

These dikes I would make similar to those that have been made under your supervision at Nebraska City, Omaha, and Atchison. They would be made up of "weeds" placed in the direction desired at intervals of about 10 feet. The "weeds," as they are technically called, are made by tying scraggy buoyant brush to poles or ropes, and anchoring them by heavy stones or bags of sand. As the brush has not sufficient buoyant power to keep the weed upright in the water, a barrel or box is attached to one end having sufficient buoyancy to hold it up. It is proposed to make these weeds from 30 to 50 feet in length. The dikes, when made as indicated with one row of "weeds," will cost in this locality about \$1 per foot.

The exact position in which each of these dikes should be placed is a matter that cannot be definitely decided upon in devising any plan which comprehends the use of several when the position of a lower one depends upon the effect produced by those above.

Careful observations must be made during construction, and positions and directions changed accordingly. Only approximate positions can be indicated before going into the field. For the case under consideration I have done this upon the map by lines marked thus: \* \* \* \* \* Where two of these lines occur parallel to each other, I propose to place two rows of weeds, those in the lower row opposite the intervals in the upper.

It is hoped that by arranging the dikes somewhat as they are indicated in the bend above Cambridge they will check the current near the bank and cause a deposit behind them which will result in forcing the channel over to the right bank, if not in the upper part of the bend, at least high enough up to wash away the deposit which has formed in front of Cambridge and restore to that town its old steamboat-landing and improve its facilities for river commerce. This will relieve the bend next below from the effects of the current, which now impinges against it with full force.

The dikes projected for this bend, it is hoped, will be sufficient to check the current here and crowd it gradually over to the left, along the south side of the island higher up than it now is. Where the channel now leaves the island and turns to go back to the main shore on the right through the large sand-bar in the bend there are two channels, one about 1,600 feet wide and the other about 800. In these I propose to place dikes, as indicated, which, by checking the current, it is hoped will fill up by gradual deposits and force the channel around in the direction desired.

To assist in the accomplishment of this object, by raising as it were the whole of the river bottom in this bend, is the object of the other dikes in this vicinity. Since it is our design to force the river to make for itself a channel along the lower end of Harrison's Island, it will be necessary to suppress all tendency to the formation of deposits there.

With this object I would therefore close entirely the present high-water chute along the north side of the island. It is already very much silted up, and only at high-water is there any current through it. This object it is thought can be easily attained by building a brush fence across it, some time in early summer so as to catch the sand that would be blown against it by the wind, or if this was not expedient, a dam made of brush and sand would be sufficient, since there would be no current here to wash them away. Such a structure would cost not more than 25 cents per linear foot.

For the completion of this improvement upon the plan as proposed I estimate as follows:

FOR LOWER BEND.	
For 14,000 feet of brush revetment, at \$2.25 per linear foot .....	\$31,500
For 14,000 feet of floating brush dike, at \$1 per linear foot .....	14,000
Contingencies and superintendence .....	5,000
	\$50,500
FOR MIDDLE BEND.	
For 8,000 feet of brush revetment, at \$2.25 per linear foot .....	18,000
For 6,800 feet of floating brush dike, at \$1 per linear foot .....	6,800
Contingencies and superintendence .....	4,000
	28,800
FOR UPPER BEND.	
For 14,400 feet of brush revetment, at \$2.25 per linear foot .....	32,400
For 14,000 feet floating brush dike, at \$1 per linear foot .....	14,000
Contingencies and superintendence .....	7,000
	53,400
For closing chute on the north side of Harrison's Island .....	300
Total .....	133,000

Respectfully submitted.

Maj. CHARLES R. SUTER,  
Corps of Engineers, U. S. A.

THOS. H. HANDBURY,  
Captain Corps of Engineers.

O 5.

IMPROVEMENT OF MISSOURI RIVER AT KANSAS CITY, MISSOURI.

Under date of January 10, 1879, a report, with plan and estimate for the improvement of the Missouri River at this locality, was submitted to you (published in Senate Ex. Doc. No. 37, Forty-fifth Congress, third session). An appropriation of \$30,000 having been made for this work by act approved March 3, 1879, work under the general plan proposed was begun April 29, 1879, and is still in progress, Assistant John W. Nier being in charge. During this time, the river being high, work has been confined to the construction of a floating brush dike, intended to turn the channel away from the left bank near the head of Kaw River Bend. The results so far obtained are satisfactory. Later in the season it is proposed to construct 8,000 feet of mattress revetment above and 500 feet below the shore end of this dike, to prevent any further erosion of the bank in that vicinity. These operations will exhaust the present appropriation. To carry out the proposed plan an additional sum of \$62,810 is asked for, which can be profitably expended in one season.

