from this difference; the remainder added to the station's low-water will give required high-water reading.

For river stages above 5 feet, tidal influences at Saint Helens and Portland are small and not well defined. Above stages of 10 feet, gauge readings do not show tidal changes.

FOR MEAN DAILY RIVER STAGES.

[0 to 5 feet at Station.]

Station.	From Astoria times.								Difference between tidal range at Astoria and station.			
	High-water interval.				Low-water interval.							
	No. of results	Range.	Mean.	Probable error.	No. of results.	Range.	Mean.	Probable error	No. of results.	Range.	Mean.	Probable error.
		h. m.	*h. m.*	±*m.*		*h. m.*	*h. m.*	*m.*		*Feet.*	*Feet.*	*Feet.*
Saint Helens.............	199	5 19	3 50	±3	197	6 51	4 53	±3	197	6.1	4.70	±0.1
Portland.................	118	3 19	6 04	±2	118	3 32	7 31	±3	122	5.9	4.8	±0.1

[5 to 10 feet at station.]

Station.	No. of results	Range.	Mean.	Probable error.	No. of results.	Range.	Mean.	Probable error	No. of results.	Range.	Mean.	Probable error.
Saint Helens.............	..	......	......	......	......	......	......	......	73	6.9	6 47	±0.1
Portland.................	82	3 29	6 33	±4	82	7 09	7 19	±6	89	7.1	5.7	±0.1

PORTLAND HARBOR LINES.

At the request of the chief engineer of the Oregon Railway and Navigation Railroad Company an exterior pier line along its river property next below Albina (opposite North Portland) was selected by me. Extensive wharves and docks are now being constructed on this line. An extension of the line was also placed on the maps of Albina and East Portland. A copy of the Albina map, with co-ordinates of the pier line, was furnished one of the larger owners of Albina water property upon his request.

DONATED FUNDS.

Funds have been furnished, commencing February, 1882, by the city of Portland and Portland Board of Trade for continuance of work, and expenditures made as follows:

City of Portland fund...	$2,000 00
Expenditure	1,892 06
Balance	107 94
Portland Board of Trade fund..	5,442 50
Expenditures	5,442 07
Balance...	43

The city fund was limited in use to the works on the Willamette River as required by the municipal charter, and was applied to payment of current expenses of dredging at Swan Island Bar. The Board of Trade fund was used principally for work on the Columbia River and Saint Helens bars.

The authority for application and expenditure of above-named funds upon projects in progress of the improvement of the Lower Willamette and Columbia rivers, under the stipulation and understanding that the United States is not to be in any way liable for their reimbursement, was communicated in department letter of January 30 and telegram of February 3, 1882.

APPROPRIATIONS TO DATE

Act June 23, 1867, Lower Willamette	$15,000	
Act March 2, 1867	30,000	
Act July 25, 1868 (allotted)	21,000	
Act April 10, 1869 (allotted)	13,365	
Act July 11, 1870	31,000	
Act June 10, 1872	50,000	
		$160,365 00
Act March 3, 1873, Lower Willamette and Columbia from Portland, Oreg., to the sea	20,000	
Act June 23, 1874	20,000	
Act March 3, 1875	20,000	
Act August 14, 1876	20,000	
Act June 18, 1878	30,000	
Act March 3, 1879	45,000	
		155,000 00
Act June 18, 1878, mouth of the Columbia	5,000	
Act March 3, 1879	5,000	
Act August 2, 1882	7,500	
Act August 2, 1882	500	
		18,000 00
Act June 14, 1880, Lower Willamette and Columbia from Portland, Oreg., to the sea, including bar at the mouth of the Columbia	45,000	
Act March 3, 1881	45,000	
Act August 2, 1882	100,000	
		190,000 00
Total		523,365 00
Amount expended to June 30, 1882		413,952 27
Balance		109,412 73

Money statement.

July 1, 1881, amount available		$39,737 88
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	$38,325 15	
July 1, 1882, outstanding liabilities	503 57	
		38,828 72
July 1, 1882, amount available		909 16
Amount appropriated by act passed August 2, 1882		100,000 00
Amount available for fiscal year ending June 30, 1883		100,909 16
Amount (estimated) required for completion of existing project as modified		125,209 75
Amount that can be profitably expended in fiscal year ending June, 30, 1884		125,000 00

COMMERCIAL STATISTICS.

The Lower Willamette and Columbia rivers are in collection districts of Willamette and Oregon. The nearest ports of entry are Portland and Astoria, Oreg. The nearest light-houses and works of defense are at the entrance to the Columbia River. The revenue collected for the year ending May 31, 1882, at Portland was $332,664.65, and at Astoria $62,705.

The following refer to the district of Oregon for year ending May 31, 1882, and are furnished by Mr. C. Brown, deputy collector:

Value of imports	$221,188
Value of exports	3,803,893
Coastwise arrivals, number, 245; registered tonnage	464,275
Coastwise clearances, number, 215; registered tonnage	431,482
Foreign arrivals, number, 33; tons of cargo or ballast	29,884
Foreign clearances, number, 131; tons of cargo	130,629

The following refer to the district of Willamette for year ending May 31, 1882, and are furnished by Mr. F. N. Shurtliff, collector:

Value of imports	$558,001
Value of exports	6,614,243
Coastwise arrivals, number, 161; registered tonnage	272,619
Coastwise clearance, number, 124; registered tonnage	240,580
Foreign arrivals, number, 131; tons of cargo or ballast	118,818
Foreign clearances, number, 168; tons of cargo	154,408

The above statements show an excess of the actual number of arrivals and departures between the Willamette or Columbia river and the sea, since a vessel discharging or receiving part of cargo at Astoria and remainder at Portland, as several vessels are known to have done, is entered as an arrival or clearance at both ports. Taking money values for a comparison of foreign commerce of the year with that of the preceding one, it is found that the revenues have decreased 11 per cent., the imports increased 12 per cent., and the exports increased nearly 200 per cent.

The principal industry on the Lower Columbia is salmon fishing and canning; Astoria is the point of distribution of the product, which goes mostly to foreign markets. In 1866 the pack was 4,000 cases; in 1881 it was 550,000 cases at $5 a case, and in the present year it is estimated as 525,000 cases at $5.20.

The following table of the Portland wheat fleets was compiled from the files of the Portland Journal of Commerce:

Month.	1875-'76.		1876-'77.		1877-'78.		1878-'79.		1879-'80.		1880-'81.		1881-'82.		Monthly means.		
	Arrived.*	Cleared.	Arrived.*	Cleared.	Arrived.	Cleared.	Arrived.	Cleared.	Arrived.	Cleared.	Arrived.	Cleared.	Arrived.	Cleared.	Arrived.	Cleared.	Both.
July	....	....	....	....	1	....	1	2	4	....	2	....	9	8	3.4	2.0	5.4
August	....	....	....	1	2	1	6	1	6	1	6	1	9	10	5.8	2.5	8.3
September	....	4	....	4	16	5	11	1	9	3	7	2	19	12	12.4	4.4	16.8
October	....	9	....	14	29	20	18	11	16	15	4	6	31	19	19.8	13.4	33.2
November	....	8	....	12	11	22	12	14	11	14	6	9	17	21	11.4	14.3	25.7
December	....	8	....	14	5	15	6	10	10	15	7	10	18	26	9.2	14.0	23.2
January	....	9	....	13	4	3	1	12	8	10	8	6	18	21	7.8	10.6	18.4
February	....	6	....	1	2	3	1	4	5	9	2	7	12	17	4.4	6.7	11.1
March	....	6	....	2	1	2	....	4	6	7	4	5	9	11	4.0	5.3	9.3
April	....	5	....	1	1	2	....	2	3	6	12	5	6	9	4.4	4.3	8.7
May	....	2	....	....	1	1	....	1	....	1	16	3	2	4	3.4	3.1	6.5
June	....	2	....	....	4	....	....	5	1	1	5	7	5	6	3.8	3.0	6.8
Totals	....	59	....	62	77	74	56	67	79	82	79	71	155	164	89.8	83.6	173.4

* Not reported.

Abstract of contract in force during year.

Name and residence of contractors.	Contract.		
	Date.	Subject.	Expiration.
Holmes & Sweeney, Portland, Oreg.	Oct. 9, 1880.	Pile dike at Coon Island Slough	Oct. 1, 1881.

REPORT OF LIEUT. P. M. PRICE, CORPS OF ENGINEERS.

ASTORIA, OREG., *May* 31, 1882.

SIR: I have the honor to submit the following report of an examination of the bar at the mouth of the Columbia River with a view to the selection of a suitable channel for scraping, made on May 23 and 24, 1882, in accordance with your letter of instructions dated May 20, 1882.

The examination was made with the bar tug Astoria, whose position at short intervals, generally two minutes, was determined by theodolite readings at the two shore stations on Cape Hancock and Fort Stevens, used during my survey of May and June, 1881. The methods were in every respect the same as used on that survey, described in my report of July 13, 1881.

A comparison of this examination with the survey of 1881 shows that Clatsop Spit has changed but little if any in position or extent. The southern side of Sand Island has about the same position, but the northern point has made out considerably farther into Baker's Bay.

The "cut-off" channel between the old south channel and the north channel has widened and deepened, and shows a least depth at mean low-water of 21 feet.

The Middle Sands have made to the northward, throwing the north channel to the north, and Peacock spit has made to the eastward. The north channel shows a least depth of 19 feet at mean low-water.

The south channel is almost the same as last year, full of lumps with 15 to 17 feet of water on them.

A thorough examination was made of that part of the Middle Sands between the north and south channels where the survey of last year indicated that there was a disposition for the ebb currents to break through and open a new and straight channel. The cutting out at this locality has continued, and now there is a straight channel over the sands with a least depth of 17 feet. The distance between the 18-foot curves in passing through this channel is one-fourth mile, and between the 24-foot curves is one-half mile. There is one lump with a least depth of 17 feet, one-fourth of a mile to the eastward and detached from the general 17-foot shoal.

The tug was allowed to drift from the deep water off Clatsop Spit Buoy, when the tide was about half ebb, and the result showed that ebb currents set directly through this channel, and with great force.

The bottom is hard sand. It was therefore selected as the proper place to scrape, and on the 28th of May three buoys were placed by the Shubrick, the light-house tender, as guides for the scraping. Two of these buoys are on the north side of the channel 3¾ miles magnetic south of Cape Hancock, and one on the south side of the channel selected, the width between them being three-fourths of a mile.

The scraper is the one used on the "cut-off" in 1880. It is now ready, a tug engaged, and scraping will be commenced on the first suitable day.

In closing this report I desire to call your attention to the injurious effect, in my opinion, of the fishing upon the bar. The fishing season is fixed by law from the 1st of April to the 31st of July. The nets used are about 300 fathoms in length and 30 feet in width. Formerly the fishing was confined to the river proper, but during the past three or four years the fishing has gradually extended farther down, until during the past two seasons, as well as this season, many boats have fished out upon the bar itself. On the 24th of May I counted thirty-one boats on the middle sands and in the south channel.

The surveys of the last three years show that the sands have flattened out, and now cover a much greater area than formerly, have deepened, and that the channels have shoaled, until they are almost obliterated. It would certainly seem that this effect is directly due to these immense nets drifting backward and forward over the sands during the season when the currents are the strongest by reason of the high water in the Columbia. I do not think that natural causes, or those combined with artificial means, such as scraping or the water jets, or blasting, will ever be able to open out and maintain a good channel over the bar, as long as the fishermen are permitted to drag their nets over it and stir up the sand as they now do.

Very respectfully,

PHILIP M. PRICE,
First Lieutenant of Engineers.

Capt. C. F. POWELL,
Corps of Engineers, U. S. A.

O O 2.

IMPROVEMENT OF UPPER WILLAMETTE RIVER, OREGON.

The project adopted in 1870 was for improvement of light-draught navigation from Oregon City (Willamette Falls) to Eugene City, a distance of 160 miles. It consisted in the annual removal of drift, snags, and overhanging trees, and scraping of bars, and in addition, for the reach below Corvallis, in the contraction of water way by low cut-off or wing-dams.

Up to June 30, 1878, $71,373.25 had been expended in execution of this project. At that time the demands of commerce necessitated an enlargement of the improvement. A new project was therefore prepared which included the same class of work as formerly carried on, and, in addition, rock removal, application of propelling power to the snag-boat, a second snag-boat with scraper and pile driver attached, for service above Corvallis, and a systematic survey from Corvallis to Portland. The estimate of first cost was $80,000, and about $12,000 for annual maintenance thereafter.

The work has been continued under this modified project, exclusive of the second snag-boat and the survey. These items were recommended in subsequent annual reports, but appropriations made did not permit the expense.

In years following, to the present time, the improvement was extended to the lower 6 miles of the Yamhill, a tributary of the Upper Willamette, and to the part of the river below Oregon City to Portland, 12 miles.

The estimate of cost for completion of project was revised in 1879, and then fixed at $46,000, exclusive of an annual appropriation for maintenance of $17,500. Between the times of the two estimates on the modified project $32,000 had been appropriated. The estimate for completion in 1880, subsequent to an appropriation of $12,000, was again revised and placed at $53,000, inclusive of $15,000 for one year's maintenance. This estimate has remained without change.

Operations during the past year consisted of snagging, bar scraping, and minor repairs to existing dams from Oregon City to Harrisburg, 137 miles, and on about 6 miles of Long Tom Creek. All work was performed by the snag-boat Corvallis and her crew. Snagging operations were confined principally to the reach between Corvallis and Harrisburg, and other work to that below Corvallis.

There was no special demand for navigation between Harrisburg and Eugene City; this reach is an exceedingly troublesome one for the comparatively large and deep-draught steamers now used on the river; the farming country is removed from the immediate banks, and between it and the landings is an expanse of low, swampy land, cut up by numerous sloughs. Moreover, the main valley railroad crosses the river at Harrisburg, touches at Eugene, and affords more convenient transportation than the river would. It is probable that hereafter Harrisburg will continue to be the practical head of navigation instead of Eugene.

In the removal of drift, trees, &c., endeavor was made to dispose of them for bank protection and as temporary wings for bar sluicing. The scraper used in late years and during the early part of the season is patterned after Long's. The small propelling power on the snag-boat did not permit efficient use of the scraper, even with aid of boom timbers applied in this way: a timber was lashed to each side of the boat and on the scraping passage the up-stream end was allowed to swing out, thus increasing by the current the power on the scraper, and forming a sluice-way on the bar. Better results were obtained by a common road scraper, which was pulled across the channel with the boat capstans and guided by a man at the handles; its loads of gravel were dumped on the channel sides and served to concentrate the water.

The snag-boat was withdrawn on two occasions during the year for service elsewhere, when it could be done without great detriment to the river improvement.

The following table shows the amount of work performed; the details of operations are given in the accompanying report of the assistant engineer in supervision of this improvement:

Number of snags removed	524
Number of trees cut from banks	3,019
Number of days worked snagging	101
Number of days worked on other service	29
Number of miles run	1,012

While the Corvallis was absent from the river a force was sent with small boat, tools, and explosive for minor operations not included in the tabulation of work.

Portland, Oreg., is the place of supply and export for the river traffic; there is only one independent steamer regularly engaged therein. One small steam-craft is used for local towing and freightage. All other steamers belong to the corporation, which owns the locks at Oregon City and now controls all the valley railroads. Excessive tolls at the locks prevent general competition on the river. The charges are 10 cents per head for passengers, sheep, and hogs, 25 cents per head for horses and cattle, and 50 cents per ton for freight. The lock charter expires by limitation in 1893, when the locks can be purchased, on a prescribed method, by the State of Oregon.

The Willamette Valley is of considerable extent and great fertility. It furnishes about two-thirds of the grain and flour shipped from the Columbia River. With the same quality of crops the yearly product is constantly increasing. The amount of river traffic has decreased, however, 35 per cent. during the past four years, as measured by the down freights at the Willamette locks, the amounts of which are given under commercial statistics herewith. During the period named, the condition of the river has been improved from year to year, and last year its navigation, especially on the part below Corvallis and which is the important portion, was easier than during any year preceding. Part of the reduction in river traffic is referred to the extension of 50 miles, in 1880, of the west side division of the O. and C. Railroad, another part to the late construction of rail feeders—but a small part, since the feeders are generally on the sides of the main lines opposite from the river; and, finally, the reduction was completed by that action of the controlling corporation which forces traffic from the river to the railroads as much as practicable.

The boats and locks of this company are worked, it is judged, to prevent interference with railroads and competition by outside boats. To neutralize these results and encourage competition in transportation, a prompt completion and earnest maintenance of the river improvement are judicious.

The appropriation, $31,000, asked for is intended to be applied as follows:

Construction of new snag-boat	$18,500
Current expense of operation	7,500
Construction of 2,000 feet of low dams	5,000
	31 000

The present boat, Corvallis, has been used part of the time during late years on the lower rivers, and on the Cowlitz, as well as on the upper river. A snag-boat is needed to patrol these rivers, and for inspection and repair duty on dikes and revetments. The necessity of operations named occurs simultaneously for the different localities. The length of river and extent of operations are too great for one boat. The Corvallis requires extensive repairs, and her machinery is better adapted for a boat on the lower than on the upper river. It is expected to repair her from appropriation for the lower river, use her mainly for service below the falls, and station the new boat above them.

MORRISON-STREET BRIDGE, PORTLAND.

A part history of this structure is given in Annual Report, 1881, and certain papers relating to the construction were published in Senate Ex. Doc. No. 162, Forty-seventh Congress, first session.

At the time of suspension of work in compliance with preliminary injunctions granted in the United States circuit court, district of Oregon, March 28, 1881, and April 16, 1881, the construction had been advanced as follows:

All piers were completed up to low-water line.

No. 1 (west support) had one tier of two iron cylinders, 8 feet high, in place and filled with concrete; fender-pile cluster in place and banded.

No. 2 (pivot pier). Masonry laid up to 18 feet above low-water level.

No. 3 (east support) in same condition as No. 1; fender-pile cluster complete and banded.

Nos. 4 and 5. Same as No. 3, with fender-pile cluster.

Nos. 6 and 7 (pile-piers). Piles driven and capped at level of lower chord. These two piers were substituted for the corresponding length (350 feet) of pile trestle after winter freshets had shown the necessity for more room for passage of drift.

Six bents of pile were driven from East Portland shore outward, and capped at level of lower chord.

