

boldt Bay," which I suppose to mean the same as "Humboldt River," was found to be the most impracticable. So very impracticable did the Board regard the improvement of the entrance to this harbor that it did not even make any "plan or estimate of cost for a breakwater at this place, deeming it, if not impossible of execution, highly improbable that a breakwater or jetties will be attempted here at the present time." And of the other places examined, the Board regarded Crescent City Harbor as the worst. It is contracted and full of sunken dangers, both inside the harbor and in approaching it.

The Board stated in its report that—

Crescent City Harbor is usually regarded as the most dangerous roadstead on this coast. * * * Nevertheless, in order to have definite ideas as to the location and cost of a breakwater here, we have included it among the roadsteads for which we have given plans and estimates of cost for breakwaters.

In short, Humboldt Bay and Crescent City Harbor were the two places which the Board of Engineers, when considering the whole subject of a harbor of refuge on this coast, in 1876, reported particularly against.

I can only point to the report of the Board of Engineers for the Pacific Coast of February 14, 1877, as containing my views as to the impracticability of improving either of them.

That report contains my views, in every particular, as to the merits of these two places in connection with a harbor of refuge on the northern coast of California.

I have the honor to be, very respectfully, your obedient servant,

B. S. ALEXANDER,
Lieutenant-Colonel of Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers U. S. A.

APPENDIX K K.

ANNUAL REPORT OF MAJOR JOHN M. WILSON, CORPS OF ENGINEERS, FOR PART OF FISCAL YEAR ENDING JUNE 30, 1879.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., October 22, 1878.

GENERAL: I have the honor to transmit herewith reports of operations upon the works in my charge on the Pacific coast, for the portion of the fiscal year ending June 30, 1879, terminating this day.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,
Major of Engineers, Bvt. Col., U. S. A.

The CHIEF OF ENGINEERS, U. S. A.

K K I.

IMPROVEMENT OF THE LOWER WILLAMETTE AND COLUMBIA RIVERS, OREGON.

The amount available at the commencement of the fiscal year was not sufficient to construct either of the dams projected for the improvement of the river and at the same time keep the dredge at work on the various bars; it was, therefore, determined to continue operations as usual dredging through the various bars in the Willamette and Columbia Rivers.

The United States dredge having been thoroughly repaired, was put into commission on July 15, and on the 16th was sent to

THE MOUTH OF THE WILLAMETTE RIVER,

where the channel through the bar had been filled up during the annual freshet of the Columbia in May, June, and July.

Operations were commenced on the 17th, and by August 3 a cut 100 feet wide and 17 feet deep at low-water had been made by excavating 4,915 cubic yards of mud and sand.

The dredge was towed on the 6th of August to

SAINT HELEN'S BAR, COLUMBIA RIVER,

where a similar filling to that at the mouth of the Willamette had occurred, the channel dredged in 1877 having been entirely filled up.

The cause of this bar has already been fully discussed in previous reports, and it is only necessary to say that dredging will be required annually until the projected dams are constructed.

Operations were commenced on August 8 and were continued until September 18, with more or less delay from breakage, hauling out for vessels, &c.; a channel 600 feet long, 100 feet wide, and 18 feet deep at low-water was opened by removing 9,405 cubic yards of sand and gravel; the buoys were properly located and the range beacons on shore changed so as to mark the line of the new channel.

On September 19 the dredge was towed to

SWAN ISLAND BAR, WILLAMETTE RIVER,

where the usual filling had taken place in the channel during the winter freshet in the Willamette.

Operations were commenced at Swan Island Bar on the 20th of September, widening, deepening, and straightening the channel, and have been continued up to this date, with more or less interruption from breakage, &c.; 5,930 cubic yards have been removed during this period.

The following is a summary of the amount excavated up to this time:

	Cubic yards.
From bar at mouth of Willamette	4,915
From Saint Helen's Bar, Columbia River	9,405
From Swan Island Bar, Willamette River	5,930
Total	20,250

The water in the Willamette River has been lower during the present fall than at any time since I have been on duty here, but by keeping the dredge actively at work and making repairs at night when necessary, vessels have had less trouble than usual on the bars.