The work is situated in the collection-district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 30, 1879, was \$2,355.38.

Money statement.

Amount appropriated by act approved March 3, 1879 .....	\$30,000 00
July 1, 1879, amount expended during fiscal year .....	97 38
July 1, 1879, outstanding liabilities .....	7,235 09
	7,332 47
July 1, 1879, amount available .....	22,667 53
Amount (estimated) required for completion of existing project .....	62,810 00
Amount that can be profitably expended in fiscal year ending June 30, 1881 .....	62,810 00

EXAMINATION OF MISSOURI RIVER AT AND NEAR ITS JUNCTION WITH KANSAS RIVER.

UNITED STATES ENGINEER OFFICE,  
Saint Louis, Mo., January 10, 1879.

GENERAL: I beg leave to submit herewith a copy of a report made to me by my assistant, Capt. Thomas H. Handbury, Corps of Engineers, U. S. A., upon the Missouri River at and near its junction with the Kansas River, as called for by act of Congress approved June 18, 1878.

From this report and the accompanying map it will be seen that the erosion on the left bank of the Kaw River Bend, immediately above Wyandotte, Kans., is progressing so rapidly as to threaten to cut off the point opposite Kansas City, Mo., and to isolate if not destroy the railroad bridge erected over the Missouri River at that point. The whole situation is, therefore, quite similar to that at Omaha, Saint Joseph, Atchison, and other points along the river where works of protection are now in progress, and the plan of improvement proposed is based upon our experience at these localities. It is proposed to protect by brush mattresses the bank which is now caving, and then to attempt the rectification of the river by a system of floating spur and training dikes.

Captain Handbury's estimate for this work, which is approved by me, is as follows:

For revetting 25,000 feet of bank, at \$2.25 per foot .....	\$56,250
For constructing 13,200 feet of training dike, at 80 cents per foot.....	10,560
For constructing 10,000 feet of spur dike, at \$1.60 per foot.....	16,000
For contingencies .....	10,000
Total .....	92,810

The whole amount estimated should be appropriated at once, in order that the entire work may be carried through in one season, experience having shown that unless this is done the ultimate cost will greatly exceed the original estimate.

I am, general, very respectfully, your obedient servant,  
 CHAS. R. SUTER,  
*Major of Engineers.*

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

REPORT OF CAPTAIN THOMAS H. HANDBURY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,  
 Saint Louis, Mo., December 26, 1878.

SIR: I have the honor to submit the following plan, prepared under your direction, for the improvement of the navigation of the Missouri River at Kansas City, Mo., and for the protection of property from destruction by the river in the vicinity of that city.

For several years past a change has been taking place in the regimen of the river in this locality. The channel has taken an unfavorable direction, the banks are being eroded at a rate which is rapidly increasing with each succeeding year, property of great value is threatened with destruction, and prosperous commercial interests which shaped themselves to a former state of affairs are in danger of being thrown in confusion, if not entirely destroyed. So alarming have these changes become that it has been thought necessary to call in the aid of the government to arrest them. Accordingly Congress at its last session directed that a survey should be made with a view to ascertaining the extent of those changes and the propriety of adopting measures to arrest them, if possible. A tracing from the map of this survey, made under your direction, has been submitted to you, together with a report, by Assistant D. W. Wellman. This map, which was made to a scale of 1 inch to 400 feet, has, for convenience, been copied on a reduced scale of 1 inch to 2,000 feet. A tracing is herewith submitted, with approximate location of proposed works of improvement marked upon it.

From such reliable information as could be obtained, Assistant Wellman plotted a portion of the right bank of the river in this vicinity as it was in 1855, and a portion of the left bank as it was some time previous to 1847, although the exact time could not be ascertained.

From the tracing it can be seen that a great change has taken place in the shape of the river in this vicinity within the last few years. Unfortunately we have not the data for ascertaining the rate of this change, but sufficient is known from the reports of those living in the vicinity, and from other data that we have, to show us that the change is rapid, and its rate is increasing from year to year.

The most striking changes which are noticeable upon the map are those that have taken place in the bend above Wyandotte, and below between the mouth of the Kaw River and the bridge. There seems to be something in the soil in the point immediately opposite Wyandotte which renders it more tenacious than that in the concave above, and prevents it from being washed away. The concave is becoming sharper and sharper, and at the same time is moving down and narrowing the neck which separates it from the river below at a rate which at no distant day will carry it through unless the erosion here is stopped. The whole of this point is low ground, which is submerged at high-water, as can be seen by an examination of the profile upon the accompanying tracing. Upon this low ground are placed the foundation for the trestles which support the approaches to the south end of the Kansas City bridge, a structure which originally cost somewhat over a million of dollars. This bridge has become one of the great railroad crossings of the Missouri River. Its first and second piers, on the north end, rest upon piles which are supported only by friction and the sand. The third pier rests upon piles driven down to the bed-rock. The remaining piers rest upon bed-rock. These foundations of sand, when subjected to the action of the current, will soon doom the bridge to destruction.