Upon a final hearing of the cause before the same court in which action was brought, a perpetual injunction was ordered by decree of October 22, 1881.

During suspension of work the pivot pier has been lighted by the bridge company; submerged parts were not buoyed.

On account of drift, impact of vessels, and current erosion the following damage to bridge parts has been done, and the following accidents to shipping have occurred:*

No. 1. Cylinders knocked off, fender-piles leaning against pier.
No. 2. (Pivot) pier leaning down-stream, masonry-beds dipping up-stream.
No. 3. Fender-piles carried away; pier leaning down-stream.
No. 4. Fender-piles gone.
Nos. 5, 6, and 7 in place.

Trestle piling in place, excepting two bents which were pulled out to allow escape for accumulated drift.

March 15, 1881.—Steamer Welcome had her rudders fouled by drift, became unmanageable, drifted against one of the piers, doing considerable damage.

March 8, 1881.—Bark Irwin, down tow by steamer Welcome, through the west span along shore, was carried by the current against the cylinder of west support pier. The cylinders were knocked into the river.

March 10, 1881.—Steamer Welcome drifted against east support pier and forced the fender-piling 16 feet out of line.

About the same time (exact date not given), a vessel in charge of Pilot G. A. Pease, when coming down through the western along-shore span, ran against the west support pier, which was then submerged (being in process of construction).

About August, 1881, the tug Ben Holladay with two scows ran hard against and on top of one of the piers, then submerged, and remained there about a day. The hull of the tug was injured.

September, 1881.—The steamer ——— in a fog ran hard against the west support pier, breaking her knuckles and several timbers.

About the same time a grain vessel, tow of steamer Vancouver, ran on the west support pier, and was pulled off after three hours, with assistance of another steamer.

About January, 1882, the Vancouver ran against the base of one of the piers in the middle of the river, knocked a hole in her hull, and had to be beached for repairs.

The bridge structures, as now existing, are most serious obstructions to navigation and ought to be removed. It seems proper that the State of Oregon should make the removal, since the obstructions were placed under the authority of an act of its legislature, which act is void, by decision of United States district court.

It is a commentary upon the location and plan of the bridge that pilots rarely use the draw spans, but actually take craft through the wider spans which would be low and fixed ones in the completed bridge. The Oregon Railway and Navigation Company do not permit their tow-boats to take any vessels through the bridge whatever.

* Compiled by Assistant Engineer R. A. Habersham, from testimony before court, and other information.

APPROPRIATIONS TO DATE.

Act March 3, 1871	$16,000 00
Act March 3, 1873	3,000 00
Act June 23, 1874	7,500 00
Act March 3, 1875	25,000 00
Act August 14, 1876	20,000 00
Act March 3, 1879	12,000 00
Act June 14, 1880	12,000 00
Act March 3, 1881	15,000 00
Act August 2, 1882	5,000 00
Total	115,500 00
Amount expended to June 30, 1882	109,360 53
Balance	6,139 47

Money statement.

July 1, 1881, amount available	$9,221 23
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	8,081 76
July 1, 1882, amount available	1,139 47
Amount appropriated by act passed August 2, 1882	5,000 00
Amount available for fiscal year ending June 30, 1883	6,139 47
Amount (estimated) required for completion of existing project *	33,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	31,000 00

COMMERCIAL STATISTICS.

The Willamette River is in the collection district of Willamette. The nearest port of entry is Portland, Oreg. The nearest works of defense are at the entrance of the Columbia River. The revenue collected at Portland for the year ending May 31, 1882, was $332,664.65.

Amount of freight passed through Willamette locks for twelve months ending May 31, from reports of superintendent.

Description.	1879.	1880. †	1881. ‡	1882.
Down freight ... tons	70,873			45,962
Up freight ... do	8,857			6,856
Total	79,930			52,818

Exportations from Willamette Valley, via Oregon and California Railroad lines, from June 1, 1881, to May 31, 1882, compiled at company's office by R. A. H.

		Quantity.
Cattle	Number	1,272
Hogs and sheep	do	16,872
Beef, tallow, and hides	pounds	865,787
Pork and lard	do	946,168
Wool	do	1,426,361
Butter, eggs, and poultry	do	796,083
Wheat	tons	93,740
Other grain	do	8,127
Flour and mill stuff	do	12,068
Seeds, grass, hemp, flax, &c	pounds	798,563
Fruit, green and dry	do	1,956,216
Lumber, laths, and shingles	do	719,643
Hops	do	183,766
Coal and stone	do	152,735
Lime and cement	do	400
Salt	do	6,902
Manufactured articles, &c	tons	2,149
Sundries	do	5,903
Wood for fuel	cords	2,335

* Exclusive of expense of annual maintenance.
†About same as in 1879. ‡No report.

REPORT OF MR. R. A. HABERSHAM, ASSISTANT ENGINEER.

ENGINEER OFFICE, PORTLAND, OREG.,
June 30, 1882.

SIR: I have the honor to submit the following report of operations on the Upper Willamette, for the fiscal year now ending:

During July and part of August, 1881, the snag-boat was at work between Oregon City and Salem, removing snags, cutting away trees, which had fallen over the banks into the channel, and raking shoal bars. The shoals known as Fairfield Bar, Gervais Prairie Bar, McCloskey's Chute, and Salem Bar, were raked, as well to give the best direction to the current as to deepen the water. The dam at McCloskey's Chute, which had suffered some injury from drift, was repaired, and temporary dams, formed by laying large bushy trees along the edge of the channel to confine the current to the center, were built at McCloskey's, Gervais Prairie, Fairfield, and head of Thompson's Slough. On the 22d of August, the river being clear below Salem, the snag-boat was ordered to Cowlitz River, Washington.

* * * * * * *

November 20. * * * The snag-boat returned to the Upper Willamette, beginning work on the 24th at Harrisburg, and by the end of the month had cleared the river as far down as Hayes Bend, 14 miles below. December 8, the water having risen so high as to prevent efficient work, the boat was ordered to the Lower Willamette. * * * The water continuing high, work on the upper river was not resumed until near the end of January. The boat was then sent to Harrisburg, to clear out the snags and drift brought down by the late freshet, and worked between that point and Corvallis until February 25, when the river began to rise rapidly, forcing a suspension of work.

By the 2d of March the water had risen to 23.5 feet above zero, and the quantity of heavy drift running was so great tha tthe boat had to be tied up out of danger; the water falling almost as rapidly as it had risen. On the 12th of March work was resumed. Centennial Chute and Hogue's Creek were cleared out, and a number of snags removed from the edge of the channel at various points between Corvallis and Salem, by the 5th of April, when, the water continuing high and the river free from material obstructions below Harrisburg, the boat was brought down to Portland, and after doing some necessary work below the city was laid up on the 15th and the crew paid off.

The work performed by the snag-boat on the Upper Willamette during the fiscal year was as follows:

Number of snags removed	524
Number of trees cut from banks	3,019
Number of days worked scraping, &c	29
Number of days worked snagging	101
Number of miles run	1,012

Two-thirds of the snags were taken out above Corvallis, the head of low-water navigation. Formerly the greater portion, almost the whole, of the work of snagging was done below Corvallis, but the concentration of the volume of the river by means of wing-dams and scraping has caused the heaviest drift to run nearer to the thread of the current, while the systematic and judicious removal of snags from the channel has gone far towards preventing the accumulation of drift on the shoals and consequent growth of gravel bars by accretions, so that this section of the river is now in better condition, both as regards depth and freedom from obstructions, than it has ever been before.

The number of trees cut from the bank includes 1,865 from Long Tom Creek, the only outlet into the Willamette for a large and productive section of the valley.

The stage of water during the year has varied as follows:

1881, from July 1 to October 15, lowest 0.3 foot, highest 2.0 feet; October 15 to 28, lowest 1.5 feet, highest 2.0 feet; October 28 to June 30, 1882, lowest 3.3 feet, highest 23.5 feet; average from 4 to 8 feet above low-water. So that for $8\frac{1}{2}$ months of the year the river maintained what may be called its best boating stage.

Steamboating was carried on through the low-water season of 1881, with but little interruption from bar obstructions. The only two points presenting obstacles to good low-water navigation were Lone Tree and Buena Vista bars, which have been minutely described in the report of the Chief of Engineers for 1880, pp. 2282–'3. As was there reported, wing-dams have failed to effect any permanent good on these bars. Each is situated just below the foot of a long, steep slope in the river, where the sudden loss of velocity causes deposits of large quantities of heavy pebbles and cobble-stones, borne along by the current during floods. The remedy would seem to be to raise the level of the water at the foot of the steep slope by a dam, and thus equalize the fall above and below the bar.

Careful surveys of the localities at low-water will have to be made before a plan in detail can be fixed on.

Boats have run regularly to Corvallis and, when required, to Harrisburg, all through the winter and spring.

* * * * * * *

Appended will be found also an estimate of the probable cost of closing minor channels and contracting wide shoal reaches between Corvallis and Harrisburg. As the slope between these two points at low-water does not exceed 2.55 feet per mile, or 1 in 2,070, and as the obstacle in the way of low-water navigation has been found solely in the shoalness of the bars, where water is wasted in wide reaches or through side channels, there is no apparent reason why this section should not be improvable so as to allow boats to ascend to Harrisburg at low-water, affording a much-needed outlet to a large area of the wheat lands of the valley, which now depends on wagon roads.

The hull of the snag-boat is so much decayed that it cannot be expected to last another year; indeed, it is liable to be snagged and sunk at any time. And as the work of the boat is increased every year by a number of miles of navigable river to be patrolled, it is important that it should be put into good working condition as soon as the necessary funds can be obtained. A new hull should be built. It is almost certain that the old one is scarcely worth repairing.

Respectfully submitted.

ROBT. A. HABERSHAM,
Assistant Engineer.

Capt. CHAS. F. POWELL,
Corps of Engineers, U. S. A.

DAMS REQUIRED BETWEEN CORVALLIS AND HARRISBURG.

1 at head of Hogue's Creek.
2 at Turntable.
1 at one-fourth mile below Peoria.
1 below mouth of Long Tom Creek.
1 above mouth of Long Tom Creek.
1 at Finley's Landing.
1 at Evans's Chute.
2 at Haye's Landing (to contract channel.)
1 above Haye's Landing.
1 at Davis' Chute.
1 at Wilson's Chute.
2 below Alford's Chute (to contract channel).
1 at Alford's Chute.
1 at Ingram's Bend.
1 at Roth's Island.
3 at Harrisburg.

21 dams; average length, 300 feet=6,300' feet, at $2=$12,600.

O O 3.

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

All work during the year was prosecuted by contract and confined to the Lower Snake River. It consisted of solid rock removal. The localities of work were Taxas, Palouse, and False Palouse rapids.

TAXAS RAPIDS.

Work at this place was the remaining part of a contract with George J. Ainsworth, dated September 25, 1879, and whose expiration was November 15, 1880. For reasons stated in preceding annual report, money not paid the contractor had been retained.

At the beginning of the low-water season, when work only is practicable, following the supposed completion, a force was sent to remove the small projecting points as required before final payment.

Operations were recommenced October 18, 1881. After some difficulty in placing the working scow and an interruption of a few days by a river rise, the contractor's agent succeeded in getting down some heavy charges of No. 2 giant (dynamite) powder into the holes and crevices of rock masses partly removed last year. The blasts were quite successful in scattering the rock in fragments into deep water.

The work was examined on October 31, and carefully surveyed November 7. The contractor removed his force and plant on the following day, and was subsequently paid in full.

Rocks removed are shown on the chart which accompanied last year's report. The total amount was 602.66 cubic yards.

THE PALOUSE RAPIDS.

Work was commenced on the main rapid the previous year by J. B. Montgomery, whose contract was dated November 15, 1880, and expired December 31, 1881. Some blasting in drill holes of cluster of rocks, marked 3 and rock 1 on map herewith, had been done when operations ceased, as explained in previous annual report. This contract included work at Umatilla Rapids, Columbia River, with right on part of officer in charge for entire omission, and at several rapids of the Snake. The whole amount of the contract was 1,000 cubic yards, approximately. It was considered desirable to put all of the work at Palouse; the part of rock No. 2 to be removed was therefore turned over to the contractor. During August, 1881, he had built quarters and made needful preparations for the season's work. Drilling was commenced in the latter part of the month. Work was steadily pushed forward, advantage being taken of the favorable weather and low stage of river, which permitted footing on the rocks or erection of platforms over them. All drilling was done by hand. Efforts to recover the steam drill which had been lost during the flood of the previous February were not successful. Drill holes were skillfully placed and directed, and then heavy charges used to throw the rock when broken in pieces into deep holes.

When the work was well under way a violent outbreak of small-pox occurred among Indians, whose village was in close proximity. Seven dead Indians laid unburied for six weeks in the neighborhood. A stampede among the workmen was feared, and consequent suspension of work for another season. This did not take place, however, and fortunately none of the white men caught the infection.

On November 15 the steamer Spokane brought down two scows through the rapid; they were lashed to the steamer, one forward and one at her side. The work was half finished and the river at a very low stage. It is not considered that the attempt to tow the scows through would have been made without the improvement already done. The attempt is worthy of notice as a beginning of the use of the barge system on Upper Columbia waters.

Work under Mr. Montgomery's contract was completed December 15. The total amounts of rock removed to a level at least 5½ feet below low stage are as follows:

	Cubic yards.
Rocks 1	446.17
Rocks 2	356.63
Rock 3	66.31
	869.11

For work under the appropriation of March 3, 1881, a contract was made with Mr. Silas Smith. The contract was dated September 7, 1881, and expired January 1, 1882. The rock removal to a level of 5½ feet below low-water was specified as follows:

Umatilla Rapids, Columbia River, 500 cubic yards, at $24.
Homly Rapids, Columbia River, 200 cubic yards, at $25.
Palouse Rapids, Snake River, 200 cubic yards, at $16.50.
False Palouse Rapids, Snake River, 100 cubic yards, at $16.50.

It was considered judicious to place all the work at the two Snake River rapids and finish the improvement at this locality provided for by the present project. The contractor readily assented, and rock No. 4 at Palouse was designated for commencement of work September, 1881. This rock was 121 feet long, and was taken off to a line 17 feet from its face. Its entire removal would have been advantageous, but could not be made without prejudice to other and more serious obstructions; 60 drill holes were made in the rock and fired with No. 1 giant powder; broken fragments were cleared away by surface blasting.

Rocks 5 and 6 were removed by Mr. Smith, and the work at Main Palouse Rapids finished December 15. The contractor's force and plant were then transferred to False Palouse, and work commenced on two bowlders near the left bank. The object was to furnish an easy side channel for ascending boats during medium stages, thus avoiding a strong current of the main channel. Work was finished on December 18, 1881, and the contract closed. The following are amounts of rock removal under it:

	Cubic yards.
Rock 4, Palouse	488.83
Rock 5	241.84
Rock 6	10.06
Rock 1, False Palouse	7.58
Rock 2	1.11
	749.42

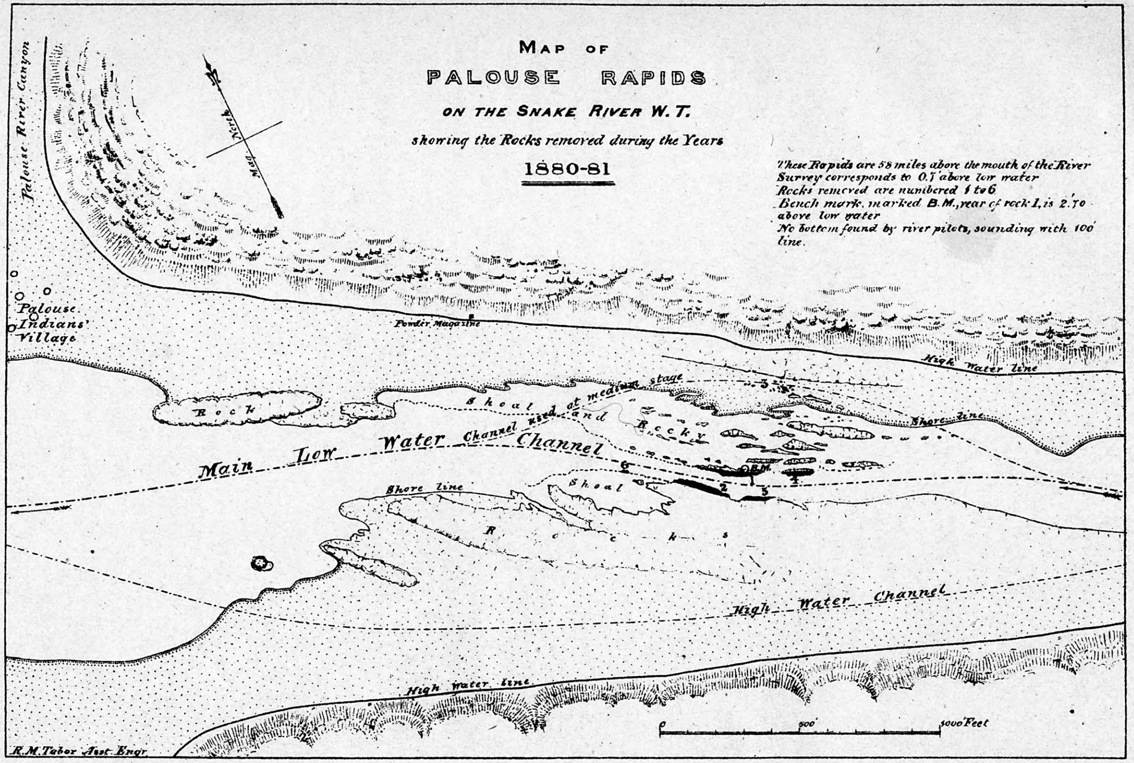
Assistant Engineer R. M. Tabor has been the inspector on the contracts of the year.

During the past few months scows loaded with stone have been regularly towed from Taxas Ferry, above the Palouse Rapids, to Ainsworth, at the mouth of the Snake. Two scows are taken at a time and are towed back light. The towage has been so successful that it is probable that grain will be transported in a similar way this fall—a thing which has heretofore been regarded by many Snake River men as utterly impracticable.

The appropriation, $6,000, of the act of August 2, 1882, is to be applied at and near the Five-Mile Rapids, Snake River, now the worst obstruction on the navigable Snake. An improvement there will be of special value to the commerce between Taxas Ferry and Ainsworth, which depends entirely upon the river.

