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COLUMBIA BAR IMPROVEMENT.

Lieut.-Colonel Mendell's Minority Report.

UNITED STATES ENGINEER OFFICE, SAN FRANCISCO, October 17, 1882.

GENERAL: A difference of opinion on some important points relating to the improvement of the Columbia river entrance leads me to express my views separately.

The peculiar circumstances of heavy sea waves, strong and alternating currents, and the prevalence of sand in the vicinity, in unstable positions, introduce obstacles of so serious a nature that they may be said to place limitations upon the application of principles at the Columbia river.

An application of principles successful at the Danube or the Mississippi, where these obstacles do not exist, may require modification to become practicable at the Columbia.

A work extended seaward from Point Adams to a point two or three miles south of Cape Disappointment must cross a deep channel of the river over a mile in width, with an unstable bed, which at times in each day carries several hundred thousand cubic feet of water per second.

An encroachment upon the sectional area of a channel of this character, in which water moves with considerable velocities, is likely to develop an equal compensation by scouring the bed, so that the operation of closing becomes one of delicacy and difficulty, even when both banks can be occupied and stored with material in the most convenient positions.

Where the channel is several miles from shore, with limited communication with the shore and exposed to waves which disturb the bottom to considerable depth, the obstacles to success are much increased. This combination of circumstances affects the construction of such a work with a considerable degree of uncertainty.

The changes in phases of the river entrance, while not so sudden as those which affect the bars of smaller harbors on the sandy coast, do yet occur within periods shorter than that required to complete a work such as has been alluded to. It is therefore quite possible that such a work might be overtaken during its construction by one of these changes which would not only forbid its further prosecution, but involve the loss of a part already advanced to completion.

These considerations seem to be entitled to govern in a great degree the protection of a work at the mouth of the Columbia river. They suggest that the formidable difficulties to be met in deep water should be avoided until a plain necessity compels us to encounter them. Such a necessity can hardly be said to be demonstrated until all the advantages that can be realized from the occupation of Clatsop spit shall be developed and found to be insufficient to effect the desired result. The advantages cannot be developed until the spit is occupied by a work raised to a higher level than that of low tide.

The points here sketched, namely, the extension of the jetty to deep water, and its height, are those in which I am not able to agree with the board.

These remarks lead to inquiry as to the extent and character of improvement possible, which shall not be exposed to the great contingencies of cost and disaster, threatening a structure such as has been mentioned.

The decaying influence of Sand island in dividing the waters of the river at its point of departure for the sea leaves the river in a

more favorable condition for works of improvement than has in this respect been the case for many years. The injurious influence, now at large, is constantly diminishing. The river may soon be a unit between Point Adams and Sand island. In 1868 the river was divided by the island into two large and not very unequal parts. One of these fractions maintained for itself for some years a channel over the bar two miles wide, with depths of 35 to 27 feet.

The controlling natural feature which seemed to be entitled to the credit of this great result was Clatsop spit, which, for more than two miles in length, stood two or three feet above low water. It now lies four or five feet below low water, six or eight feet below its level in 1868.

It is practicable to restore and magnify this condition of Clatsop spit by work which shall present no unusual difficulties of construction, which shall be subjected to a minimum exposure, one which is practicable at a moderate cost, and capable of being built in three years.

It may be remarked that it is not to be expected that the restoration of Clatsop spit will reproduce the channel in the position of 1868. The direction of Clatsop spit and the unity of the river point to the development of a channel well to the north, approaching in position that of 1792.

If it were desired to re-establish the position of 1868, it would be necessary to build works other than here proposed, if indeed the project could be considered to be practicable.

To concentrate the river within moderate width, and to discharge it as a unit to the sea, are the objects sought.

This condition attained gives the best assurance of good results.

The most favorable position for a work which shall fulfill these conditions appears to be a line on the north side of Clatsop spit and about parallel to the crest.

This line is now assumed to conform to the 8-foot contour of depth, in the expectation that this depth will afford a fair degree of accessibility, on the flood-tide, to vessels discharging stone, thereby promoting cheapness.

But for this consideration the line would be better located near the crest of the spit. It is possible that a depth less than 8 feet may be found sufficient. If this be the case, the estimate of cost herein given, based on a depth of 8 feet, will be reduced.