The concave in front of and below Wyandotte has been subjected to considerable erosion, but at present that part which is included between the mouth of the Kaw River and the bridge is protected from further erosion by a riprapping of stone, made by the bridge company and the citizens of Kansas City. From time to time, as the scour deepens the water along this reach, this riprap slides out in places and requires renewal, which is done by the parties interested.

The soil throughout the locality under consideration is the usual Missouri River Valley alluvium, which succumbs so easily to the action of the slightest current, with occasional harder deposits, which deflect the current with very marked effect. The erosion takes place by the water undermining the lower portion of the bank; the top then falls in.

The depth of water in the channel at the time of the survey is shown by the cross-section and referred to the Kansas City gauge. The current runs from 2 to 8 miles per hour, depending upon the locality and state of the river. The river bed is shifting sand, which can be moved about or deposited at the caprice of the current.

In devising a plan for the improvement of this portion of the Missouri River, the two most striking points for consideration are to stop the erosion where it threatens vital interest, and to provide a means which will prevent a recurrence of the threatened danger.

Upon careful consideration of the situation of affairs here it is evident that if we can stop the erosion of the bank in the concave bend above Wyandotte, and can rectify the river into something like its old shape, with its old cross-section and slope, and keep it there, one object will be accomplished.

To attain the first object, it is proposed to protect the bank throughout its entire extent by covering it below low-water, where the erosion first takes place, with brush made into thin, flexible mattresses of about 1 foot in thickness. These mattresses should be of sufficient length to extend from the water surface, at the time they are put in, down to the foot of the bank and out along the bed of the river a sufficient distance to insure that, in case a scouring out should take place along the bottom, they will fall back into the hole and still protect the slope. From an inspection of the various cross-sections it is obvious that this length need not exceed 50 or 60 feet. From the manner in which the erosion takes place, it is evident that the foot of the slope must always be protected, no matter how far beneath the surface of the water it may be; hence the necessity for giving the mattresses sufficient length to reach this point under any circumstances.

These mattresses it is proposed to make in a manner essentially the same as that which this year's experience with various forms and modes of construction upon the works of improvement along the Missouri River under your charge proves to be the best and most economical. Its exact mode of construction will be governed somewhat by circumstances, dependent upon the incidents of locality. Its cost, based upon the experience above referred to, can be placed at about \$2 per running foot of bank.

For the protection of the banks above the in-shore edge of these mattresses, it is proposed to grade it back upon a slope of about 1 or 2, and cover it with a thin layer of willow brush about 4 inches in thickness, fastened to the slope by wire and stakes. Experience has shown that such a covering can be made at a cost of about 25 cents per running foot of bank.

The whole extent of shore that it is deemed advisable to protect in that manner is in the neighborhood of 25,000 feet, and is marked in the tracing thus: = = =

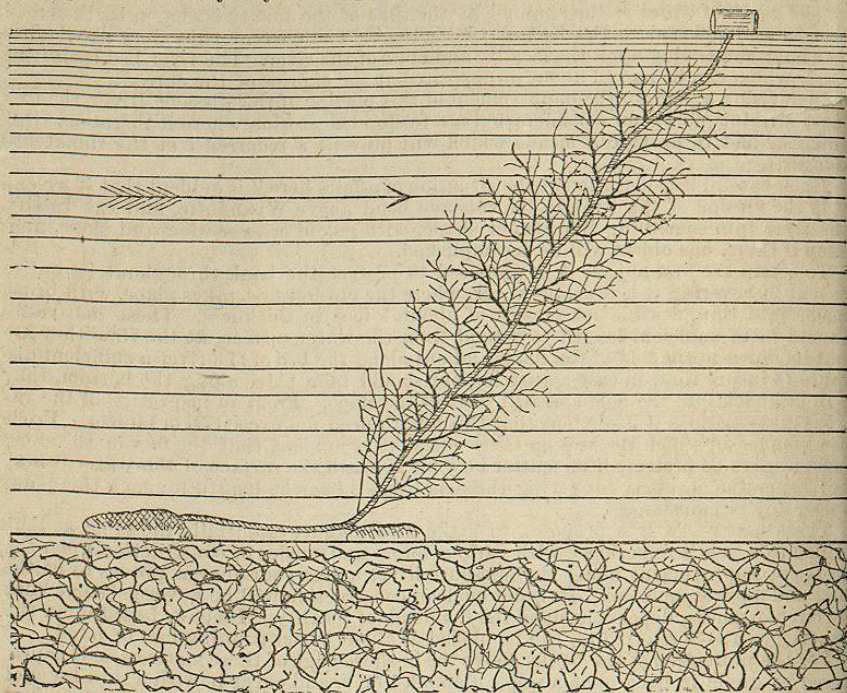
With regard to the second object, that of giving some permanency to the check which it is thought that the plan proposed above will give to the erosion in this bend, it is evident that if we can cause a deposit to take place in this bend which will fill it out to something like the old shore line, say to the line marked thus \* \* \* \* \* upon the tracing, and cut away a portion of the point opposite Wyandotte, the desired end would be accomplished. To cause this deposit, and at the same time to give the channel of the river a gradual curve around the bend, it is proposed to go above, and from the right bank, at some point in the vicinity of Q, run a floating brush spur-dike out into the stream a distance of about 600 feet, and about 1,000 feet below this run another one out about 800 feet.