The appropriation, $56,000, estimated for the next year is intended for completion of the present project of improvement on the Upper Columbia and Snake rivers. The object of this project is to give channels of navigable width 5½ feet depth on the Columbia from the head of the Dalles obstructions to the mouth of the Snake and 4½ feet depth on the Snake to the mouth of the Clearwater.

Prices paid during the year were from $16.50 to $18 per yard for removal of rock; $25 per yard was the contract price at places when no work was done; the prices are excessive only because the amount of work under each contract was small. With liberal appropriations the work should be done for about one-half the cost named.

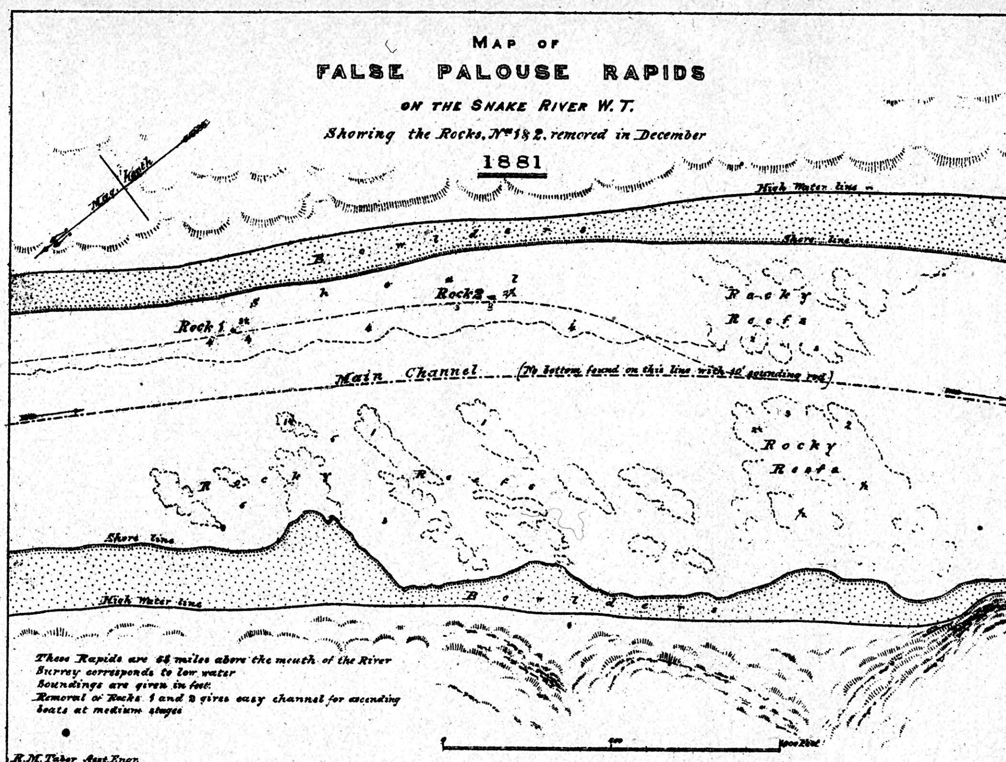


U. S. ENGINEER OFFICE, PORTLAND, OREGON

To accompany annual Report June 30th 1882

Chas. F. Powell

Captain of Engineers



U.S. ENGINEER OFFICE, PORTLAND, OREGON

To accompany annual Report June 30th 1882

Chas. F. Powell.

Captain of Engineers

APPROPRIATIONS TO DATE.

Act June 10, 1872, Upper Columbia River	$50,000	
Act June 23, 1874	20,000	
Act March 3, 1875	35,000	
		$105,000 00
Act August 14, 1876, Upper Columbia and Snake	15,000	
Act June 18, 1878	20,000	
Act March 3, 1879	20,000	
Act June 14, 1880	15,000	
Act March 3, 1881	15,000	
Act August 2, 1882	6,000	
		91,000 00
Total		196,000 00
Amount expended to June 30, 1882		189,871 02
Balance		6,128 98

Money statement.

July 1, 1881, amount available	$31,425 32
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	31,296 34
July 1, 1882, amount available	128 98
Amount appropriated by act passed August 2, 1882	6,000 00
Amount available for fiscal year ending June 30, 1883	6,128 98
Amount (estimated) required for completion of existing project	56,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1884	56,000 00

COMMERCIAL STATISTICS.

These rivers are in the collection district of Willamette. Portland, Oreg., is the nearest port of entry. The nearest light-houses and works of defense are at the mouth of the Columbia River; there are several garrisons of troops in the immediate region.

The productions of the Upper Columbia River country are rapidly increasing. For the year ending May 30, 1881, the value is reliably computed at a little more than $2,000,000, and for the following 12 months at nearly $6,000,000. The productions consist principally of wheat, wool, flour, flax, cattle, hides, and barley.

Preceding railroad constructions of the last two years all freight was brought down by the river to the head of the Dalles Portage Railroad. The river boats are now used as feeders for the through rail routes; one line of Snake River boats runs from Lewiston, at the mouth of the Clearwater, to the railroad near Taxas Ferry, and another from next below that point to Ainsworth, at the mouth of the Snake. On the Columbia, boats run from Priest Rapids, 73 miles above Ainsworth, to Ainsworth, and thence down the river to Celilo for accommodation of traffic on the Washington side.

The amount of freight carried by river boats could not be obtained. It is judged to be less than formerly, for the largest boat was withdrawn for service on the lower river and has not been replaced.

There is sufficient traffic from regions which the railroads cannot reach, and which the rivers do, to warrant the completion of the present project of improvement. Eureka Flats may be taken as an example of such localities. This small tract is near the south bank of Snake River, about midway between the rail crossings at Taxas Ferry and Ainsworth; four years ago its shipments were almost nothing; last year they included 40,000 bushels of grain.

The steep, high bluffs of the river shore make hauling by wagon from the farm to the landing, expensive and in many cases impracticable. This difficulty has retarded settlement of regions so situated, but is now overcome by wheat chutes, which transport and at the same time clean grain at less cost than on ordinary wagon roads.

Every improvement now made for local river traffic will be of more benefit when navigation on the river shall be made continuous by improvements at the present complete barriers of the Cascades, Dalles, and Priest Rapids, or even when the present work at the first-named place be finished.

Abstract of proposals for removal of solid rock from channels of the Upper Columbia and Snake rivers, opened by Capt. Charles F. Powell, Corps of Engineers, August 16, 1881.

Number.	Name and residence of bidder.	Removal of solid rock. Location.	No. of cubic yards, more or less.	Price per cubic yard.	Remarks.
1.	S. R. Smith, Ainsworth, Wash.	Upper Umatilla Rapids	500	$24 00	Contract awarded.
		Homly Rapids	200	25 00	
		Palouse Rapids	200	16 50	
		False Palouse Rapids	100	16 50	

Abstract of contracts for improving the Upper Columbia and Snake rivers in force during the fiscal year ending June 30, 1882.

Number.	Name and residence of contractor.	Date of contract.	Subject of contract, removal of rock.	Price per cubic yard.	Remarks.
			Cub. yds.		
1	J. B. Montgomery, Portland, Oreg.	Nov. 15, 1880	100	$25 00	Contract expired December 31, 1881.
			650	17 00	
2	S. R. Smith, Ainsworth, Wash.	Sept. 17, 1881	500	24 00	Contract expired January 1, 1882.
			200	25 00	
			300	16 50	

O O 4.

CONSTRUCTION OF CANAL AROUND THE CASCADES OF THE COLUMBIA RIVER, OREGON.

The usual summer high-water did not permit operations on the canal proper during the early part of the fiscal year. For that time work was confined to the quarrying of bowlders on high ground for building-stone, procurement of timber, and wood for fuel, building of a drill scow, and general preparations for work of the low-water season. This work consisted of two parts—canal construction, and river improvement next below the canal. Of the canal part, the excavation for continuation of the stone protective wall on the river side, for extension of its concrete hearting to a junction with the bulkhead at the foot of the canal, and the hearting extension were completed. The protective wall was built to the intended end, but not to the full height. Sixteen hundred and thirty cubic yards of dry rubble were laid in the wall, and 310 cubic yards of concrete in the core.

Part excavation was made for the dry stone side wall of the canal on the right, and the wall commenced; 1,133.7 cubic yards of masonry were laid. The face stone are roughly squared and placed in courses on a *batir* of 1:12; the bottom of the wall is 2 feet below the guard sills of the level of that part of the canal; the foundation course, 2 feet high, projects $1\frac{1}{2}$ feet beyond the wall face. The top of the wall is intended to be at the surface of the highest stage for which the present project provides lockage; this makes the wall 24 feet high. The top is at the level of the embankment berm. Fenders are to be hung on the face of the wall.

The canal project required that this wall should be vertical, and of strong timber cribs to 1 foot below low-water surface, and then a dry stone wall 11 feet high, or the top 4 feet below highest stage of lockage.

It was quite necessary to build the side wall now, several years in advance of the opening of the canal, and stone was convenient. For these reasons, principally, the present structure was substituted for the crib-work and wall of the project, by authority of Colonel Gillespie, officer in charge at the time, and on my recommendation.

If additional lockage is given for higher stages than now contemplated, the fenders on the face are to be replaced by part of a timber frame-work which is intended to surmount the wall and be arranged in tiers for convenience in lining vessels through the canal.

Material of excavation was disposed of in raising the protective embankment or in filling on the land side of the canal.

Excavation and borings show that good foundation cannot be obtained at reasonable depth for the lower part of the proposed guard-lock of the high-water system; and that the foundation of the high guard-gate at the head of the canal, which was to form part of the guard-lock, is of doubtful nature. Should more extensive examinations show the impracticability of advancing this lock, it will be necessary to make it join the low-water lock. In that case it is proposed to omit the guard-gate at the extreme head of the canal, for reasons stated in the report of the officer in local charge, and which I had the honor to urge from my experience at the Cascades, to the two Boards of Engineers who have considered the canal construction. My predecessor, Colonel Gillespie, did not favor any gate in advance of the embankment across the canal line, for economical reasons.

Lieutenant Price, who has now lived during one winter at the Cascades, is clearly of my opinion, that an opening of 70 feet (gate span) at the head of the canal would make the upper entrance difficult during the stormy period.

A contract was made with Messrs. Chalmers & Holmes, August 13, 1881, for removal of solid rock from the river below the canal at $3 per yard for rock 2 feet above extreme low-water and $25 per yard for rock below that plane. The submerged rock was to be removed for a depth of 10 feet below extreme low-water. Material was to be dumped at designated places on the bank or in deep holes of the river bottom, to a depth of not less than 15 feet at low-water.

The contractors' appliances were limited, and their work was of the character which made it just sufficient to come within the letter of the agreement. The contractors were not required and did not do any submerged rock work. They removed 4,527.48 cubic yards of bowlders from the Big Eddy and Middle Block House Points, right bank, working with derricks on shore.

Work of improvement on the canal side of the river was conducted by hired labor; 8,348 cubic yards were removed at a cost per yard of about one-half the contract price. This work, like the contractors', consisted in the reduction of projecting points covered with bowlders.

The places of rock removal were near canal stations 35, 50, 67, and

73. Considerable blasting was done at intermediate places and next below station 73.

The drilling was done partly by steam and partly by hand. From the scarcity of white men a small force of Chinese drillers was employed.

For work on rocks in the channel removed from shore, the steam-drill scow was used, or where the rocks furnished good footing and could be reached by small boat, drilling by hand was done. The largest of these masses is called Umatilla Rock; some small blasts were fired there and a tunnel partly made. While a gang of eight Chinese were being ferried from the rock to shore by a white employé, the Chinese became frightened, seized the ferry rope, and capsized the boat; five of them were drowned in the rapid.

The work of the drill-scow was not fully satisfactory, from the want of a tow-boat to handle the scow. A suitable boat could not be chartered except at very great expense; the scow was laid up until more funds were available and the government tow-boat completed which was then under construction. Subsequently, when the river had fallen so that some of the rocks were more easily reached by small boat, good and cheap blasting was done by lodgments of large charges of high explosive. For costs of rock removal and details of the season's operations, attention is invited to the interesting report herewith of Lieut. P. M. Price, Corps of Engineers. This officer has been stationed at the Cascade locks, and been in local charge of the Cascades improvement since October 3, 1881; he has rendered valuable assistance by a zealous performance of an important and responsible duty.

A stern-wheel tow-boat, built at Portland by job work and hired labor, was completed in February, but has not been used on account of suspension of the Cascades work in that month from want of funds.

A small balance of the appropriation was retained for emergencies. By May it appeared probable that the summer high-water would be considerably above the average; the greater part of the reserve fund was expended in protective work during late May and first half of June.

Much interest was felt in the effect of the high-water at three points where hard cemented gravel had been uncovered by removal of bowlders in the winter's river work. The gravel was effectually eroded. Extensive slides of the bank opposite the Middle Block House, under the new railroad track, occurred; all except the heaviest material in these slides, and that of small amount, rapidly disappeared under action of the strong current, leaving as at the other places larger cross-section of river.

Navigation at the middle stages appears to have been decidedly improved. The result of river work and high-water warrants the probability that navigation to the canal can be made practicable for stages higher than that provided for by the low-water lock.

The improvement project requires an expenditure of $100,000 on river work below the canal, and then a consideration of results with reference to practicability of navigation before a continuance of such work; $30,554.26 have already been expended and applied principally in enlargement of cross-section above low-water. It is expected to continue that work next winter, and complete the submerged work, and thus determine by actual demonstration the resulting new low-water surface at the foot of the canal, and also give a much improved navigation to that point.

The remainder of funds now on hand are to be applied to the building of a bowlder dredge; to the purchase of additional land for canal purposes; completion of protective wall and timber bulkhead; continuation of excavation and of side wall of canal and wing walls of lock, and to the preparation of masonry stone. For the bowlder dredge it is intended to use the clam-shell dredge machinery and grappling apparatus on hand, and belonging to the improvement of the Lower Willamette and Columbia rivers. The dipper can be replaced when it is desired to use the boat as an earth dredger.

The appropriation asked for, $500,000, is intended for guard-gate and part lock construction, and additional river improvement if required. It is quite probable that the full amount can be expended to good advantage, and it is earnestly recommended that all of the estimated amount be appropriated, on account of the commercial importance of the improvement and for advantageous work.

The increase of amount required for completion of existing project over that named in the preceding annual report is caused by increased cost from enlargement of canal, intended construction of guard-lock to above low-water before opening canal, and revision of estimates.

APPROPRIATIONS TO DATE.

Act August 14, 1876	$90,000 00
Act June 18, 1878	150,000 00
Act March 3, 1879	100,000 00
Act June 14, 1880	100,000 00
Act March 3, 1881	100,000 00
Act August 2, 1882	265,000 00
Total	805,000 00
Amount expended to June 30, 1882	539,482 40
Balance	265,517 60

Money statement.

July 1, 1881, amount available	$133,847 17
July 1, 1882, amount expended during fiscal year, exclusive of outstanding liabilities July 1, 1881	133,329 57
July 1, 1882, amount available	517 60
Amount appropriated by act passed August 2, 1882	265,000 00
Amount available for fiscal year ending June 30, 1883	265,517 60
Amount (estimated) required for completion of existing project	1,655,397 31
Amount that can be profitably expended in fiscal year ending June 30, 1884	500,000 00

Abstract of proposals for the removal of solid rock and bowlders from the Columbia River adjacent to and below the site of the locks at the Cascades, opened by Capt. Charles F. Powell, Corps of Engineers, August 6, 1881.

No.	Name and residence of bidder.	Per cubic yard submerged.	Per cubic yard exposed.	Remarks.
1.	Chalmers & Holmes	$25 00	$3 00	Contract awarded.

Abstract of contract for the removal of solid rock and bowlders from the Columbia River adjacent to and below the site of the locks at the Cascades, in force during the fiscal year ending June 30, 1882.

No.	Name and residence of contractors.	Date of contract.	Subject of contract.	Price per cubic yard.	Remarks.
1.	Chalmers & Holmes, Portland, Oreg. (David Chalmers and William E. Holmes).	Aug. 13, 1881	Removal of solid rock and bowlders.	Submerged, $25; exposed, $3.	Contract expired March 31, 1882.

COMMERCIAL STATISTICS.

The Cascades Canal is in the collection district of the Willamette. The nearest port of entry is Portland, Oreg., 69 miles distant by river; the nearest light-houses and works of defense are at the mouth of the Columbia River, 162 miles distant.

The Cascade obstructions are the only obstacles to a good continuous navigation from Astoria and from Portland to The Dalles, 45 miles from the Cascades. While the productive areas between the Cascades and The Dalles are limited, The Dalles is on the border of the great Columbia River country, from which so much is expected in the near future. To reach the heart of this region extensive improvements will be necessary at the Dalles-Celilo obstacles, but without such improvements and with the head of continuous navigation at The Dalles the extensive traffic of the upper country will center there, and no single corporation can then control the transportation of the Columbia River.

The following table was carefully compiled from daily reports of receipts on file at the Portland Merchants' Exchange. A small part of the freight, not exceeding 5 percentage at the most, was received at landings below the Cascades, and consequently should not be credited to the upper country. The stated increase of the last year over the preceding one is in excess of the actual increase; the principal item of this difference is 15,000 tons of wheat, which the transportation first available could not promptly carry away. The amount of up freight is not known; it is considerably less than the down freight.

Columbia River traffic transported to Portland by Dalles and Cascade route of Oregon Railway and Navigation Company.