KK 2.

IMPROVEMENT OF UPPER WILLAMETTE RIVER, OREGON.

The description of this river and the various obstructions to its navigation during the low-water season from June to October has already been fully given in previous reports.

Early in the fiscal year it was determined to devote the \$20,000 appropriated by the act of June 18, 1878, to the removal of rock at Bissell's and Dove's Rocks; to keep the snag-boat at work during the low-water season; to apply steam propelling power and a scraper to the boat during the coming winter, and to devote any balance remaining in the spring of 1879 to the construction of such wing-dams as might then be found necessary.

THE UNITED STATES SNAG-BOAT.

The United States snag-boat was put in complete order, manned and equipped and sent up the Willamette early in July. Work was carried on vigorously between Corvallis and Portland until October 10, when she was brought to Portland and laid up for the season. During this period the boat moved in all 223 miles; removed 491 snags from the channel, some of them of enormous size; cut down 84 trees that were liable to fall into the river and give trouble, made repairs at various wing-dams on the river where they were necessary, and removed por-

tions of old dams built many years ago at Bower's Bar and Clackemas Bar which had become serious impediments to navigation.

BISSELL'S AND DOVE'S ROCKS.

At certain stages of the Willamette River the current sets directly on these rocks, two steamers having been almost totally destroyed within a few years by striking them.

It was determined to widen the channel at Bissell's and to straighten it at Dove's.

Proposals were invited in the latter part of July for removing 272 cubic yards, more or less, of rock, and at the opening of bids, August 20, the work was awarded to Mr. Joseph Paquet, the lowest bidder, at \$8.90 per cubic yard.

Operations were commenced on the 29th of August and continued until October 15, 1878, when the contract was completed.

The following rocks were removed:

	Cubic yards.
A portion of Bissell's Ledge	64.64
Dove's Rock, No. 1	82.37
Dove's Rock, No. 2	93.43
Dove's Rock, No. 3	7.56
Dove's Rock, No. 4	34.16
Total	282.16

Buoys were permanently attached to the rocks to indicate the channel.

The following is a summary of the work done during the months of July, August, September, and October, 1878:

- Removed 491 snags from the river.
- Cut down 84 overhanging trees.
- Repaired various wing-dams.
- Removed portions of old dams at Bower's and Clackemas Bars that were obstructions to navigation.
- Removed 282.16 cubic yards of rock from channel of river.

It is proposed to apply steam propelling power and a scraper to the snag-boat this winter, and when this is done the boat can be moved from place to place and the crew can build temporary dams of brush and gravel to sluice out channels through the bars when necessary.

KK 3.

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

It was determined early in the fiscal year to devote the \$20,000 appropriated by the act of June 18, 1878, to the improvement of the channel through the rapids in the Snake River.

Proposals were invited for this work July 25, and upon the opening of bids on August 20 the contract was awarded to Mr. George J. Ainsworth, of Portland, Oreg., the lowest bidder, at \$13 per cubic yard. This price was the lowest ever paid for work of this character in this section of the country. In 1875 the contract was let at \$36 per yard, in 1876 at \$31 per yard, in 1877 at \$24.75 per yard, and in 1878 at \$13 per yard.

A contract was at once executed for removing 1,300 cubic yards, more

or less, of rock from the channel of the river, and operations were commenced on the last day of August.

The work will be confined to Pine Tree Rapids, Five Mile Rapids, and Fish Hook Rapids. From Pine Tree 27 rocks will be removed, and from Five Mile 5 rocks; any balance remaining within the amount contracted for—1,300 yards—will be applied to Fish Hook Rapids.

It is impossible to state the exact amount to be removed from each rapid, as the velocity of the current is so great that a rock cannot be accurately measured until the scow is anchored over it for the purpose of drilling.

Operations were carried on with great energy during the months of September and October, about 300 cubic yards of rock having been removed up to the 20th instant. It is confidently expected that the whole 1,300 yards will be removed before the close of the calendar year, and that no difficulty will be experienced thereafter in passing Pine Tree and Five Mile Rapids at any stage of the river, except when closed by ice.