The length of this second dike and its distance below the first will depend very much upon the action of the first.

The object of these dikes is to form a deposit in this vicinity which will throw the main body of the water, which is now on the right side of the river bed at this point, over to the left side, and make it impinge against the bank somewhere in the vicinity of the railroad dikes. From near where the creek puts in, just below these railroad dikes, it is proposed to build a floating training-dike, with auxiliary floating spur-dikes, somewhat as indicated upon the tracing. By means of these it is hoped to gradually turn the main body of the water in the desired direction, and so check the velocity of that portion which passes between the training-dike and the shore as to cause it to deposit the material which it is transporting and result in a bar being formed here. Neither the location, direction, nor extent of these auxiliary spur-dikes can be determined beforehand with any degree of definiteness. After the first, or probably

the second, of these have been located, the others will result from the action of the training-dike and those which precede them. In the progress of construction, constant observation of the effect produced will be necessary. These floating dikes are to be made essentially as those that have been made under your direction at various points along the river.

It is proposed to make the weeds from 30 to 50 feet long, and place them along the lines indicated at intervals of from 10 to 12 feet. For the spur-dikes the intervals should be less. They will be made by tying light and buoyant brush to a pole or cord of the requisite length. When placed in position, one end will be anchored at or near the river bottom, and will be held up to the surface of the water by a box or barrel having sufficient buoyancy for the purpose.



From the experience gained during the present season's operations, it is thought that these weeds can be put in place for about \$8 each, or, supposing them to be placed in these dikes at intervals of 10 feet, the dike will cost 80 cents per running foot.

The length of training-dikes that it is thought will be necessary is 13,200 feet; of spur-dike, 10,000 feet.

It is evident from the nature of the materials from which these floating dikes are made that they are of short duration; hence they must accomplish the object for which they are designed as speedily as possible. To do this, they should be in the water when it is transporting its greatest amount of sedimentary matter; that is, when the river is at its flood stages. For the reason that floating ice will carry off the buoys, and cause the weeds to sink before they accomplish their work, it is evident that the dikes cannot be built with a view to utilizing to advantage a winter or early spring flood. They should be built as early in the spring as the absence of ice in the river will permit, so that they may have their full effect upon all the floods that occur until the succeeding winter.

The total cost of the improvement proposed it is estimated will be:

For revetting 25,000 feet of bank, at \$2.25 per foot .....	\$56,250
For constructing 13,200 feet of training-dike, at 80 cents per foot .....	10,560
For constructing 10,000 feet of spur-dike, at \$1.60 per foot .....	16,000
For contingencies .....	10,000
<b>Total .....</b>	<b>92,810</b>

Respectfully submitted.

Maj. CHAS. R. SUTER,  
Corps of Engineers, U. S. A.

THOS. H. HANDEBURY,  
Captain, Corps of Engineers.

O 6.

IMPROVEMENT OF MISSOURI RIVER AT FORT LEAVENWORTH, KANSAS.