Articles.	June, 1880, to May, 1881, inclusive.	June, 1881, to May, 1882, inclusive.	Price.	Value, 1880-'81.	Value, 1881-'82.	Increase in quantity.
Wheat .... cwt..	397, 113	2, 019, 390	$1 50	$595, 669 50	$3, 029, 085 00	1, 622, 277
Flour .... bbls..	98, 657	202, 204	4 50	443, 956 50	909, 918 00	103, 547
Oats .... cwt..	75	3, 074	1 33	99 75	4, 085 42	2, 999
Barley .... do...	....	39, 147	1 50	....	58, 720 50	39, 147
Mill feed .... sks..	62	3, 474	65	40 30	2, 258 10	3, 412
Potatoes .... do...	37	16, 689	1 08	39 96	18, 024 12	16, 652
Wool .... lbs..	5, 336, 516	6, 309, 918	20	1, 067, 305 20	1, 261, 983 60	973, 402
Hides .... do..	1, 030, 445	1, 047, 221	15	154, 566 75	157, 083 15	16, 776
Cattle .... head..	1, 187	5, 413	40 00	47, 480 00	216, 520 00	4, 226
Sheep .... do...	4, 405	9, 356	3 00	13, 215 00	28, 068 00	4, 951
Butter .... cases..	17	186	20 00	340 00	3, 720 00	169
Eggs .... do...	21	50	10 00	210 00	500 00	29
Fruit .... bxs..	274	7, 119	8 00	2, 192 00	56, 952 00	6, 845
Corn .... sks.	....	481	2 00	....	962 00	481
Flax .... do..	32, 974	81, 552	2 92	96, 284 08	258, 131 84	48, 578
Bacon .... pkgs..	7	38	60 00	420 00	2, 280 00	31
Chickens .... bxs..	4	7	5 00	20 00	35 00	3
Seeds .... sks..	91	45	5 00	455 00	225 00	....
Pelts .... pkgs.	5, 762	226	2 00	11, 524 00	452 00	....
Horses .... head..	....	92	75 00	....	7, 100 00	92
Lime .... bbls..	186	....	1 50	279 00	....	....
Fur .... pkgs..	78	....	50 00	3, 900 00	....	....
Salmon .... cases..	4, 100	....	5 00	20, 500 00	....	....
Hops .... bales.	748	....	4 00	2, 992 00	....	....
Vegetables .... crates..	96	....	5 00	480 00	....	....
Hogs .... head..	80	....	30 00	2, 400 00	....	....
Tallow .... pkgs..	197	....	20 00	3, 940 00	....	....
Lard .... cases..	1	....	20 00	20 00	....	....
Totals				2, 468, 278 68	6, 017, 103 73	....
Increase for year ending May 31, 1882				....	3, 548, 825 05	....

The population by the census of 1880 of counties which furnished the above corrected amount of freight is 66,000.

During the last year immigration largely increased. Notwithstanding the expense and tediousness of the trip via San Francisco and the sea, steamships arriving here each four days have, of late, been bringing 300 to 400 settlers on their way to the Upper Columbia country. Direct railroad connection with the East promises to start an unprecedented tide of immigration.

Through river traffic is much decreased now on account of the late completion of a railroad westward to the Cascades. For that reason two steamers were taken from the Middle Columbia over the Cascade rapids for service elsewhere. The rail portage on the Washington side is still maintained and passengers have choice of boat or rail. The new railroad on the Oregon side is a single-track one, and will almost necessarily remain so: it is subject to breaks from land-slides and from a stretch of treacherous bed near the present lower end.

REPORT OF LIEUT. P. M. PRICE, CORPS OF ENGINEERS.

ENGINEER OFFICE,
Cascade Locks, Oregon, June 30, 1882.

SIR: I have the honor to submit the following report of operations on the construction of a canal around the Cascades of the Columbia River, Oregon, during the fiscal year ending June 30, 1882.

In accordance with your order of October 1, 1881, I assumed the local charge of the above work on October 3, 1881, taking station at the Cascade Locks.

1. CANAL WORK.

All work on the canal has been done by hired labor.

During July and the greater part of August, 1881, the high stage of water prevented work in the canal, and the laboring force was employed in quarrying bowlders for building-stone, moving stone for convenient use in proposed constructions, procuring derrick timbers and cord-wood for full season's use, and generally in preparations for the fall and winter work.

Active operations on canal work proper and that part of the river improvement done by hired labor were begun during August and were continued with a fair working force until December 5, when the small balance of the appropriation remaining available for expenditure on the canal made necessary a reduction of force from about two hundred men to one hundred and ten. From that date the men were gradually discharged as the condition of the work permitted until on February 20 work was entirely suspended, except the necessary care and preservation of the public property and animals. Assistant Engineer H. P. Davock and Draughtsman F. J. Carrel were retained for several months and were employed in making computations and drawings for the canal and locks.

Early in May it became evident that the water would be unusually high this year, and it was feared it might undermine portions of the river side of the protection wall on the right of the lower lock, and a few men were therefore employed to strengthen the riprapping along the foot of the wall and to move exposed derricks, engines and other property beyond the reach of the highest water. During the last days of May and first days of June the weather was so warm and the water was rising so rapidly that it was feared it might flow over the embankment across the canal at station 6. The embankment was therefore raised about 2½ feet, making the reference of the top 141, or 45 feet above extreme low-water. The upstream side of the raised part was revetted with sand bags and riprapped with stone. The flood reached its maximum height on the 12th of June, and remained at a stand until the 15th, when it began to fall, and the work of protection was stopped. The maximum rise above extreme low-water was 40.8 feet at the head and 51.1 feet at the foot of the canal. The rise was 1.1 feet less than that of the flood of 1880, the second highest recorded flood. None of the plant has been lost or damaged, and so far as can yet be ascertained the only injury to the work is a washing down of the bank at the back of the excavation for the retaining-wall on the right.

EXCAVATION.

The only excavation during the year has been that for the retaining and protection walls on the right, and for a ditch to drain the upper level of the canal. The ditch extends from station 10 to 24. The excavation for the retaining-wall has been completed from station 10 to 16 + 60 or 660 feet. The total amount of material removed, much of it bed rock, requiring blasting, was about 8,000 cubic yards. This material was disposed of in raising the height of the embankment on the right of the canal, and in filling up and grading the ground on the left of the canal.

RETAINING WALL ON THE RIGHT.

The building of this was begun in the latter part of October. The base of the foundation course is at reference 86, which is 2 feet below the miter sill of the upper guard-gate. This course is 2 feet high and 11.5 feet wide. The wall proper is to be 22 feet high (reference of top 110), 8 feet 2 inches wide on top, and 10 feet wide at bottom. The back is vertical and the front has a batir of 12 on 1, leaving a berm of 1.5 feet on the foundation course. The stone is laid dry; the face stones are roughly dressed and laid in courses; the backing is of rubble masonry. The bed rock was found to be too soft to be stepped off and left in place as a natural backing. This bed rock is hard when first uncovered, but on exposure slakes and crumbles into dust.

According to the present plan of the canal this wall will extend from station 9+50 to 19+25. From the latter station to station 12 it will rest on the bed rock. Above station 12 the bed rock dips down nearly vertically and gravel takes its place. From station 10 to station 12+69 the wall has been built to an average height of 12 feet, containining 1,133.7 cubic yards of masonry

PROTECTION WALL ON RIGHT OF LOWER LOCK.

This has been continued in the manner described in your report of last year.

The concrete hearting has been extended from station 25+40 to 27+71, where the wall ends, and thence by a turn to connect with the timber bulkhead at station 28. The lowest reference of the bed rock on this new part was 65 (or 8.4 feet below extreme low-water) near station 26+15. The concrete was built up to a height of reference 100 through the wall, and to reference 94 on the extension to the bulkhead, this being the height of the top of the bulkhead. The protection wall has been extended from station 25+15 to 27+71, where it ends in a semicircle, and has been built to an average height of reference 105. The canal face, however, has been entirely completed for only about half this distance. The foundation of the lower end of the wall was carried down to reference 86.

Three hundred and ten cubic yards of concrete were laid, and 1,630 cubic yards of masonry built.

WING-WALL ON RIGHT.

Six hundred and eighty-eight cubic yards have been added to this during the year.

BULKHEAD STATION 28.

The drainage ditch left under the bulkhead was filled with concrete in December.

In order to make the junction of the bulkhead with the gravel bank on the left of the canal water-tight, the gravel was removed around the end of the bulkhead to as great a depth as was practicable on account of the mountain water, and an attempt was made to drive sheet-piling through the remaining gravel to the bed rock. This was unsuccessful on account of the bowlders mixed with the gravel. Two rows of planking about 3 feet apart were then placed around the end of the bulkhead and the space between them filled with clay well rammed. On account of the inferior quality of the clay and the permeability to water of the underlying gravel it is doubtful if this end of the bulkhead will be found water-tight when the lock pit is pumped out. It may therefore be necessary to dig a trench from the end of the concrete foundation of the bulkhead along the left side of the lock pit until high bed rock is reached and then fill this trench with concrete.

MISCELLANEOUS.

The sinking of three test-pits on a line perpendicular to the axis of the canal at station 3+50, to determine the depth at which a proper foundation for a high guard-gate at that point could be found, was begun in the latter part of November, but had to be abandoned on account of want of money before any satisfactory conclusion was reached.

A hydrographic survey and borings were also made at the head of the canal with reference to the planning of a coffer-dam, which will have to be built if the guard-gate is placed at the above point. Rock was found at reasonable depths, but whether it was bed rock or bowlders could not be ascertained from the borings.

In this connection it may be stated that the excavations already made show that if the upper guard-gate is located near station 3+50 the foundation for the lower end of the walls of the upper guard and lift lock, and for the lower gates of that lock, will be on gravel. The bed rock above station 12 dips down to a considerable depth below the contemplated level for the base of those walls, and it is exceedingly doubtful if it can be reached without undermining the embankment on the right of the canal. It is not yet known whether or not the bed rock rises again anywhere under the proposed location for the upper lock.

If the locks should be built as combined locks with the upper gate of the upper lock near station 14, a bed-rock foundation would be secured for the entire construction, and a wide and easy entrance to the canal could be made at less cost than by the other method. There would be no trouble about drift and ice coming into the canal, because the directions of the wind and currents are such, both in the winter, when the ice breaks up, and during the summer flood, that neither ice nor drift runs on this side of the river. The deposit of sediment is ordinarily very small, and would be about the same for either location. The lower location would obviate the necessity of building an expensive coffer-dam around the head of the canal, and would greatly reduce the cost of excavating the upper end of the canal, as this could then be done entirely by dredging.

The total expenditure on the canal from July 1, 1881, to June 30, 1882, has been $73,351.86.

2. RIVER IMPROVEMENT BELOW CANAL.

This work consists in removing rock from the projecting points of both banks, and depositing it in the bends, and in blasting bowlders and reefs in the river channels and either removing the *débris* or dragging it into deep holes, the object being to increase the water-way and ease the currents at places of difficult navigation.

On account of want of proper appliances and of funds to procure them, and especially on account of the want of a suitable powerful steamer, but little work was done in the channels last winter. It is hoped that with the aid of the powerful tow-boat which was built at Portland, under your own supervision, last winter, the large bowlders which obstruct the channel at the Big Eddy Rapids can be removed as soon as the water falls to a low stage.

During January and February the river was unusually low, and the conditions favorable for the work of river improvement, both channel and shore, and it was much regretted that the lack of funds prevented advantage being taken of this circumstance. This work can be done to so much greater advantage, and at so much less cost at the very low stages, that I recommend that preparations for such work be made in the fall, but that the work itself be not commenced until the river falls to such stages, and then prosecuted only during their continuance.

The work on the left bank and in the channel was done by hired labor, and that on the right bank by contract.

WORK ON LEFT BANK BY HIRED LABOR.

Rock removal from the point near △ 7 L was commenced the latter part of August, with one fixed derrick. About the middle of September, the same work was begun at points 2,300 and 3,700 feet below the lock site, with one traveling derrick at each point, and early in October a second traveling derrick began work at the latter point. The stone, previously blasted into convenient sizes for handling, was lifted by the derricks to dump-cars running on elevated tramways, which led to the bends either above or below the points.

On account of the difficulty of procuring laborers a small force of Chinese drillers was employed. A 3-inch Ingersoll steam drill was used part of the time. Not more than half of the rock blasted has been removed. The statement below shows the amount and cost of the work done.

Plant:	
Four derricks	$1,000 00
Four hoisting-engines	4,905 00
One steam drill and hose	600 00
Nine cars	900 00
Track iron	400 00
Tools	200 00
Drills	137 19
Freight	125 00
	8,267 19
Drilling and blasting:	
Labor	3,478 93
Powder, fuse, caps, &c	622 60
	4,101 53

Labor of removal of rock	$6,936 09
Labor on tramways	834 03
Drilling and blasting (two-thirds of total amount)	2,734 35
Setting up four derricks	272 71
Material, fuel, and supplies	489 16
Ten per cent. of cost of plant	826 72
	12,093 06

Amount of rock removed, 8,349 cubic yards.
Cost per cubic yard, $1.45.

WORK IN CHANNELS BY HIRED LABOR.

For this work a drill-scow was built at the locks, and launched on the 22d of October. The scow is 80 by 24 feet. The middle portion of the house is occupied by a large hoisting-engine, with sufficient boiler capacity to supply two three and a half inch steam drills. The ends are occupied respectively as a blacksmith shop and quarters for the crew. The water was too high to do much work with the scow between the time when it was ready for service and that of being obliged to lay it up for want of funds. A number of small bowlders off Bowlder Point, and two large ones requiring 42 holes of an average depth of 14 feet each, were drilled and blasted. The steam drills worked satisfactorily, each drilling about 34 feet in ten hours at a cost of 37½ cents per foot.

After discontinuing work with the drill-scow, the water fell to so favorable a stage that surface blasting was tried for a few days with very good results, notwithstanding the disadvantage of not having proper appliances to work with. The powder in boxes weighted by attaching stones was lowered from a common row-boat alongside the rock to be blasted and fired by a triple tape fuse. Below is a summary of the work.

SUMMARY OF COST OF REMOVING SUBMERGED ROCK BY SURFACE BLASTING.

Columbia River, below Cascade Locks, Oregon, January, 1882.

Rock No.	Reference of top of rock.	Depth of water over charge.	Least depth over rock after blast.	Number of blasts.	Rock displaced, cubic yards.	Pounds of powder No. 1.	Pounds of powder No. 2.	Remarks.
(Wat	er=71.6.)	*Feet.*	*Feet.*					
1	73.0	12	9	1	37.6	......	100	
2	73.6	15	8	3	96.0	200	100	No rock left.
3	70.0	12	7	2	42.7	50	50	Do.
4	74.0	6	1	3	20.0	50	75	Mass of shattered rock previously blasted. Small portion still remains.
5	77.0	12	6	1	55.5	50	100	This rock drilled by steam drill, 11 holes.
6	74.0	8	6	2	41.0	100	......	No rock left.
7	70.0	10.5	7	3	88.8	150	100	Do.
8	70.0	8	7	3	32.7	50	100	Do.
9	73.6	11	6	2	21.3	......	100	Do.
9*a*	72.6	7	6	1	9.0	50	......	Do.
12	72.0	N. B. 14	0	1	10.0	......	50	Previously blasted by drilling. Small portion still remains.
13	70.0	7	6	1	13.0	50	......	No rock left.
14	70.0	9	7	1	23.7	50	......	Do.
15	69.5	8	7	1	7.7	50	......	Do.
15*a*	71.0	7	6	1	12.0	......	50	Do.
16	70.0	6.5	6	1	8.0	......	50	Do.
16*a*	71.9	6	6	1	8.0	......	25	Do.
					527.0	850	900	

Wages, four men three and a half days, at $8.50	$29 75
Cost of powder	625 50
Freight, &c., 35 boxes of powder	30 00
Caps and fuse	5 25
	690 50

Giant powder No. 1, 850 pounds, at 45 cents	$382 50
Giant powder No. 2, 900 pounds, at 27 cents	243 00
	625 50
Cost of powder per cubic yard of rock	1 18
Total cost per cubic yard of rock	1 30

The total expenditure for work in the channel of the river, including cost of construction of drill-scow, was $4,387.24.

WORK ON RIGHT BANK BY CONTRACT.

Under their contract dated August 13, 1881, Messrs. Chalmers & Holmes began the removal of rock from Big Eddy Point early in September, and from Middle Block House Point early in November. They ceased work on the 26th of February, 1882. The contract required payment by the cubic yard of solid rock removed. Some question having arisen as to the measurement and percentage of voids to be allowed, a tank was built of sufficient capacity to permit the lowering into it of a car box. The tank, partly filled with water, was placed under the derrick, and the cubical contents of each car box determined by lowering into the tank and measuring the displacement. Afterwards a number of loaded boxes were measured in the tank each day for about ten days, and a mean of the results gave the average contents of a box. If a box did not appear to be well loaded the inspector would mark it in his record of the number of boxes as one-half, two-thirds, or three-fourths of a box, as the case might be. In case of dispute the box was measured in the tank.

Messrs. Chalmers & Holmes were paid $13,582.44 for the removal of 4,527.48 cubic yards of solid rock, at $3 per cubic yard. The cost of inspection was $491.52.

The total expenditure during the fiscal year for river improvement below the locks, including the total cost of plant, drilling, and blasting, contract work, and construction of tow-boat, was $67,254.59.

RECORD OF THE NAVIGATION OF THE MINOR RAPIDS BELOW THE CANAL.

On August 28, 1881, the light-draught steamer A. A. McCully landed the contractors' plant at the foot of Big Eddy Rapid when the water was 15.7 feet above extreme low-water.

On September 23, gauge No. 2 reading 8.5 feet above extreme low water, the steamer Lurline landed 20 tons of freight at Bowlder Point, 3,700 feet below the lock site. Time from Lower Cascades, 26 minutes.

On October 22, gauge No. 2 reading 6 feet, the Lurline landed 30 tons of freight at the lock site. Time from Lower Cascades to lock site, 45 minutes, having at first taken the wrong channel at Big Eddy Rapid. After landing freight the Lurline towed the drill-scow through Big Eddy Rapid to Bowlder Point.

On October 10, gauge No. 2 reading 7.4 feet, the steamer Manzanilla landed freight for contractors at foot of Big Eddy Rapid. Did not attempt the passage of the latter rapid.

On October 29, gauge No. 2 reading 6.2 feet, the same steamer came to foot of Middle Block House Rapid.

On December 5, gauge No. 2 reading 4.4 feet, the *City of Salem* landed powder at Bowlder Point and then attempted to pass the Big Eddy Rapid, but was unsuccessful.

On February 4, 1882, gauge No. 2 reading 8.3 feet, the *Manzanilla* took the contractors' plant from the foot of Big Eddy Rapid.

CLASSIFIED STATEMENT OF DISBURSEMENTS.

Third quarter, 1881.		
Hired labor	$23,530 02	
Materials	18,806 61	
Transportation	127 11	
Telegrams, traveling expenses, &c	338 77	
		$42,802 51
Fourth quarter, 1881.		
Hired labor	48,373 37	
Materials	9,307 14	
Transportation	1,624 06	
Telegrams, traveling expenses, &c	271 79	
Contractors on river improvement	5,508 84	
		65,085 20

First quarter, 1882.