KK 4.

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

In accordance with instructions from the honorable Secretary of War, suit was commenced during the last fiscal year in the United States district court for the condemnation of the land required for the Cascade Canal.

This case came up for trial on July 22; the court and jury visited and went over the ground on the 23d, and the actual trial commenced on the 24th; on the evening of the 26th the jury brought in a verdict assessing the value of the land and the consequential damages at \$7,500.

The papers in the case were forwarded for the consideration of the honorable Attorney-General of the United States on August 5, 1878, and were approved by him on September 13, 1878. By authority of the honorable Secretary of War, dated September 18, 1878, and received by me October 1, I paid into the United States court on that day the sum of \$7,548.60, being the assessed value of the land, with the costs of the defendants, and on October 5 the court rendered judgment placing the title to the land in the general government.

Early in August proposals were invited for furnishing labor and materials for the construction of a portion of the locks up to a height of about 7 feet above the floor of the upper lock. A number of prominent contractors took great interest in the work, and proposals were received from New York, Chicago, San Francisco, and elsewhere. At the opening of bids, October 1, the contract was awarded to Messrs. Ball & Platt, of New York City, the lowest bidders, and upon the approval of the award by the Chief of Engineers, a contract was made with these gentlemen on October 19, 1878. The senior member of this firm proceeded to the Cascades October 21 to commence work immediately.

In September, 1878, I prepared a bill granting the United States jurisdiction over the land condemned for canal purposes. This bill passed the State senate with but one vote in the negative, and passed the house unanimously. It was signed by the Governor, and became a law October 16, 1878.

KK 5.

IMPROVEMENT OF THE MOUTH OF COLUMBIA RIVER, OREGON.

The act of Congress approved June 18, 1878, made an appropriation of \$5,000 for the improvement of the mouth of the Columbia River, Oregon, "the same or so much thereof as may be necessary to be expended under the direction of the Secretary of War in making a thorough survey of the bar at the mouth of said river and in the preparation of a plan and estimates for its permanent improvement; any balance to be used in the temporary improvement of said bar."

The Columbia River is, I believe, the second river in magnitude in the United States; it drains an area of 300,000 square miles, and is about 5 miles wide at its mouth, with two good ship channels, one with a depth of 23 feet at mean low-water and the other with a depth of 20 feet, the tide rising from 7 to 9 feet.

In accordance with instructions from the Chief of Engineers, First Lieut. A. H. Payson, Corps of Engineers, reported to me for duty on August 10, to take charge of the survey provided for by the law.

Lieutenant Payson was immediately sent to the mouth of the river, and after properly organizing the survey party proceeded to work with energy.

As a rule, the months of August and September are the best for a survey of this character, and during the period mentioned this year, the bar, as a general rule, was comparatively smooth. Unfortunately, however, very severe forest fires commenced about the last of August, and the smoke became so dense that it was impossible to take observations with the sextant; a violent storm during the latter part of September and early part of October further delayed operations for about ten days.

The survey was, however, completed on the 8th of October, and the chart is now being prepared.

Lieutenant Payson deserves great credit for the skill and energy with which he has carried on this important survey.

The following is a summary of the work done:

Area surveyed, square miles	44.6
Double angles taken	2,729
Miles of soundings run	821½

Current observations were also taken at various localities at the mouth of the river.

KK 6.

SURVEY OF ENTRANCE TO COOS BAY, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., September 30, 1878.

GENERAL: I have the honor to transmit herewith a chart of the entrance to Coos Bay, Oregon, together with the report of Mr. C. M. Bolton, assistant engineer, and to submit the following report of a survey made under my direction in August, 1878, in accordance with the act of Congress approved June 18, 1878.

OBJECT OF THE SURVEY.

The law of June 18, 1878, required a survey of "the entrance to Coos Bay" and an estimate of the cost of improvements "proper to be made."

COOS BAY.