The line, as near as can be projected on the latest map, is 14,000 feet in length. It starts from the westerly side of Point Adams, and ends at a point near the end of the spit, 3 miles distance from the cape, and about 2 miles to the westward and one-half mile northward of the end of the work projected by the board.

The object to be secured by this work, which is merely the practical elevation of Clatsop spit, permits enough latitude in its location to take in all the natural advantages of the position. This line is to be occupied by a work built to the level of mid-tide, being raised along its whole length to low water, before any large portion of it is built higher.

The line projected by the board occupied in the same way over the portion of its length lying on Clatsop Spit, would be productive of the same or similar results, at some additional cost.

Projecting this work as 12 feet high, which is 4 feet above low

water, 20 feet wide on top, and with slopes of 1 and 3 base respectively, its contents become 275,000 cubic yards.

Placing stone at \$4 per cubic yard, the estimate becomes \$1,100,000; adding 25 per cent. for contingencies, it is \$1,375,000.

By the circumstances of its location, under the shelter of the crest of the spit lying to the southward, the dimensions assumed are thought to be entirely reasonable, and perhaps in excess of those that will be required. The same circumstances permit the use of small materials and are thought to dispense with unusual sizes, and this, together with the accessibility of the line to barges, makes the estimate of \$4 per yard reasonable, and not likely to be exceeded. The estimate is believed to be full.

Assuming the average depth at low water over Clatsop spit to be 5 feet, and adding the height of the work, 4 feet, it will be seen that the sectional area of the waste-weir, through which the ebb tide now escapes, and which will be closed by the proposed work, is 126,000 square feet, being a channel 14,000 feet long and 9 feet average depth.

The mid-tide cross-section of the river between Point Adams and Chinook Point is 500,000 square feet. Through this section the whole ebb, estimated at an average of 1,000,000 cubic feet per second, passes.

The contraction secured is therefore one-fourth of the river section at Point Adams.

The quantity of water thus to be diverted into the main river channel is hardly a matter of calculation under the present circumstances of our knowledge, nor can its effect on the improvement of the bar channels be accurately demonstrated.

It may, however, be claimed that this project affords a real concentration of the river in as great a degree as now appears to be practicable at a moderate cost, and further, that the history of the river justifies hope that a great improvement in depth will thereby be secured. The conditions under which 4 fathoms and more existed in the past do not seem to me so favorable for good depth as those that will be established by this work.

The line is sheltered as far as possible by the spit to the southward; it is accessible, it presents no unusual difficulties, its cost is moderate, it can be built in three years, it is in a position to receive aid from the action of the flood tide and waves which transport sand over Clatsop spit, and lastly, its construction must enforce the river by a material increasement.

The estimate is based upon the use of stone, but wood in mattresses and perhaps in other forms may be used with advantage.

If this work were completed, it might at some subsequent time be a question whether it ought or ought not to be raised above the high water level.

If, as anticipated, Clatsop spit shall form to the height of the work, it would be comparatively inexpensive to raise the line 4 or 5 feet higher.

It would seem as tending still more towards unity in the river, that further elevation in the line would be beneficial. It has been suggested that the elevation of a jetty to mid-tide level may interfere with the entrance of the flood tide. This might be the case if the bottom were unyielding. The history of the river and common observations show the bed of the entrance to be very unstable. Beds of this character

usually adapt themselves with great facility to changes of width.

The construction of a work of the kind proposed is gradual. It makes, day by day, no violent changes in sections. The ebb tide has plenty of time to adapt itself to new conditions. In confirmation of these remarks, it may be said that in 1868, when Clatsop spit was above low water and the middle sands and Pennek spit were shoaler than now, it was not found that the ingress of the flood tide was impeded. The fact that the channel then existing was the best the river ever had, would seem to indicate that the flood supplied all the water that was needed.

Now that the river section is much enlarged by the deepening on the shoals, it is not claimed that the flood tide supplies more water than it did in 1868.

San Francisco harbor enters and discharges its 3,000,000 cubic feet of average tide per second through an entrance of barely 1 mile in width.

Analogy indicates that an opening of 3 miles is sufficient to permit the entrance of 100,000,000 feet into the Columbia.

The real concern of a project appears to be to concentrate the ebb to get its maximum effect. If this be successfully done, the flood may be trusted to do its part.

I am, very respectfully, your obedient servant,

G. H. MENDELL,
Lieutenant-Colonel Corps of Engineers.

The Chief of Engineers, U. S. A.

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