Hired labor	$12,340 12	
Materials	9,136 39	
Transportation	40 35	
Telegrams, traveling expenses, &c	1 60	
Contractors on river improvement	8,073 60	
		$29,592 06

Second quarter, 1882.

Hired labor	2,660 60	
Materials	464 33	
Telegrams	2 00	
Transportation	1 75	
		3,128 68

Amount expended July 1, 1881, to June 30, 1882	140,608 45
Amount available July 1, 1881	141,126 05
Amount available July 1, 1882	517 60

Assistant Engineer J. A. Gillespie was employed on the work until December 15, when he resigned. Assistant Engineer H. P. Davock was present from November to April 15, when he went on leave. Draughtsman F. J. Carrel and Overseer E. B. Allcutt have been present during the year. To all of them my acknowledgments are due for faithful services.

Very respectfully,

PHILIP M. PRICE,
First Lieutenant of Engineers.

Capt. CHARLES F. POWELL,
Corps of Engineers.

O O 5.

IMPROVEMENT OF ENTRANCE TO COOS BAY, OREGON.

The present project for this improvement, adopted in 1879, consists in the construction of a jetty from near Fossil Point, inside of the entrance, on a slightly curved line towards Coos Head, exterior to the entrance, the object being to open and maintain a deeper and more direct channel across the sea bar. The top of the jetty was to be about 2 feet above mean low-water, and the structure of wood and stone, or stone. An interval was to be left between the inner end and the shore for the passage of scows and rafts from South Slough.

Previous to the recommencement of work May, 1881, 650 feet of crib structure had been placed. Owing to a necessity of sinking cribs during high-tide, the top of the timber wall is at high-water. The cribs are 50 feet long; the first 7 are 20 feet wide and from 12½ to 18½ feet high; the last 6 cribs are 26 feet wide and from 18½ to 22½ feet high. The inshore interval was 540 feet.

Extreme difficulty was encountered in sinking the last cribs from strong currents and rough water of the advanced position of the jetty end. It was also found out that the inshore interval was not needed for South Slough craft. In fact, subsequent experience shows that the jetty, so far, is a convenience for inside navigation. The tides of the slough and bay make, at times, a little different. Vessels plying between them come down with a favorable current, wait under the jetty a short time, and then take a tide up.

The project for the prosecution of the work under the appropriation of March 3, 1881, provided for closing the shore interval and extending the jetty by a rock embankment formed by dumping stone from the end.

OBSTRUCTIONS TO NAVIGATION.

These consist of two rafts, situated 3 miles above the mouth of the Black River, which are respectively 150 and 250 yards long, and a third 15 miles above Montesano, 50 yards long; besides snags. These last are not numerous, as the river carries but little drift. The gravel bars, being covered by several feet of water during the boating stage, are not considered obstructions. The rafts and snags can be removed at a cost of $5,000, with the aid of a steam boat provided with a steam capstan. This done, the Chehalis and its tributaries afford 112 miles of navigable river to boats drawing 3 feet for six or eight months in the year. A boat suitable for this work is now building. The removal of the obstructions is a very necessary work.

At present the only means of supply, export, and travel, for a distance of 70 miles through a section of country containing one hundred and fifty farms, is a wagon road, which during winter is impassable from mud and flooded crossings.

The question of a system of slack-water navigation, by means of a series of low dams with gates, up the Chehalis to Black River, thence up the latter to its source in Black Lake, 3 miles from Olympia, in all 80 miles, has been presented, and is worthy of consideration. The total head to be overcome is 123.18 feet.

No extraordinary difficulties, from an engineering point of view, exist so far as is known, but a discussion of the project will require a more careful examination than I could make in the limited time at my disposal.

Very respectfully,

ROBT. A. HABERSHAM,
Assistant Engineer.

O O 12.

SURVEY OF THE COLUMBIA RIVER AT THE DALLES IN OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., May 30, 1882.

SIR: I have the honor to submit the following report upon a survey of the Columbia River at the Dalles, Oregon and Washington Territory, with a project for improvement for navigation:

A survey at the Dalles, Oregon, with plan and specifications for canal and locks, was required by act of Congress of March 3, 1879.

The principal part of the field-work of the survey now reported upon was performed between October, 1879, and January, 1880, by direction of Maj. G. L. Gillespie, Corps of Engineers, officer in charge, and under my supervision.

Subsequently and at various times additional surveys and examinations were made of special localities, to furnish results more detailed than ones obtained by the main party, and also for studying the variable phases of the river during its widely different stages.

An excellent instrumental examination had been made in 1874 by Assistant Engineer R. A. Habersham, and under the orders of Maj. N. Michler, Corps of Engineers. A map on a scale of 1:7,200 was plotted from this examination. No definite project for an improvement, however, was prepared. The obstacles to be overcome were briefly described in a report, and some plans were suggested. The time of the examination was necessarily too brief to include all the varying features which enter into this grand and useful work, and to give the data for solving this difficult problem of engineering, which appears at first sight, as stated by Major Michler, almost insurmountable.

The examination paved the way for a detailed survey, and the map of the former furnished a good groundwork on which to arrange the latter.

One month preceding the commencement of the survey, permanent water gauges were established, and from that time read daily, as a rule, until June, 1881. All the gauges are on the Oregon side. No. 1 is fixed on the railroad incline at Celilo; it marks the level of the river next above Tumwater as locally known, or Celilo Falls, as given on our maps. Gauge No. 2 is at the foot of the Falls. No. 3 is at the head, and No. 4 at the foot, of the Five-mile, or Dalles Rapids proper. No. 5 is on the railroad incline at the city of The Dalles. The Ten-mile Rapids are about midway between gauges 2 and 3. The Three-mile Rapids or Narrows are about midway between gauges 4 and 5. Gauges 1 and 5 are at termini of present navigation.

The survey was based on a triangulation and a circuit of duplicated levels covering both banks of the river from Celilo to The Dalles. There were one hundred and twenty-two trigonometrical stations, equally distributed on both banks and generally placed above mean high-water. As a rule the stations were marked by 0.5 or 0.75 inch drill holes in the natural rock, thus insuring permanency for use during construction or subsequent surveys. A triangle was cut around the holes, and adjacent stone pyramids erected for prominent surface marks. Consecutive stations were generally intervisible. The elevations of the trigonometrical stations were determined for convenient use in topographical work, and to furnish a series of well-located bench-marks, on both shores, throughout the whole reach of the survey.

Four base-lines were measured. The true meridian was determined near Celilo. Observations were made for magnetic declination near the Dalles. Connection was established with three land-survey points—one near Celilo, one near Five-Mile Rapids, and one near The Dalles.

The water surface was leveled to at sounding stations and also at principal breaks. The high-water line of 1879, which had remained plainly visible on the banks, and the high-water marks of 1876 at Celilo and at The Dalles, were included in the levels. The stage of 1879 is that of mean high-water. The flood of 1876 is the highest known to white inhabitants.

Topography was run with the stadia and was extended to the foot of the bluffs, or where the valley widened, as it does near The Dalles, to include all overflowed land. On the upper half of the region of survey topography was plotted in the field on specially prepared sheets. On the other part the advanced state of the winter season made necessary a resort to sketching in the field-book, without curtailing, however, the field-notes.

Soundings were taken wherever the current made the use of a small boat safe. Above the Falls, sounding stations were built 400 feet apart on both banks; zigzag lines were run between the stations and soundings made at regular intervals of time. Below the Falls the current is too swift to keep a boat on a given short range across the river. Straight lines were, therefore, made as nearly perpendicular to the current direction as practicable; the ends of the lines were marked with stakes after reaching shore. The nearest gauge was read before and after each set of soundings. Levels were run to the sounding stakes as soon after the sounding as practicable, and the gauges read at times of such leveling.

Surface velocities of current were obtained at principal places during stages near extreme ones.

Gauge stations were inspected occasionally. Gauge readings were plotted monthly and care exercised to detect errors. Some few suspicious results were rejected entirely. From the unusual height of the winter freshet of 1881 it was correctly judged that the following summer rise would not reach a mean, and consequently add but little value to the high-water observations already obtained. Readings to the end of February, 1881, were therefore submitted to an analysis for determination of slopes at different stages, and for compilation of tables of convenient reference.

The period of gauge observations included the flood of 1880, which was the third highest known to white inhabitants, and which was only 2.7 feet at Celilo below the great flood of 1876. Two winter low-waters, when the upper river was closed by ice, and an unusual spring low-water of 1880, when the river was free, were also included.

For the analyses, all readings had been previously reduced to the datum plane; those of gauge 1 were arranged in nearly consecutive order from the lowest to the highest. In parallel columns and on the respective horizontal lines were placed observed corresponding results of other gauges. Gauge 1 was then compared with each of the other gauges and the readings separated into groups, so that the range was small and the number of results in the groups was reasonably large. The limit of range was taken as 1 foot on gauge 1; the average range on the same gauge is 0.74 foot; the average number of results in all the groups is 16.2. The means of corresponding groups in each comparison were considered as rectangular co-ordinates of points of a line, which would represent, by abscissas and ordinates, corresponding readings on the two gauges under consideration. Through points plotted by each series of such co-ordinates the mean curves were drawn. The curves were extended to extreme high-water as found by leveling to reliable marks of the 1876 flood, and to an extreme low-water as transferred by deduction from the Cascades Canal, where such a stage had been definitely fixed. For this deduction two periods of observation on the Dalles gauges and on the Cascades gauge number 1 were selected, when the river was low and during a time of little change and no rain. Each period included eight days' observations. The mean of the Cascade readings for one of the periods was 1.7 feet above extreme low-water, and for the other period 3.2 feet. Simple proportions gave readings on the Dalles gauges corresponding to the low-water reference adopted at the Cascades.

From the plot of the curves of corresponding readings on gauge 1, with those on gauges 2 to 5, tables were made which give readings between extreme high waters on the other gauges for each foot on gauge 1.

These tables and levels to the river surface at points between the gauge stations give the data for a profile of water surfaces.

To avoid confusion only characteristic stages were plotted. The project for the Cascades Canal contemplates improvement for navigation from low water to a reading of 20 feet on Cascade gauge No. 2. The stage corresponding to this, at The Dalles, is shown on the profile. Readings of that stage, on the Dalles gauges, were deduced in this way: a period of ten days was chosen when the river was nearly at a standstill, and the mean of whose daily readings exactly marked the 20 foot stage at the Cascades; considering that one day was required for water to flow from The Dalles to the Cascades, a distance of nearly 50 miles, the corresponding mean was taken at the Dalles gauge No. 5; for the other gauges interpolation was made in the table.

The profile sheet of water surfaces also shows the river bottom along the line of deepest soundings.

RIVER DESCRIPTION.

The bed and permanent banks are of basalt. The rock is full of seams and fissures, and overlaid in places by gravel, shingle, and cobble-stones. Between high and low water lines there are large areas covered with shifting sand-dunes.

The trough of the low river is from 10 to 60 feet deep. The depths through the Dalles Rapids, where sounding is impracticable, were computed to vary from 30 to 40 feet. The sides of the trough are generally precipitous, and in many places vertical and from 40 to 80 feet high. The widths vary, at low-water, from 125 to 2,500 feet, and from 1,250 to 4,500 feet at flood stage.

Surface current measurements, made at stages of from 4 to 5, and from 40 to 44 above low-water at gauge 5, and which are nearly mean low and high stages, give the following results: Low-water velocities vary from 1.2 to 12.7 miles per hour; and high-water ones from 5.1 to 18.8 miles per hour. Velocities in detail are given in accompanying tables.

The total fall from Celilo to The Dalles (city), a distance of 13.6 miles, is:

	Feet.
At extreme low-water	81.4
At mean high-water (flood of 1879)	61.7
At extreme high-water (flood of 1876)	56.6

The slope at any one stage is not uniform, as shown by the profiles of water surfaces. At the lowest stage, beginning at Celilo,

For 9,000 feet, the slope is 1 : 9000; then a vertical fall of about 20 feet—middle of Celilo Falls.
For 2,000 feet, the slope is 1 : 75.
For 1,900 feet, the slope is 1 : 158.
For 10,900 feet, the slope is 1 : 2870.
For 5,400 feet, the slope is 1 : 720. Ten-Mile Rapids.
For 5,200 feet, the slope is 1 : 2080.
For 1,800 feet, the slope is 1 : 487.
For 6,800 feet, the slope is 1 : 2430.
For 5,200 feet, the slope is 1 : 520. Dalles Rapids.
For 3,000 feet, the slope is 1 : 3000.
For 28,800 feet, the slope is 1 : 14857.
At mean high stage:
For 5,000 feet, the slope is 1 : 10000. Celilo Falls.
For 400 feet, the slope is 1 : 160.
For 5,600 feet, the slope is 1 : 1400.
For 11,300 feet, the slope is 1 : 7060.
For 5,700 feet, the slope is 1 : 1055. Ten-Mile Rapids.
For 15,000 feet, the slope is 1 : 21429.
For 1,800 feet, the slope is 1 : 138. Dalles Rapids.
For 1,700 feet, the slope is 1 : 1700.
For 1,700 feet, the slope is 1 : 154. Dalles Rapids.
For 2,400 feet, the slope is 1 : 267.
For 10,600 feet, the slope is 1 : 964.
For 10,800 feet, the slope is 1 : 5400.

The profile at the extreme high-water does not vary much from that at mean high stage; the slopes of the former are somewhat less than those of the latter, from Celilo to the head of the Dalles Rapids; below, the slopes of the two stages are nearly equal.

The serious obstructions to navigation are Celilo Falls, Dalles Rapids, and Ten-Mile Rapids. The Three-Mile Rapids and another minor rapids, about 2 miles above the Dalles Rapids, offer but little difficulty at any stage, even to ascending steamers; velocities at the latter minor rapids decrease as the river rises, and the difficulty to navigation disappears entirely at mean high-stage. At the Three-Mile Rapids, velocities are the least at low stage; they increase, however, as the river rises. Wherever soundings appear on the maps transmitted herewith, navigation may be considered easy at all stages.

The ledge of rock forming the Celilo Falls juts out from the left bank

1 mile below the Celilo landing, and extends directly down stream for nearly 1.75 miles. Large openings at the shore end of the ledge make the partial fall known as the Horseshoe, and whose waters escape to the river below through the deep narrow chute made by the ledge and the rock walls of the Oregon side. The main volume of river flows over and through depressions of a wide ridge, at right angles to the current, and which joins the ledge near its lower end, with a rock plateau on the Washington side. The ledge, ridge, and plateau are completely covered at the higher stages of river. Extreme rise of the upper level is 28.3 feet, and of the lower level 72.3 feet. The total fall at the extreme low stage is 47.2 feet, and consequently only 3.2 feet at extreme flood.

From the basin, where unite the two main parts of Celilo Falls, there is a good boating river, for two miles, to the head of Ten-Mile Rapids. This obstruction is a chute 0.5 mile long, from 200 to 300 feet wide, with vertical sides from 60 to 70 feet high, and through which flows the entire river at stages lower than about 20 feet, locally. A portion of a higher river passes through a channel on the north side, formed by a natural depression in a rock plateau. The velocities of the low river and of the high-water channel are equal and about 7.5 miles per hour. The current is not so much of an obstruction as the disturbance of water produced by an irregular cross-section and submerged rocks, which cause swirls and strong eddies. A boat cannot be held steadily on her course, but is rendered liable to be dashed against the rock sides or forced on the reefs.

Three and one-quarter miles farther down is the head of the Dalles Rapids. The name is said to be derived from Canadian French, D'aller, meaning a mill-race. Next in advance of the rapid, the river is wide and somewhat shoal; the low and sandy banks here are the mouths of deep ravines extending into the bluffs. Walls of rock put out from the river sides at right angles to the current forming the head of the rapid. The gorge is 8,000 feet long and from 125 to 350 feet wide. The sides are precipitous and from 40 to 60 feet high; between them flows the entire volume of the Columbia at the lower stages.

A rising river on reaching 30 feet above low-water begins to escape through two side channels—one on the right near the head, and the other on the left near the middle of the chute. The flood river spreads over the walls, but their height and the narrowness of even the high river cause floods to back up almost to Celilo. The extreme rise at the head of the rapid is 87 feet, and at the foot 66.6 feet. The low-water fall, in the rapid, is 11.2 feet; the maximum fall, 35 feet, occurs at a stage about mean high-water. Near the lower end there are several dangerous rocks in the rapid, and at the foot large masses of rock divide it into different parts; the main channel empties into a capacious, deep basin of rectangular shape, called the big eddy. The river leaves this basin at right angles to the direction of the rapid, and again quickly turns another sharp corner. Up-stream navigation of the rapid at low stage, and a down-stream passage during high river only are possible. Navigation cannot even for possible cases be made practicable without extensive radical improvement.

Below Three-Mile Rapids navigation would be easy. In fact, 1 mile above The Dalles' landing is the mooring place or harbor for craft not in use.

The bottom of the river from Celilo to The Dalles is a succession of deep pockets and high ridges; the latter are natural submerged weirs, over which the low river falls with greater or less slopes, depending upon the relative elevations of consecutive dams. The profile sheet of water surfaces plainly shows this condition of river regimen. For the same locality changes of slopes at different stages are due to engorgements of the river, or, in other words, changes of relative lengths and average heights of the dams.

The gauge tables transmitted herewith show the difference of river surface elevations between gauge stations, with horizontal distances, for different stages of river.

The distance from safe water above Celilo Falls to navigable river next above The Dalles landing is 56,200 feet; the total fall, at low stage, is 80.7 feet; this fall decreases gradually to flood stage, when it becomes 53.2 feet.

ATTEMPTS IN NAVIGATION.

Several craft have made the trip from the Upper to the Middle Columbia, and generally with safety. The passage from Celilo to the head of the Dalles Rapids is made during high-water, and through the Dalles at low stage. A notable case, as showing the extent of possible navigation on the Snake River and partly on the Columbia, is that of the steamer Shoshone. This boat was built on the Upper Snake for the Boise country trade, before the construction of the Northern Pacific Railroad. She navigated, without difficulty, a reach of 170 miles, and afterwards made the passage of the Great Cañon of the Snake, the Dalles obstructions, and the Cascades, and was subsequently used on the Upper Willamette. The distance, by river, from the highest point reached on the Snake to the present head of navigation on the Willamette, is 841 miles. The steamer Harvest Queen is the last boat brought down from Celilo, February, 1881. She jumped the falls at the low stage, for such an attempt, of 10.6 feet on gauge 1, and 53.9 feet on gauge 3. Her wheel, rudders, and machinery were damaged, the boat rendered unmanageable, and prevented, with difficulty, from being carried into the Dalles Rapids. A little later, when the river had fallen to a stage of 22.4 feet at gauge 3, the steamer finished the passage without a scratch.