Coos Bay empties into the Pacific Ocean about $2\frac{1}{2}$ miles E. N. E. of Cape Arago. On the north side of the mouth the ground is low and sandy with shifting sand dunes, and on the south side it is high and bold.

The bay is completely land-locked, presenting a fine harbor after getting inside. From its entrance it extends in a northeasterly direction a distance of about 7 miles to North Bend, with an average width of $\frac{1}{2}$ a mile and a channel of not less than 22 feet depth at low-water, with the exception of one bar about $\frac{1}{4}$ of a mile long, upon which there is a depth of 15 feet.

At North Bend another bar extends across the bay with a depth of 11 feet at low-water, although by careful sounding a narrow intricate channel of 22 feet has been found.

From North Bend the bay extends in a southerly direction to Marshfield, a distance of about 5 miles, with a depth of about 16 feet at low-water.

Coal Bank Slough, which enters the bay at Marshfield, carries a depth of 10 feet at low-water to the Newport and Eastport Mining Companies' landings, about 2 miles from the bay. Isthmus Slough has a depth of about 20 feet at low-water for a distance of about 6 miles.

THE ENTRANCE TO COOS BAY.

The great difficulty at the entrance to Coos Bay arises from the shifting character of the sand and the peculiarities of the tides. During the summer the heavy northwest winds, sweeping down the coast, drive the sand thrown up on the shore by the currents along the north spit, emptying it into the bay and into the channel at its entrance, thus prolonging the spit. The movement of this spit is said to be very regular, the channel breaking through to the north of its present position about once in five years; soon after the new channel opens, the north sands again commence to move southerly, the ebb-tide not being strong enough, for reasons hereafter to be given, to carry them off; this continues, the spit lengthening until it occupies about the position now indicated on the chart, forcing the channel close under Coos Head on the south side; while this is in progress, the sand bar outside of Coos Head and north of "Lone Rock" makes northerly, caused by the fact that Cape Arago, jutting out abruptly about 2 miles to the westward, prevents to a great extent the escape of the drift sand, and the convergence of the shore-line between the mouth of Umpqua and the entrance to Coos Bay (the main shore-line running nearly north and south, while that of Cape Arago runs nearly east and west) concentrates the force of the northwest seas into this pocket; moreover, as the channel inside of the north spit makes down and the current strikes Coos Head, it is forced to the northward along the western side of the spit.

When this condition of affairs is reached the water again breaks through the north spit to the north of its present exit, and presents for a short time a good and straight channel out to deep water.

The condition of affairs to-day is ripe for the opening of a new channel. The line of deepest water has been forced down toward Coos Head; the spit has worked down; the outer sand bar has grown toward the north; there is a depth of only about 9 feet at low-water on the outer bar, although 14 feet can be carried up along the west face of the north sand spit and thence to deep water beyond.

TIDES AND CURRENTS.

The mean rise and fall of tides is 5.1 feet, of spring tides 6.8, and of neap tides 3.7 feet.

I remarked in the description of the entrance to Coos Bay that the ebb tide was not sufficiently strong to prevent the growth of the north spit.

An examination of the chart will show that after crossing the bar, entering, the waters divide, forming Coos Bay proper to the north and the south slough to the south. It has been observed that the incoming tide runs up the south slough nearly an hour before it commences to ascend the bay proper, and that the ebb tide runs out from the slough about the same length of time before it begins to run from the bay; we therefore find the apparent anomaly of a flooding and ebbing tide in the same body of water; moreover, as the ebb comes down the bay proper it meets that coming down the slough, the two running in opposite directions causing an eddy and greatly diminishing the velocity and scouring force at the entrance, where it is so necessary in order to carry out the sands coming down the coast from the north.

PROPOSED IMPROVEMENT.

In any improvement of the entrance to this bay three objects must be kept in view: first, the tidal flow in the bay proper must not be decreased, but must be made as great as possible; second, the flow of the ebb from the bay must be so directed as to prevent it from meeting directly that coming from the south slough; and, third, steps must be taken if possible to prevent the drift sands from moving down the north sand spit into the channel.

To overcome the difficulties arising from the meeting of the ebb tides it is proposed to run a training wall, starting from the east side of the bay about $1\frac{1}{2}$ miles from Coos Head, and carrying it across the spit out to deep water near the line through which the channel is generally cut; parallel to it and at a distance about equal to the present width of the entrance will be another wall, and it is hoped and expected that the increase of velocity gained by the ebb tide passing between these walls will be sufficient to keep a good channel open out to deep water.

To prevent the sand coming down the spit, it is thought that several strong fences across it at certain intervals will answer present purposes, these fences to be renewed as soon as the sand reaches their tops.

The tops of the training walls should be built to a height of at least 3 feet above low-water in order to gain the scouring force due to the ebb-tide; the outer ends should be carried up to high-water mark, and upon them should be placed a cement-masonry superstructure about 15 feet high and 20 feet square. The lower wall should have a harbor-light at the outer end. The walls should be built entirely of stone, as the "teredo" and "limnoria" rapidly destroy wood work of any character used in constructing wharves, &c., in the bay.

Within the limits of the bay they could be built of ordinary rubble-stone, the sides and top to be of large pieces from one to four tons in

weight; where the violent action of the sea is felt outside the immediate limits of the bay, they could be constructed of ordinary rubble to a height of 10 feet below low-water, and of rubble in pieces from 5 to 20 tons from that height to the top, the sides to be well protected by blocks of the same size. It is possible that the upper wall may not be required. Of course it would be highly advantageous to use mattresses of twigs in these constructions were it possible, but as there is no fresh water, they would be rapidly destroyed.

The estimated cost of the work, in order to obtain a channel with a depth of 22 feet at low-water, is approximately as follows:

Southern training wall, 8,000 feet long, at \$70.....	\$560,000
Northern training wall, 5,000 feet long, at \$70.....	350,000
2 masonry abutments, at \$8,000 each.....	16,000
Contingencies, 5 per cent.....	46,000
Total.....	972,000

It is possible that the northern training wall will not be required, in which case the estimated cost of the work would be about \$600,000.

It is proposed to so regulate the direction of these walls that vessels seeking shelter from southwest gales, which are the severest and most dangerous on the coast, can enter without coming broadside to the wind, as is now necessary in navigating the present entrance; this would place the walls nearly at right angles to the northwest seas, and prevent the silting up from sand driven along by them. Stone for the construction of this work can be obtained near at hand in Coos Bay.

COMMERCIAL STATISTICS.

I transmit herewith a statement of the statistics of Coos Bay, prepared by a committee of citizens.

The export value of lumber, coal, and other products from January 1, 1871, to August 31, 1878, was \$3,192,161.75; during the same period 1,388 vessels, with a carrying capacity of 565,550 tons, entered and cleared. The ship-building interest is second to none on the coast; 40 vessels, including the Western Shore, a ship of 2,000 tons capacity, have been built in the bay. Fourteen sawmills are in operation, with an aggregate capacity of about 115,000 feet, board measure, per day.

There are 5 coal-mines already opened on the bay, with at otal capacity of about 1,800 tons daily.

Two steam-tugs are employed towing on the bar, and four small steamers carry passengers and freight on the bay and its tributaries.

Coos Bay is in the collection-district of Southern Oregon. Empire City on the bay is a port of entry.

There were no foreign imports, and consequently no revenue collected therefrom, during the last fiscal year.

Only one vessel cleared for a foreign port during the year; her cargo was 160,000 feet of lumber, valued at \$16,000.

The number of coasting vessels entering and clearing during the year 1877 was 189, with a carrying capacity of 89,100 tons.

The estimated value of the coal, lumber, and other exports shipped from the bay in 1877 was \$468,170. The nearest light-house is at Cape Arago; the nearest works of defense are at the mouth of the Columbia River, about 180 miles distant.

The report of Mr. C. M. Bolton, assistant engineer, and a copy of the statistics of Coos Bay are transmitted herewith; in making this survey and that of Coquille River, Mr. Bolton was subjected to numerous minor difficulties, and he deserves credit for the faithful and energetic manner in which he has performed the duties assigned to him.