No steamer has attempted to ascend the Dalles Rapids. Before the time of steam navigation, however, batteaux were taken up. Captain Silas Smith, a river pioneer, states that in March, 1858, when the river was doubtless not below a mean low stage, he took a bateau fleet to the foot of Celilo Falls; each boat carried two tons and was manned by four men; at The Dalles the crew doubled, and cordelled the loaded bateaux through the rapids.

Mr. Lawrence Coe, who was formerly interested in Dalles steamers, assures me that several years ago one of his boats, and of a kind less powerful than steamers now in use, ascended the Three-Mile Rapids without difficulty during low stage.

The government launch, stationed at the Cascades, and whose speed is only 10 miles per hour, steamed from The Dalles to the Big Eddy, July, 1881, during a stage of 47.5 feet at gauge 3. Some difficulty was experienced at the Three-Mile.

During September, 1881, the small steam ferry-boat belonging at the Dalles went to the Big Eddy with ease; guage 3 read 38.1, or a stage of 17.6 feet.

CHARACTER OF RIVER AND NAVIGATION BELOW THE DALLES AND ABOVE CELILO.

The Middle Columbia, as the reach is named from The Dalles to the Cascades, has a good 8-foot channel at an extreme low-water, whose average annual duration is very short. Steamers plying here are large and powerful. Barges are much used; they are fitted with sails and frequently sail upstream; winds prevail in that direction, except during winter. There are several lumber and wood scows on this reach. Through river traffic is much decreased now, on account of the late completion of a railroad from The Dalles to the Cascades. For that reason one steamer was taken over the Cascades for service elsewhere.

A second steamer, and the largest of the fleet, is in readiness for transfer to the lower river. The rail portage on the Washington side is still maintained, and passengers have a choice of boat or rail. The new railroad on the Oregon side is a single-track one, and will almost necessarily remain so; it is subject to breaks from snow blockades, land slides, and from a stretch of treacherous bed near the present lower end of the line.

The government has commenced a navigation improvement at the Cascades, consisting of a canal with lock and extensive open river work along the lower approach. The project is intended to give navigation during low and medium stages of river, lasting about one-half of the year, and is arranged for convenient development into a high-water system; $540,000 have been appropriated, so far, for this improvement.

Below the Cascades to the mouth of the Willamette, the present head of ship navigation on the Columbia, the river, 51 miles in length, has a natural capacity for navigation, fully as large as the middle river. The same class of steamboats and barges ply here as there. Below the mouth of the Willamette and on that river to Portland, Oreg., are found first-class craft of all kinds—river, coasting, and foreign trade. A more detailed description of the middle, lower, and also upper river, with dimensions and numbers of river craft, is given in a paper accompanying the report of the Board of Engineers on the Cascade Canal, of November, 1880.

THE UPPER COLUMBIA.

Present navigation on the Columbia and Snake rivers, from Celilo up, is continuous to Lewiston, 266 miles; and also from the mouth of the Snake to Priest Rapids, on the Columbia, 73 miles. Navigation is likewise practicable, beyond Lewiston, for 15 miles on the Clearwater, and for 42 miles on the Snake.

Low-water navigation on the river reaches named is difficult on account of numerous rapids, made by rock obstructions. The government has entered upon projects to give a 5.5 foot channel from Celilo to the Snake, 4.5 feet on the Snake to Lewiston, and 4 feet, for 40 miles from Lewiston, on the Clearwater; $200,000 have been appropriated, and $86,424 are estimated for completion of the projects.

Steamboats on the Upper Columbia and Snake are smaller than those on the middle river, but equally well appointed; the average tonnage of the former is 626 (measurement). There has been no regular barge navigation on the upper river; limited scow towing was lately introduced for carrying stone down the worst part of the navigable Snake to Ainsworth, and has proven so advantageous that doubtless grain will be transported in a similar way this fall. Larger steamers and barges could be used during medium stages; but from the isolation of the route only boats have been constructed for its trade which could profitably navigate the rivers during the busy season of low-water.

As on the middle river, the construction of the railroad on the south bank has much decreased the traffic by boat and portage. The fleet of the rail and navigation company is now used for places not reached by the railroad.

The average annual ice blockade on the upper river lasts about six weeks. Prevailing high winds occasionally increase to gales and impede navigation.

On the whole river different stages of water occur with regularity; low-water follows the harvest season with certainty; mean low stage is reached about the first of October; a freeze-up during the holidays; freshets giving good boating stages in late winter or early spring, and high-water at summer solstice. Mean low to medium stage is the easiest for navigation.

PROJECT FOR IMPROVEMENT FROM CELILO TO THE DALLES.

This improvement should be arranged for use during the same periods as that at the Cascades. These two works of magnitude and importance are only 50 miles apart and both are between the principal producing region and ship navigation; each one is the natural complement of the other, and especially is it true that navigation at the Dalles, with the Cascades closed, would be of little value.

The Cascade stage of river of 20 feet, which marks the limit of expected navigation there for present time, corresponds on the Dalles gauges—

At No. 1, to a reference of 97.5, or local stage of 8.0 feet.
At No. 2, to a reference of 74.9, or local stage of 32.7 feet.
At No. 3, to a reference of 62.6, or local stage of 42.1 feet.
At No. 4, to a reference of 32.7, or local stage of 23.4 feet.
At No. 5, to a reference of 25.0, or local stage of 17.0 feet.

Referring now to the adaptability of the localities for different kinds of improvement, it may be stated that open river navigation from good water at the lower end of the obstructed reach to the foot of the Dalles Rapids and of the rapid reaches between the Dalles and the falls may all be made entirely practicable. The Dalles Rapids are also susceptible of similar improvement during *lower* stages; but the point on a rising river, to which it can be judiciously carried, is problematic; it is not even certain that navigation through the rapid can be made practicable up to the Cascade stage of 20 feet; moreover, extensive river improvement at this locality may increase the work at rapids above. For the passage of Celilo Falls lockage will be required for all stages below mean high-water, and radical improvement below the falls will doubtless make such lockage necessary for higher stages.

The following plans have been considered:

1. To carry the Celilo level by a trunk or canal, with a lock at the upper end, to a flight of locks located near gauge station 4.
2. With lift locks as in plan 1, to dam the river, making the overfall into Big Eddy.
3. Open river improvement for all stages to Celilo Falls, and lockage for the same at the falls.
4. Open river improvement for lower stages to Celilo Falls; lockage from low to mean-high water at the falls; open passage over the falls for higher stages, and lockage from medium to highest stage at the Dalles Rapids.

The trunk or canal of plan 1 would need to be water-tight at its bottom, and on the sides to low-water line. The maximum total lift would be 81.1 feet. To give 8 feet draught and exclude high river the outer wall of the canal would be from 28 to 38 feet high. The lock on a level could be conveniently placed south of gauge station 2; the Oregon chute of Celilo Falls could be made part of the canal.

There is one peculiarity of this locality which merits consideration in this connection with the long canal plan, and that is the extensive movements of sand on the river sides. Between gauge stations 2 and 3, railroad gangs work uninterruptedly to keep the track free of sand. This part of the road has been in use several years, and no remedy has been found to make daily sand work unnecessary. A little beyond Celilo sand blockades on the railroad have actually occurred.

Plan 2 would raise the flood line and cause an expensive elevation of the railroad track, unless the dam were a low one and part of the lift made at the falls.

Plans 3 and 4 are of about equal cost, and possess the advantage over the others of more open navigation instead of lockage; and the advantages of prime importance in providing navigation for the busy boating season in the least time, and furnishing benefits quickly available for each annual appropriation. Plan 3 has these merits in the greater degree, and when the injudiciousness of continuation on that plan has been practically demonstrated, a change to plan 4 may be made without loss. Open river improvement to the falls and the Celilo Canal are therefore recommended. In connection therewith a free wagon road from Big Eddy to good water of Celilo has been estimated for. The river work should begin at the lower end, and as it advances the wagon road shortened; and when boats are able to reach the foot of the proposed canal, the road be replaced by a rail portage, or the latter structure added on the Oregon side.

A similar free portage railroad is included in the Cascade project; its length would be 3,000 feet. The length of the Dalles wagon road would be 9.6 miles; and the part around the Celilo Falls, 7,000 feet. The aggregate length of rail portages would be less than 2 miles. Their free use for the present, and until the opening of the Cascade and Celilo canals, would be of immense value to the whole Columbia River country, and an actual saving to the canal appropriations, from reduced transportation and convenient delivery of material.

The open river work of the low-water project consists in the removal of projecting points and isolated knobs of rock at the rapids. Prices given in the estimates are much less than those for which rock work has been done on the upper rivers, but are yet believed to be liberal, on account of the quantity of work required and other favorable circumstances. The places of rock removal are shown by colored areas on the maps herewith.

The extension of river improvement for open navigation of the high-water system contemplates rock removal down to or near, but not below, low-water; closing of channel on left bank opposite Three-Mile Rapids, and building of four submerged dams below that rapid. The work is calculated to give areas of least cross-section—

	Square feet.
At low-water of	6,800
At Cascade stage 20 feet of	45,240
At mean high-water	75,360

And is expected to make a nearly continuous slope from Celilo Falls to next below, the Dalles, not exceeding 0.85 foot per 1,000 feet at the stage of greatest slope.

The location of the Dalles Canal, which is the substitute of the high-water open river improvement, is on the south side of the Dalles Rapids, as shown on the Celilo-Dalles map No. 2.

The location of the Celilo Canal is chosen on the rock plateau, flanking the falls on the Washington side. The total length of canal is nearly 3,640 feet, and of the approaches, 1,200 feet. The width between vertical sides of canal prism is 90 feet; the gate span is 70 feet, and the lock chamber 90 feet by 462 feet. These dimensions are the same as in the Cascades Canal, and are intended for the admittance of a medium-sized side-wheeler and lockage of a fleet of tow-boat and three barges. The least draught is 6 feet instead of 8 feet, as at the Cascades. Six feet through the canal is certainly as great a navigable depth, for stern-wheel boats, as 7 feet at the rapids; it allows ample margin for additional depth on the upper river over that contemplated by present project. The plan provides a high guard-gate at the head and a guard-gate at the foot of the canal. The high guard-gate can subsequently be made the upper gate of a guard-lock for use as a lift-lock in the high-water system. Room is left for this addition and for an intended enlargement of the canal prism. These two changes are shown in broken lines on the plan of the canal as drawn on the Celilo Falls map. A dry-dock would be very advantageous; one to be located north of the lower part of the guard-lock is included in the estimates. Two locks, combined, are provided in the low-water system; the lifts are 23.6 and 24.6 feet; this division results from a discussion herewith.

Detailed estimates of cost are attached. Estimates in the aggregate, according to desirable stages of construction, are as follows:

SUMMARY, LOW-WATER PROJECT.

(1.)		
(*a*) Title to land and right of way for river improvement and Celilo Canal	$10,000 00	
(*b*) Improvement up to Big Eddy	252,300 00	
(*c*) Wagon road and bridge	21,053 61	
		$283,353 61
(2.)		
(*a*) Improvement at Five-Mile Rapids	3,382,190 00	
(*b*) Improvement at Ten-Mile Rapids	1,001,700 00	
(*c*) Improvement at Ten-Mile Rapids (relief channel)	112,680 00	
		4,496,570 00
(3.)		
Celilo Canal		2,894,571 90
Total		7,674,495 51

SUMMARY OF ESTIMATE, HIGH-WATER PROJECT.

(1.)		
Open river improvement below Celilo Falls		$2,272,321 00
(2.)		
Celilo Canal.		
(*a*) Enlargement of canal	$17,400 00	
(*b*) Guard-lock	407,800 00	
(*c*) Dry-dock	145,327 20	
		570,527 20
Total		2,842,848 20

The first stage in the low-water project gives navigation to the foot of the Dalles Rapids and the wagon road from there to head of the Falls; the second gives navigation to the Falls, and the third to Celilo. For judicious work and advantageous results the appropriation should not be less, for the first year, than the cost of the first stage; $1,000,000 each year thereafter until the river improvement is completed, and then $500,000 annually for the canal; this would require about eleven years for the completion of the project.

COMMERCIAL STATISTICS.

The Columbia is the great river of the Pacific coast. In volume and commercial value, it is second only to the Mississippi. Its banks are more stable, its waters are more clear, its ice blockades are much less in duration than on the great water-way of the East. Unlike the Mississippi, the Columbia seeks the ocean on a line parallel to trade channels, and not at right angles to them.

The drainage area of the Columbia River, above The Dalles, is estimated at 182,000 square miles; it comprises Eastern Oregon and Washington, Idaho, part of Montana, and a portion of British Columbia. The natural outlet to the seaboard for the productions of this region is by the river. With isolated reaches of navigation and corporation portages, traffic will be by railroads, difficult in construction and expensive in maintenance, with consequent high rates of transportation.

The following table was carefully compiled from daily reports of receipts on file at the Portland Merchants' Exchange. A small part of the freight, not exceeding 15 percentage at the most, was received at landings below the Dalles Rapids, and consequently should not be credited to the upper country. The stated increase of the last year over the preceding one is in excess of the actual increase; the principal item of this difference is 15,000 tons of wheat, which the transportation first available could not promptly carry away. The amount of up freight is not known; it is considerably less than the down freight.

Columbia River traffic transported to Portland by Dalles and Cascade route of Oregon Railway and Navigation Company.

Articles.	June, 1880, to May, 1881, inclusive.	June, 1881, to May, 1882, inclusive.	Price.	Value, 1880–'81.	Value, 1881–'82.	Increase in quantity.
Wheat .... cwt.	397, 113	2, 019, 390	$1 50	$595, 669 50	$3, 029, 085 00	1, 622, 277
Flour .... bbls	98, 657	202, 204	4 50	443, 956 50	909, 918 00	103, 547
Oats .... cwt	75	3, 074	1 33	99 75	4, 085 42	2, 999
Barley .... do..	....	39, 147	1 50	....	58, 720 50	39, 147
Mill feed .... sks.	62	3, 474	65	40 30	2, 258 10	3, 412
Potatoes .... do..	37	16, 689	1 08	39 96	18, 024 12	16, 652
Wool .... lbs	5, 336, 516	6, 309, 918	20	1, 067, 305 20	1, 261, 983 60	973, 402
Hides .... do..	1, 030, 445	1, 047, 221	15	154, 566 75	157, 083 15	16, 776
Cattle .... head	1, 187	5, 413	40 00	47, 480 00	216, 520 00	4, 226
Sheep .... do..	4, 405	9, 356	3 00	13, 215 00	28, 068 00	4, 951
Butter .... cases.	17	186	20 00	340 00	3, 720 00	169
Eggs .... do	21	50	10 00	210 00	500 00	29
Fruit .... bxs.	274	7, 119	8 00	2, 192 00	56, 952 00	6, 845
Corn .... sks	....	481	2 00	....	962 00	481
Flax .... do..	32, 974	81, 552	2 92	96, 284 08	258, 131 84	48, 578
Bacon .... pkgs.	7	38	60 00	420 00	2, 280 00	31
Chickens .... bxs.	4	7	5 00	20 00	35 00	3
Seeds .... sks.	91	45	5 00	455 00	225 00	....
Pelts .... pkgs	5, 762	226	2 00	11, 524 00	452 00	....
Horses .... head	....	92	75 00	....	7, 100 00	92
Lime .... bbls.	186	....	1 50	279 00	....	....
Fur .... pks.	78	....	50 00	3, 900 00	....	....
Salmon .... cases	4, 100	....	5 00	20, 500 00	....	....
Hops .... bales.	748	....	4 00	2, 992 00	....	....
Vegetables .... crates.	96	....	5 00	480 00	....	....
Hogs .... head.	80	....	30 00	2, 400 00	....	....
Tallow .... pkgs.	197	....	20 00	3, 940 00	....	....
Lard .... can.	1	....	20 00	20 00	....	....
Totals	....	....	....	2, 468, 278 68	6, 017, 103 73	....
Increase for year ending May 31, 1882	....	....	....	....	3, 548, 825 05	....

The population by the census of 1880, of counties which furnished the above corrected amount of freight, is 66,000.

The principal settlements are in the regions between the Blue Mountains and the rivers Snake, Columbia, and Umatilla; and next north of the middle part of the Lower Snake.

During the last year immigration largely increased. Notwithstanding the expense and tediousness of the trip *via* San Francisco and the sea, steamships arriving here each four days have of late been bringing three hundred to four hundred settlers on their way to the Upper Columbia country. Direct railroad connection with the East promises to start an unprecedented tide of immigration.

EXTENSION OF NAVIGATION BEYOND PRESENT ROUTES.

It is the announced policy of the Oregon Railway and Navigation Company to run boats on the Clearwater, Middle Snake, and the Columbia above Priest Rapids, as soon as regions along those parts of the rivers become settled. Boats have already made trips, at favorable stages, 25 miles up the Clearwater. During the Bannock war, troops were carried by steamers to the mouth of the Grande Ronde, 42 miles up the Snake from Lewiston, and previously a steamer had ascended 54 miles farther. An estimate for improvement of the Snake from Lewiston to the Salmon River, 60 miles, based on an examination made last August, is $32,604.

On the main river Priest Rapids offers a serious obstacle to continued navigation. It is known, however, with fair certainty, that this obstruction and a reach of river above, together of 153 miles, are susceptible of improvement for navigation without canal or lock. This part of the Columbia will give an easy outlet for the splendid valleys of the Upper Yakima, Kittitas, Wenatchie, and Okinakane, the timbered land of Lake Chelan and that part of the great plains of the Columbia lying west of the Badger Mountains and the Grand Coulé; shipments from these regions are now almost nothing. Further north there are 430 miles of water to the head of navigation, broken only at two places, where permanent portages may be preferable to canals. Improvements for continuance of navigation beyond the present head on the Columbia, to limits indicated above, will require $500,000, according to rough estimates.