The sum of \$200,000 can be profitably expended upon this work during the next fiscal year.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,

Major Engineers, Bvt. Col., U. S. A.

Brig. Gen. A. A. HUMPHREYS,

Chief of Engineers, U. S. A.

REPORT OF MR. CHANNING M. BOLTON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,

Portland, Oreg., September 26, 1878.

COLONEL: In compliance with instructions from you, I started from Portland on the 10th day of August for Coos Bay to make a survey of its entrance. On arrival at Empire City, August 13, I at once proceeded to organize a party and make the necessary examinations. From the amount of money allotted for this purpose and the limited time allowed, a thorough survey of the bay could not be made. The field work was therefore confined to the entrance of the bay, extending only about 1 mile inland, but by the courtesy of Messrs. Merchant, Bailey, and others, I am enabled to give the following additional data: The bay extends from its entrance in a north-easterly direction a distance of about 7 miles to North Bend, with an average width of one-half a mile, with a channel depth to that point of not less than 22 feet at low-water, with the exception of a short sand-bar, "Lone Tree" of one-fourth of a mile in length, with a depth of about 15 feet. At North Bend another sand-bar extends nearly across the bay from the northwest side, giving a depth of 11 feet at low-water, with a very narrow and crooked channel-way of 22 feet depth. From North Bend the bay extends in a southwardly direction to Mansfield or mouth of Coal Bank Slough, a distance of about 5 miles, and has a depth of about 16 feet at low-water. Coal Bank Slough carries 10 feet depth of water at low-water to Newport and Eastport Coal Mining Company's landing, about 2 miles from the bay. Isthmus Slough has a depth of about 20 feet at low-water from its mouth to Utter City and Henryville, a distance of about 6 miles. Coos River and Hayes Slough are navigable for river steamers, the former about 7 miles, the latter 4 miles from the bay. The resources of the country tributary will be seen by reference to paper forwarded herewith, "Statistics of Coos Bay," compiled and published by a committee of the citizens of Coos County.

By the courtesy of Mr. Merchant, the tugboat Escort, Captain Magee, was placed at my disposal without charge, enabling me to get very good lines of soundings at small cost. I visited the Eastport coal mines and found them of great extent and in good working order. The stratification of the coal is such that it is worked very economically, having a natural drainage and requiring no propping.

The chief difficulty at the entrance of the bay seems to be the shifting sands and crooked channel, the tidal flow not being regulated so as to get the full scouring force of the currents in suitable directions. During ebb tide the water from the bay and that from South Slough, flowing in opposite direction, meet near the entrance of the bay, causing an eddy where the most scouring effect is needed. A peculiar feature of this tidal flow is that the incoming tide runs up South Slough nearly an hour before it begins to flow up the bay proper. The ebbing tide also runs out from South Slough about the same length of time before the bay appears to be affected, apparently making the anomaly of a flooding and ebbing tide in one body of water at the same time.

I was informed by Mr. Merchant, Captain Magee, Coos Bay pilot, and others that the movements of the sand-bars have been very regular in their changes. The channel, when best for navigation, lies near the line of the proposed training-wall. The northern sand-spit then begins to form in a southwardly direction, making gradually until it gets to about the position it now occupies, forcing the channel close on to Coos Heads, just opposite. While this is taking place, the sand-bar north of "Lone Rock" makes northwardly, forcing the channel at that point toward the western side of northern sand-spit. When in about the position the channel now occupies, the water breaks over the northern sand-spit, and again forms a new channel on the site of the first. This, I am informed, has occurred three times in the past fifteen years, making each entire change in about five years.

To obviate these difficulties, a training-wall, as shown on the chart, is proposed, which will regulate the flow to and from the bay, at the same time separate the bay from the slough, forcing the tidal currents to have full effect in opening and maintaining the channel in a desirable position. After finishing the southern training-wall, it may be found necessary to build an additional one, as indicated by the broken lines on