There are transmitted herewith—

Map tracings, Celilo to The Dalles, in two sheets, scale 1 : 6000.
One tracing Celilo Falls, scale 1 : 1200.
One tracing Dalles Rapids, scale 1 : 1200.
One set of plots of curves of corresponding readings at gauge stations.
One set of tables of corresponding gauge readings.
Profile sheet of water surfaces.
Profile of proposed wagon road.
Profile on center line of Celilo Canal.
One set of velocity tables.
A paper, notes on arrangement of lift, Celilo locks.
One set of detailed estimates, low-water and high-water improvement, Celilo to The Dalles.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Captain of Engineers.

The CHIEF OF ENGINEERS, U. S. A.

CORRESPONDING ELEVATIONS OF RIVER SURFACE AT GAUGES 1 TO 5.

Dalles gauges.

Gauge 1.	Gauge 2.	Gauge 3.	Gauge 4.	Gauge 5.	Remarks.
117.74	114.5	107.5	75.9	61.2	Extreme high-water, 1876.
117.00	113.5	106.6	74.7	60.2	**Deduced.**
116.00	112.1	105.4	73.0	58.7	**Do.**
115.00	110.7	104.2	71.3	57.2	**Observed.**
114.00	109.3	103.1	69.6	55.8	**Do.**
113.00	107.9	101.9	67.9	54.3	**Do.**
112.00	106.5	100.5	66.2	52.8	**Do.**
111 00	105.1	99.1	64.5	51.3	**Do.**
110.00	103.7	97.6	62.8	49.8	**Do.**
109.00	102.3	95.9	61.0	48.1	**Do.**
108.00	100.9	94.2	59.2	45.3	**Do.**
107.5*	....	....	....	....	***Mean high-water.**
107.00	99.4	92.3	57.4	44.5	**Observed.**
106.00	97.7	90.2	55.6	42.6	**Do.**
105.00	96.1	88.0	53.6	40.6	**Do.**
104.00	94.3	85.6	51.4	38.6	**Do.**
103.00	92.2	83.2	49.1	36.6	**Do.**
102.00	89.9	80.6	46.5	34.5	**Do.**
101.00	87.3	77.7	43 7	32.4	**Do.**
100.00	84.3	74.4	40.7	30.2	**Do.**
99.00	81.0	70.4	37.6	28.1	**Do.**
98.00	77.2	65.3	34.3	26.1	**Do.**
97.5	**74.9**	**62.6**	**32.7**	**25.0**	**20-foot stage on Cascade gauge 2.**
97.00	72.7	59.7	31.0	24.1	**Observed.**
96.00	67.6	54.1	27.8	22.0	**Do.**
95.00	62.0	48.4	24.7	19.9	**Do.**
94.00	57.0	42.4	21.4	17.6	**Do.**
93.00	52.8	36.1	18.1	15.1	**Do.**
92.00	49.5	30.5	15.2	12.9	**Do.**
91.00	46.6	26.1	12.8	10.9	**Do.**
99.00	43.7	22.4	10.5	9.0	**Deduced.**
89.45	42.19	20.49	9.30	8.01	Extreme low-water (**deduced**).

5.000′ 11.000′ 43.000′ 51.200′ 72.000′ from railroad incline at Celilo.

6.000′ 32.000′ 8.200′ 20.800′

Foot of Three-Mile Rapid 61.200 feet from railroad incline at Celilo.

	Low-water.	20 feet on Cascade gauge No. 2.	Mean high-water.	High-water.
Foot of Three-Mile Rapid	8.7	26.8	47.75	64.25
Gauge 5	8.0	25.0	45.75	61.25
	.7	1.8	2.0	3.0

Differences of corresponding readings.

Gauge No. 1.	Gauge No. 2.	Difference.
117.74	114.5	3.24
117.	113.5	3.5
116.	112.1	3.9
115.	110.7	4.3
114.	109.3	4.7
113.	107.9	5.1
112.	106.5	5.5
111.	105.1	5.9
110.	103.7	6.3
109.	102.3	6.7
108.	100.9	7.1
107.	99.4	7.6
106.	97.7	8.3
105.	96.1	8.9
104.	94.3	9.7
103.	92.2	10.8
102.	89.9	12.1
101.	87.3	13.7
100.	84.3	15.7
99.	81.0	18.0
98.	77.2	20.8
97.5	**74.9**	**22.6**
97.	72.7	24.3
96.	67.6	28.4
95.	62.0	33.0
94.	57.0	37.0
93.	52.8	40.2
92.	49.5	42.5
91.	46.6	44.4
90.	43.7	46.3
89.45	42.19	47.26

Differences of corresponding readings.

Gauge No. 2.	Gauge No. 3.	Difference.
114.5	107.5	7.
113.5	106.6	6.9
112.1	105.4	6.7
110.7	104.2	6.5
109.3	103.1	6.2
107.9	101.9	6.
106.5	100.5	6.
105.1	99.1	6.
103.7	97.6	6.1
102.3	95.9	6.4
100.9	94.2	6.7
99.4	92.3	7.1
97.7	90.2	7.5
96.1	88.0	8.1
94.3	85.6	8.7
92.2	83.2	9.
89.9	80.6	9.3
87.3	77.7	9.6
84.3	74.4	9.9
81.0	70.4	10.6
77.2	65.3	11.9
74.9	**62.6**	**12.3**
72.7	59.7	13.
67.6	54.1	13.5
62.0	48.4	13.6
57.0	42.4	14.6
52.8	36.1	16.7
49.5	30.5	19.
46.6	26.1	20.5
43.7	22.4	21.3
42.19	20.49	21.70

Differences of corresponding readings.

Gauge No. 2.	Gauge No. 4.	Difference.
114.5	75.9	38.6
113.5	74.7	38.8
112.1	73.0	39.1
110.7	71.3	39.4
109.3	69.6	39.7
107.9	67.9	40.0
106.5	66.2	40.3
105.1	64.5	40.6
103.7	62.8	40.9
102.3	61.0	41.3
100.9	59.2	41.7
99.4	57.4	42.0
97.7	55.6	42.1
96.1	53.6	42.5
94.3	51.4	42.9
92.2	49.1	43.1
89.9	46.5	43.4
87.3	43.7	43.6
84.3	40.7	43.6
81.0	37.6	43.4
77.2	34.3	42.9
74.9	**32.7**	**42.2**
72.7	31.0	41.7
67.6	27.8	39.8
62.0	24.7	37.3
57.0	21.4	35.6
52.8	18.1	34.7
49.5	15.2	34.3
46.6	12.8	33.8
43.7	10.5	33.2
42.19	9.30	32.89

Differences of corresponding readings.

Gauge No. 2.	Gauge No. 5.	Difference.
114.5	61.2	53.3
113.5	60.2	53.3
112.1	58.7	53.4
110.7	57.2	53.4
109.3	55.8	53.5
107.9	54.2	53.6
106.5	52.8	53.7
105.1	51.3	53.8
103.7	49.8	53.9
102.3	48.1	54.2
100.9	45.3	55.5
99.4	44.5	54.9
97.7	42.6	55.1
96.1	40.6	55.5
94.3	38.6	55.7
92.2	36.6	55.6
89.9	34.5	55.4
87.3	32.4	54.9
84.4	30.2	54.1
81.0	28.1	52.9
77.2	26.1	51.1
74.9	**25.0**	**49.9**
72.7	24.1	48.6
67.6	22.0	45.6
62.0	19.9	42.1
57.0	17.6	39.4
52.8	15.1	37.7
49.5	12.9	36.6
46.6	10.9	35.7
43.7	9.0	34.7
42.19	8.01	34.18

Differences of corresponding readings.

Gauge No. 3.	Gauge No. 4.	Difference.
107.5	75.9	31.6
106.6	74.7	31.9
105.4	73.0	32.4
104.2	71.3	32.9
103.1	69.6	33.5
101.9	67.9	34.0
100.5	66.2	34.3
99.1	64 5	34.6
97.6	62.8	34.8
95.9	61.0	34.9
94.2	59.2	35.0
92.3	57.4	34.9
90.2	55.6	34.6
88.0	53.6	34.4
85.6	51.4	34.2
83.2	49.1	34.1
80.6	46.5	34.1
77.7	43.7	34.0
74.4	40.7	33.7
70.4	37.6	32.8
65.3	34.3	31.0
62.6	**32.7**	**29.9**
59.7	31.0	28.7
54.1	27.8	26.3
48.4	24.7	23.7
42.4	21.4	21.0
36.1	18.1	18.0
30.5	15.2	15.3
26.1	12.8	13.3
22.4	10.5	11.9
20.49	9.30	11.19

Differences of corresponding readings.

Gauge No. 4.	Gauge No. 5.	Difference.
75.9	61.2	14.7
74.7	60.2	14.5
73.0	58.7	14.3
71.3	57.2	14.1
69.6	55.8	13.8
67.9	54.3	13.6
66.2	52.8	13.4
64.5	51.3	13.2
62.8	49.8	13.0
61.0	48.1	12.9
59.2	45.3	13.9
57.4	44.5	12.9
55.6	42.6	13.0
53.6	40.6	13.0
51.4	38.6	12.8
49.1	36.6	12.5
46.5	34.5	12.0
43.7	32.4	11.3
40.7	30.2	10.5
37.6	28.1	9.5
34.3	26.1	8.2
32.7	**25.0**	**7.7**
31.0	24.1	6.9
27.8	22.0	5.8
24.7	19.9	4.8
21.4	17.6	3.8
18.1	15.1	3.0
15.2	12.9	2.3
12.8	10.9	1.9
10.05	9.0	1.5
9.30	8.01	1.29

SURVEY OF THE DALLES, COLUMBIA RIVER, 1879–1880.

Current measurements.

Place.	Date.	Stage of river above low-water.	Surface velocity in miles per hour.	Remarks.
		On gauge 5.		
Above Celilo Falls	Oct. 22, 1879	5.2	1.2	
			1.9	
			2.2	Maximum.
			1.8	Mean.
Near △ 4 L	June 17, 1880	41.6	11.4	Maximum.
			10.0	
			6.6	
			7.5	
			8.9	Mean.
Opposite △ 6 L—△ 7 L	Oct. 22, 1879	5.2	5.4	
			6.2	Maximum.
			5.8	Mean.
Opposite △ 8 L	Oct. 25, 1879	5.4	7.0	Maximum.
			6.9	
			6.95	Mean.
Near △ 8 L	June 17, 1880	41.6	5.2	
			5.1	
			5.7	
			5.9	Maximum.
			5.5	Mean.

Current measurements—Continued.

Place.	Date.	Stage of river above low-water.	Surface velocity, in miles per hour.	Remarks.
Opposite △ 10 R	Oct. 25, 1879	*On gauge* 5. 5.4	5.3	
			5.6	
			5.8	Maximum.
			5.6	Mean.
Ten-Mile Rapid, opposite △ 17 L	Nov. 10, 1879	4.4	7.8	
			7.2	
			7.8	Maximum.
			7.6	Mean.
High-water channel, opposite Ten-Mile Rapid.	June 18, 1880	42.4	7.6	
			7.8	
			7.0	
			6.7	
			8.3	Maximum.
			7.5	Mean.
Opposite △ 20 L	Nov. 11, 1879	4.5	4.3	
			6.6	
			12.7	Maximum.
			7.9	Mean.
Near 29 R	June 18, 1880	42.4	5.6	
			5.7	Maximum.
			5.6	
			5.1	
			5.5	Mean.
Above Five-Mile Rapid, opposite △ 31 L.	Jan. 9, 1880	4.7	3.7	Maximum.
			2.8	
			3.2	Mean.
Near △ 32 L	June 21, 1880	43.8	16.7	
			12.5	
			13.6	
			7.5	
			15.0	
			13.6	
			18.8	Maximum.
			14.0	Mean.
Near △ 33 L	June 16, 1880	40.3	15.1	
			14.2	
			10.4	
			12.0	
			11.4	
			15.5	Maximum.
			13.1	Mean.
Five-Mile Rapid, opposite △ 1 C	Jan. 9, 1880	4.7	6.4	Maximum.
			6.2	
			6.3	Mean.
Opposite △ 41 L	June 16, 1880	40.3	7.6	Maximum.
			7.6	
			7.1	
			5.9	
			7.0	Mean.
Opposite 44 L	Jan. 11, 1880	4.2	1.7	
			2.1	Maximum.
			1.9	
			1.9	Mean.

Current measurements—Continued.

Place.	Date.	Stage of river above low-water.	Surface velocity, in miles per hour.	Remarks.
		On gauge 5.		
Opposite △ 45 L	June 16, 1880	40. 3	13. 4	Maximum.
			11. 8	
			12. 7	
			13. 0	
			10. 5	
			12. 7	
			12. 3	Mean.
Narrows, opposite △ 49 R	Jan. 11, 1880	4. 2	2. 1	
			3. 0	Maximum.
			2. 8	
			2. 9	
			2. 7	Mean.

NOTES ON ARRANGEMENT OF LIFT FOR CELILO LOCKS.

River improvement below the Falls will lower low-water surface. A decrease of one foot is assumed. This will make the new low-water reference at gauge 2, 41.2. A single lock for use during the Cascade stage of 20 feet would require a lower gate at least 60 feet high. With a single lift, for continued navigation beyond the Cascade stage of 20 feet, double lockage would be required until the backwater is 6 and preferably 8 feet on the proper level of canal; this would require for convenience a height of lower gate of about 68 feet. The gates must be about 42 feet wide. Pressures resulting from the heads of water which obtain are excessive. Moreover, the Cascades work so far renders practicability of navigation probable for stages higher than the 20-foot one.

The addition of a lock after the canal is opened will cause some interruption or delay to navigation. Two locks at Celilo seem desirable for the first stage of construction.

TO FIND THE BEST ARRANGEMENT OF THE LIFT.

At extreme low stage the equalization of water surfaces in two locks during lockage will be, $\frac{1}{2}(89.4 + 41.2) = 65.3$. To give 6 feet draught at this level the sill at middle gate must then not exceed reference 59.3.

Take now the same measure for maximum total pressure permissible on a gate as adopted at the Cascades Canal. This limit is expressed by the formula $P_m = 1369\,c$, wherein c is a constant depending upon gate span and rise of miter sill, which are chosen the same for the two canals. An inspection of the curve of corresponding readings on gauges 1 and 2 shows that for stages between readings of 55 and 75, gauge 2, the rise on that gauge for 1 foot on gauge 1 is uniform and equal to 5 feet.

From the ordinary hydrostatic formula we may write, $(P = c\,H^2 - H_1^2) = c\,(H+H_1)(H-H_1,)$ in which P is total intensity and $H+H_1$ are heads of water respectively on upper and lower sides of gate. Referring these heads to the n^{th} stage between the limits named, the formula becomes for the $n+1$ foot stage on gauge 1,

$$\frac{P}{c} = (H+H_1+6)\,(H-H_1-4) = H^2 - H_1^2 + 2\,[H-(5\,H_1+12.)]$$

From the last member we deduce that the total intensity at any stage will be greater or less than at the preceding stage of 1 foot on gauge 1 according as $H > 5\,H_1+12$ or $H < 5\,H_1+12$; and that the maximum value will obtain when $H = 5\,H_1+12$. For the bottom of middle gate between references 59 and 50 and readings on gauge 2 greater than 75 and less than 55 it may be shown that gate pressures are less than between those stages. From the expressions of condition above and the adopted limit of pressure, the middle miter sill is fixed as shown on the profile. Heights of gates are selected from similar considerations, to give lockage by two locks from low to near mean high-water and to have two sizes only of gates throughout the canal. Low guard-sills are placed in front of gates which are at the ends of long reaches of water.

A change of regimen of the river at the falls by radical improvement below may make a little different arrangement of locks desirable; the one offered is sufficient for a fairly close estimate of cost. The project provides for full completion of river improvement before commencement of canal construction.

CHAS. F. POWELL.

DETAILED ESTIMATES OF LOW-WATER PROJECT.

(1) *Wagon road from Big Eddy to head of Celilo Falls, Washington Territory.*

Road station.	Distance.	Grade.	Cut.	Fill.	Remarks.
	Feet.		*Cubic yards.*	*Cubic yards.*	
0 to 1	3,900	1 in 200			Smooth flat rock surface.
1 to 2	1,000	1 in 65	(Rock) 240		Station 2 is near Celilo Falls.
2 to 3	3,000	Level	(Rock) 200		Station 3 is near △ 9 R.
3 to 4	2,400	1 in 480			Station 4 is near △ 11 R.
4 to 5	200	1 in 40			Surface forming loose bowlders to remove.
5 to 6	250	Level	(Rock) 300	(Rock) 300	Do.
6 to 7	2,500	1 in 830			Do.
7 to △ 13 R	1,200	Level			
△ 13 R to 8	1,200	Level			Station 8 near △ 14 R; loose bowlders to remove.
8 to 9	1,300	1 in 93			Loose bowlders to remove.
9 to 10	1,700	1 in 212			Do.
10 to 11	2,000	1 in 166			Do.
11 to 12	900	1 in 300			
12 to 13	3,700	1 in 370	(Rock) 600	900	
13 to 14	1,800	1 in 82			Loose bowlders to remove.
14 to 15	1,000	Level	(Rock) 300	100	
15 to △ 26 R	5,200	Level	4,680	4,680	In side cut all the way, and will probably average 90 yards per 100 feet. Road 12 feet wide.
△ 26 R to △ 28 R	2,000	1 in 110	2,000	1,000	
△ 28 R to 16	2,600	Level	300	400	
16 to 17	1,700	1 in 85	1,500	1,500	Side cut.
17 to 18	300	1 in 60			Station 18, bridge begins.
18 to 19	450	Level		400	Bridge 300 feet.
19 to 20	2,000	Level		500	Loose bowlders to remove.
20 to 21	850	1 in 280	(Rock) 200	400	Do.
21 to 22	850	1 in 106	(Rock) 160	500	
22 to 23	600	1 in 150		200	
23 to 24	1,200	Level			Surface forming loose bowlders to remove.
24 to 25	900	1 in 100		700	
25 to 26	100	1 in 50		300	
26 to 27	350	Level	(Rock) 200	200	
27 to 28	400	1 in 56		260	
28 to 29	300	1 in 30		1,000	
29 to 30	100	Level		900	
30 to 31	500	1 in 122		500	
31 to 32	750	Level	200	350	
32 to 33	350	1 in 60			
33 to 34	850	1 in 28	400	200	
	50,400 9.55 miles.		11,280	15,290 +1,840	⅓ gravel and earth, ⅔ rock. To borrow.
Total				17,130	

6,500 cubic yards rock, at $1.50	**$9,750 00**
10,630 cubic yards earth and gravel, at 40 cents	**4,252 00**
2,200 cubic yards rock additional, wasted, at $1.50	**3,300 00**
10,500 linear feet, 3,500 cubic yards, dry retaining wall, at 63 cents	**2,205 00**
Bridge as per detail estimate	**1,546 61**
Total, wagon road and bridge	**21,053 61**

WAGON ROAD BRIDGE, SPAN 300 FEET.

Bill of lumber.

	B. M.	B. M.
Center bents (8):		
Piles (lower), 12″ x 12″ x 50′, 600 x 4 piles	2,400	
Piles, (dwarf), 12″ x 12″ x 15′, 180 x 2 piles	360	
Piles (upper), 12″ x 12″ x 25′, 300 x 3 piles	900	
Braces (lower), 8″ x 8″ x 35′, 175 x 2 braces	350	
Braces (upper), 6″ x 8″ x 30′, 120 x 2 braces	240	
Caps (lower), 12″ x 12″ x 20′, 240	240	
Caps (upper), 12″ x 12″ x 12′, 144	144	
Stringers, 6″ x 12″ x 29′, 120 x 2	240	
Stringers (upper), 6″ x 14″ x 20′, 140 x 6	840	
Flooring, 3″ x 13″ x 20′, 780	780	
Wheel-guards, 6″ x 4″ x 20′, 40 x 2	80	
Hand-rail and hub-guard, 4″ x 4″ x 40″ = 55 + 2″ x 4″ x 80′ = 52	107	
	6,677	
Bents	8	
	53,416	53,416
End bents:		
Piles, 12″ x 12″ x 30′, 360 x 3 piles	1,080	
Cap, 12″ x 12″ x 12′, 144	144	
Braces, 6″ x 8″ x 20′, 80 x 2	160	
Stringers, 6″ x 14″ x 20′, 140 x 6	840	
Flooring and rails as above, 970	970	
	3,194	
Bents	7	
	22,358	22,358
		75,774
At $15 per M		15
		$1,136 61
Bolts and nuts, 1,100 pounds, at 10 cents $110; Labor 300		410 00
		1,546 61

(2.) *Channel improvement from foot of Three-Mile Rapids to Celilo Falls.*

[Colored red on chart, except Cut No. 8*a*, which is yellow.]

Cut No.—		Depth to low-water.	Depth below low-water.	Length of cut.	Cubic yards above low-water.	Cubic yards below low-water.	Remarks.
Celilo-Dalles Map No. 2.	1	3.0	10.0	60	**300**	**950**	Isolated rock near △ 51 R.
	2	8.0	10.0	72	**830**	**1,100**	Isolated rock near △ 50 R.
	3	......	10.0	130	....	**900**	Submerged rock.
	4	4.0	10.0	......	**370**	**3,900**	Rock and reef.
	5	10.0	10.0	300	**4,800**	**5,000**	Portion of island opposite M.
	6	14.0	10.0	250	**6,500**	**4,600**	Point of rock at M.
	7	14.0	10.0	200	**4,600**	**2,800**	Island opposite △ 45 L.
	8	16.0	10.0	100	**2,400**	**1,700**	Point near △ 45 L.
The Dalles Map.	8*a*	3.0	0.0	150	**1,600**	....	Narrow channel near △ 43 R.
	9	40.0	10.0	260	**10,800**	**6,000**	Island near Grave Island.
	9*a*	20.0	10.0	250	**3,400**	**5,555**	Near △ 40 R.
	10	16.0	10.0	23	**300**	**180**	Island near Grave Island.
	11	19.0	10.0	130	**1,700**	**1,300**	Do.
	11*a*	6.0	10.0	100	**650**	**500**	Point on Grave Island.
	12	5.0	10.0	120	**570**	**1,100**	Island near △ 5 C.
	12*a*	15.0	10.0	200	**6,860**	**4,574**	Point near △ 39 R.
	13	8.0	10.0	50	**450**	**560**	Island near △ 5 C.
	14	40.0	10.0	470	**14,300**	**7,100**	Near △ 38 R.
	15	46.0	10.0	280	**4,100**	**3,200**	Island near △ 38 R (south side).
	16	17.0	10.0	100	**1,620**	**500**	Near △ 38 R.
	17	25.0	10.0	600	**8,300**	**5,400**	Near △ 37 R.
	18	20.0	10.0	550	**7,050**	**4,100**	Near △ 3 C.
	19	30.0	10.0	1,150	**54,000**	**27,000**	Near △ 1 C.
	20	34.0	10.0	700	**17,400**	**9,200**	Near △ 35 R.
	21	31.0	10.0	230	**1,200**	**880**	North side of channel, opposite Cut No. 22.

(2.) *Channel improvement from foot of Three-Mile Rapids to Celilo Falls*—Continued.

Cut No.—		Depth to low-water.	Depth below low-water.	Length of cut.	Cubic yards above low-water.	Cubic yards below low-water.	Remarks.
Celilo-Dalles Map No. 2.	22	31.0	10.0	600	48,000	23,900	Near △ 1 C.
	23	33.0	10.0	280	2,800	2,300	Below head of Relief Channel.
	24	30.0	10.0	600	10,600	6,500	Above head of Relief Channel.
	25	35.0	10.0	470	9,100	4,200	Above △ 34 L on south side.
	26	55.0	10.0	500	28,300	9,400	Opposite section house, north side.
	27	47.0	10.0	460	31,200	12.650	Do.

Ten-Mile Rapids.

[Colored red on chart.]

Cut No.—		Depth to low-water.	Depth below low-water.	Length of cut.	Cubic yards above low-water.	Cubic yards below low-water.	Remarks.
Celilo-Dalles Map No. 1.	28	10.0	10.0	300	4,600	6,400	Near △ 26 R.
	29	10.0	10.0	250	13,500	13,200	Do.
	30	20.0	10.0	600	14,000	8,300	Island near △ 26 R.
	31	8.0	10.0	100	1,400	2,200	Isolated rocks.
	32	7.0	10.0	100	900	1,200	Island near △ 25 R. (north end).
	33	51.0	10.0	150	6,800	1,500	Near △ 18 R.
	34	32.0	10.0	700	14,800	7,200	Near △ 17 L. (south side).
	35	33.0	10.0	150	1,400	890	Near △ 17 R. (north side).
	36	33.0	10.0	400	3,200	3,000	Near △ 17 L. (south side).
	37	30.0	10.0	600	63,800	31,400	Near △ 16 R.
					408,500	232,339	

(3.) *Enlargement of side channel near head of Dalles Rapids, Washington Territory shore.*

[Colored red on chart.]

Station number.	Width, feet.	Depth to low-water, maximum.	Depth below low-water.	Cut to low-water.	Cut below low-water.	Remarks.
		Feet.	*Feet.*			
1	100	50	10	19,800	4,100	Entrance to channel (low-water 20 feet).
				8,600	7,500	Entrance to channel (north side).
2	100	30	10	7,200	2,400	
3	100	45	10	2,700	840	
4	100	40	10	13,900	5,000	
5	100	50	10	8,700	3,200	
6	100	50	10	47,000	10,300	
7	100	50	10	20,100	4,800	(Low-water 18 feet.)
8	120	50	10	24,000	7,000	
9	120	44	10	16,500	7,500	
10	120	44	10	9,800	4,800	
11	120	50	10	12,500	3,700	
12	130	57	10	24,200	5,200	
13	120	48	10	15,000	3,300	
14	100	45	10	10,000	3,100	(Low-water 15 feet.)
15	......	40	10	9,100	6,800	(Re-enter river near △ 34 R.
				249,100	79,540	
Brought forward				408,500	232,339	
Total excavation				657,600	311,879	

657,600 cubic yards excavated down to low-water, at $2	$1,315,200
311,879 cubic yards excavated below low-water, at $10	3,118,790
Total	4,433,990

(4.) *Enlargement of side channel near middle of Dalles Rapids, Oregon shore, to give* 8 *feet depth at stage of* 20 *feet on Cascade Gauge No.* 2.

[Colored yellow on chart.]

Station.	Depth of water.	Width of channel.	Cut.	Remarks.
	Feet.	*Feet.*	*Cub. yds.*	
0 to 400	8	100	8,300	
400 to 550	8	100	5,200	
550 to 850	8	100	4,700	
850 to 1200	9	100	1,100	In pond to left of △ 1 c.
1200 to 1400	8	100	3,700	Do.
1400 to 1700	8	100	6,500	Do.
1700 to 1900	8	100	7,100	Do.
1900 to 2150	8	100	10,500	In pond between △ 2 c and △ 4 c.
2150 to 2300	8	100	9,300	Do.
2300 to 2450	8	100	6,700	Do.
2450 to 2600	8	100	10,800	Do.
2600 to 2850	8	100	15,600	Do.
2850 to 3200	8	100	20,400	Do.
3200 to 3500	8	100	19,700	
3500 to 3700	8	100	5,200	
3700 to 4250	8	100	....	Re-enter river.
			134,800	

134,800 cubic yards, above mean low-water, at $1.50	**$202,200**
Brought forward	**4,433,990**
	4,636,190

(5.) *Enlargement of channel around Ten-Mile Rapids, Washington Territory shore, to be* 300 *feet wide and* 8 *feet deep at stage of* 20 *feet on Cascade Gauge No.* 2.

[Colored yellow on chart.]

Stations.	Depth of water, in feet.			Width.	Cut.	Remarks.
	Left.	Center.	Right.			
					Cubic yds.	
0	30	36	30	300	....	Extreme low-water near △ 16 R.
400	8	15	8	220	....	Channel 300 feet wide, 6.5 feet at sides.
800	8	15	8	225	....	Do.
1100	8	16.5	8	300	....	Do.
1500	8	17	8	300	....	Do.
1700	8	17	8	200	....	Channel may be widened with light cut.
1900	8	17	8	350	....	Head of small pond.
2400	8	20	8	500	....	In small pond.
2800	8	14	8	300	....	Foot of small pond.
2900	6.5	14	6.5	200	....	In smallest pond.
3100	8	14	8	250	....	Do.
3200	8	16	10	200	480	Cut on left bank.
3450	8	16	8	200	8,000	Between smallest and long pond.
3600	8	16	8	250	5,440	Do.
4200	8	8	8	250	13,200	Do.
4400	8	8	8	250	4,000	At head of long pond.
5000	8	12	8	220	18,500	In long pond.
5400	8	12	8	220	4,400	Do.
5700	8	12	8	250	800	Do.
5800	8	12	8	250	1,100	Do.
6200	8	8	8	250	7,400	Do.
6700	8	12	8	250	7,400	Foot of long pond.
7000	8	12	8	250	4,000	Near △ 20 R.
7300	8	10	8	250	1,000	Do.
8800	10	10	10	300	75,720	Re-enter river.

75,720 cubic yards excavation of rock above mean low-water, at $1.50	$112,680 00
Amount brought forward	4,636,190 00
Wagon-road and bridge	21,053 61
Title to land and right of way for improvement and Celilo Canal	10,000 00
Total low-water project, exclusive of Celilo Canal construction	**4,779,923 61**

(6.) CELILO CANAL.

Abstract of estimate of cost.

Protective and wing walls	$348,715 08
Excavation	1,035,419 60
Masonry	1,111,460 20
Crib-work	62,977 02
Five pairs gates	86,000 00
Buildings, machinery, culverts, and other accessories	250,000 00
Total	**2,894,571 90**

(*a*) *Estimate for protective wall on river side.*

[Structure of concrete, with facing of hard finish.]

Section.	Depth.	Area.	Length.	Cubic feet.	Cubic yards.
	Feet.		*Feet.*		
No. 1	29	337	....	....	
2	23	253	840	247,800	
3	22.7	249	360	90,360	
4	32.6	394.5	50	16,090	
5	17.6	179	170	48,739	
6	15.2	150	180	29,610	
7	17.0	172	130	6,430	
8	41.6	549	510	183,555	
9	39.6	515	180	95,760	
10	45	612	100	56,356	
11	20	210	380	156,180	
12	30.2	359	410	116,645	
13	45.4	621	50	24,500	
14	24	264	60	26,550	
15	35	394	200	66,800	
16	50	710	10	5,520	
17	50	710	40	28,400	
			3,670	1,199,295	44,418

44,418 cubic yards concrete, at $7	$310,926 00
105,590 square feet of hard finish, at 4 cents	4,223 60
	315,149 60

(*b*) *Estimate for wing wall at head of canal.*

[Structure of concrete, with facing of hard finish.]

Section.	Depth.	Area.	Length.	Cubic feet.	Cubic yards.
	Feet.		*Feet.*		
No. 1	4.5	38.7	30	582	
2	14.5	142.1	120	10,848	
3	17.5	178.5	90	14,427	
4	14.5	142.1	60	9,618	
5	24.4	269.6	150	30,877	
6	29.4	343.1	200	61,270	
				127,622	4,727

4,727 cubic yards concrete, at $7	$33,089 00
11,912 square feet hard finish, at 4 cents	476 48
Brought forward	315,149 60
Total	**348,715 08**

(*c*) *Estimate of excavation.*

Designation of section.	Area.	Average depth of cut.	Cubic feet.	Cubic yards.
		Feet.		
Approach to upper guard-gate	33,040	4.2	1,387,680	....
Masonry of upper guard-gate	1,056	10.6	12,194	....
Do	8,260	11.1	91,686	....
Upper level	48,560	11.0	534,160	....
Do	18,000	12.5	225,000	....
Do	9,000	16.0	144,000	....
Do	18,000	13.0	234,000	....
Do	18,000	16.0	288,000	....
Do	31,500	24.0	756,000	....
Do	27,000	21.5	580,500	....
Do	29,700	14.0	415,800	....
Do	5,600	5.0	28,000	....
Upper lock	8,680	28.2	244,776	....
Do	5,600	40.2	225,120	....
Do	27,450	40.2	1,103,490	....
Do	5,600	43.0	240,800	....
Do	21,648	40.4	874,679	....
Lower lock	8,162	64.0	522,368	....
Do	8,862	64.0	567,168	....
Do	40,980	63.5	2,602,230	....
Do	8,862	53.0	469,686	....
Do	8,162	53.8	439,116	....
Lower guard-gate	7,714	53.8	415,013	....
Do	700	52.8	36,960	....
Below lower guard-gate	6,240	57.0	355,680	....
Do	112,654	8.0	901,232	....
Total, rock			13,695,338	507,235
GRAVEL.				
Below lower guard-gate	112,664	8.0	901,232	....
Do	$\frac{320\times715}{2}$	=	114,400	....
Do	$\frac{16\times8\times715}{3}$	=	30,507	....
Do	$\frac{(20\times16)\times(16\times8)}{3}$	×715=	106,749	....
Total, gravel			1,152,888	42,700

460,683 cubic yards excavation of rock above low-water, at $1.20	$522,819 60
46,552 cubic yards excavation of rock below low-water, at $10	465,520 00
42,700 cubic yards excavation of gravel, at 40 cents	17,080 00
Total	**1,035,419 60**

(*d*) *Masonry.*

Section.	Cubic yards.
Upper guard-gate	4,999.7
Upper lift-gate	6,555.6
Upper lock-chamber	30,846.4
Middle lift-gate	8,260.7
Lower lock-chamber	29,620.4
Lower lift-gate	7,753.0
Lower guard-gate	5,466.0
Lift-walls	2,471.5
Total	**95,965.3**

87,987.9 cubic yards concrete, at $11	$967,867 00
7,977.4 cubic yards cut stone masonry, at $18	143,593 20
Total cost of masonry	**1,111,460 20**

(*e*) *Crib work.*

	Feet B. M.
At upper entrance on river side	331,190
At upper entrance on land side	248,040
At head of upper lock on river side	88,944
At head of upper lock on land side	79,140
At foot of canal on river side	1,227,888
At foot of canal on land side	124,032
Total	**2,099,234**
2,099,234 feet B.M., in place, crib completed, including iron, at $30 per M.	$62,977 02

(*f*) *Iron lock-gates.*

Upper guard-gates	$15,000
Upper lift-gates	15,000
Middle lift-gates	20,500
Lower lift-gates	20,500
Lower guard-gates	15,000
Total	**86,000**

II.—ESTIMATE OF HIGH-WATER PROJECT.

(1) *River work.*

For additional removal of rock down to or near, but not below, low-water, to give a continuous slope from Celilo Falls to The Dalles of not more than 0.85 foot per 1,000, at the following-named points:

	Cubic yards.
At head of Dalles (Five-Mile Rapids)	666,667
Thence through Dalles to Big Eddy	1,884,440
Opposite △ 42 L	71,100
Opposite △ 45 L	17,700
Opposite △ 47 L	15,400
	2,655,307
Less excavation included in low-water project	868,120
	1,787,187
Submerged dam and closing minor channel at Narrows	21,500
Three submerged dams at Dalles City	35,256
	56,756
Cut through shoal above Five-Mile Rapids, 150 feet wide to 8 feet below low-water	40,000
1,787,187 cubic yards excavation, at $1	$1,787,187
56,756 cubic yards excavation, at $1.50	85,134
40,000 cubic yards excavation, at $10	400,000
	2,272,321

(2) *Celilo Canal.*

	Cubic yards.		
Enlargement of canal:			
(*a*) 14,500 cubic yards excavation, at $1.20			$17,400 00
(*b*) Guard-lock:			
1,920 cubic yards excavation under masonry, at $10		$19,200 00	
27,700 cubic yards concrete, at $11		304,700 00	
1,050 cubic yards cut stone masonry, at $18		18,900 00	
1 pair gates		15,000 00	
Machinery, &c		50,000 00	
			407,800 00
(*c*) Dry dock 70 by 300 feet:			
Approach in canal 900 feet long	32,667		
Chamber 300 feet long	10,889		
	43,556		
Concrete walls	8,580		
Cut stone facing	1,000		
43,556 cubic yards excavation, at $1.20		$52,267 20	
8,580 cubic yards concrete, at $7		60,060 00	
1,000 cubic yards cut stone, at $18		18,000 00	
One pair gates		15,000 00	
			145,327 20
Total			570,527 20