At the date of the last annual report a survey of the Missouri River at this locality had been ordered. Upon its completion a report, with plan and estimate, was submitted to you under date of September 28, 1878. The plan proposed having been approved, work was begun October 3, and kept up until February 19, 1879, Assistant D. W. Church being in charge. April 28, 1879, work was resumed and is still in progress, under the charge of Assistant Church, Assistant G. T. Nelles being the local engineer. The plan proposed contemplated the protection of the Missouri shore of the large bend above Fort Leavenworth to the extent of about 14,000 feet, which, together with some works for the rectification of the channel, would, it was thought, stop the excessive caving going on in the bend above mentioned, and secure a stable regimen for the river in this vicinity. During the season 5,960 feet of shore-line has been protected by a revetment of brush mattresses, varying in width from 40 to 75 feet, and in thickness from 14 to 8 inches, according to the strength of the current and depth of water. The bank above the mattresses has been graded and covered with a layer of brush 4 inches thick, held down by wires and stakes. All this work is situated below Bee Creek Point, which must recede some distance before it reaches the shore line to be ultimately held. All this work has stood very well, the damage received in the spring having been slight and easily repaired. Work has also been commenced opposite Leavenworth, where a tendency of the river to leave the city front has been detected. At this point floating brush dikes are being used. During the season it is proposed to construct about 2,000 feet of revetment above Bee Creek Point.

To complete the work according to the plan proposed there will still be required 6,600 feet of revetment, which, with the minor works projected, will require a further appropriation of \$35,000, which can be profitably expended in one season.

The work is situated in the collection-district of New Orleans, and the nearest port of delivery is Omaha, Nebr.

Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 30, 1879, was \$2,355.33.

Money statement.

July 1, 1878, amount available .....	\$25,000 00	
Amount appropriated by act approved March 3, 1879 .....	10,000 00	\$35,000 00
July 1, 1879, amount expended during fiscal year .....	18,728 19	
July 1, 1879, outstanding liabilities .....	6,934 33	
		<u>25,662 52</u>
July 1, 1879, amount available .....		9,337 48
Amount (estimated) required for completion of existing project .....		35,000 00
Amount that can be profitably expended in fiscal year ending June 30, 1881 ..		<u>35,000 00</u>

O 7.

IMPROVEMENT OF MISSOURI RIVER AT ATCHISON, KANSAS.

At the date of the last annual report a resurvey of this locality had been ordered. Upon its completion a project and estimate were submitted to you under date of August 21 and the plan proposed having been

approved, work was commenced September 1, 1878, Assistant Chester B. Davis being in charge, and was continued until December 15, 1878. Work was resumed April 19, and is still in progress, Assistant D. W. Church being in charge, with Assistant George E. Fritcher as local engineer.

The plan proposed contemplated the protection of the Missouri shore opposite Atchison from the railroad bridge up stream as far as the bank was caving, and the construction of such auxiliary works as might be necessary to rectify the channel in the neighborhood of the railroad bridge. The appropriation was expended in the prosecution of this general plan. During the season 6,250 feet of shore line, beginning near the bridge, was protected by brush mattresses. For a length of 3,000 feet the mattress-work was 60 feet wide from the water's edge; for 2,500 feet it was 40 feet wide, and for 750 feet it was 30 feet wide, the strongest work being at the lower end, where the heaviest scour was anticipated. These mattresses varied in thickness from 12 to 6 inches, and the size was 60 feet by 40 feet, or 60 feet by 30 feet. They were built on ways, launched, floated to position, and sunk by loading the outer and upstream edges with stone. In their construction a light grillage of poles with openings 8 feet by 14 feet was used for the bottom frame. On this frame the brush was laid in successive layers, crossing each other at right angles. In place of a top frame wires were used, attached at the ends to the bottom frame, carried across the mattress in both directions and lashed at their intersections to the bottom frame. This style of mattress proved to be very flexible, and at the same time strong enough for all purposes. The bank above the mattress-work was graded back and covered with thatched layers of brush held down by wires and pickets. During the winter and spring a portion of this upper revetment was injured by the breaking against it of waves during high winds, and 1,800 feet had to be rebuilt. The rest of the work stood perfectly well. Towards the close of the season an experimental weed-dike 2,400 feet long was put in near the middle of the bend to stop a heavy cutting which was going on there. The result was attained for the time, but during the spring rise the river cut in behind and destroyed it. As soon as operations were resumed a mattress revetment was begun at this place and 240 feet had been constructed by the 30th of June, 1879. This revetment is 80 feet wide and 6 inches thick. The present appropriation will be expended in continuing it up and down stream. To complete the work at this locality it is thought that it will be necessary to build above Atchison 16,000 feet of mattress revetment and 1,500 feet below the town. This and the other works which will be needed will cost \$80,000, which can profitably be expended in one season.

The work is situated in the collection-district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans. Amount of revenue collected at Omaha, Nebr., during the fiscal year ending June 30, 1879, was \$2,355.38.

*Money statement.*

July 1, 1878, amount available.....	\$20,000 00	
Amount appropriated by act approved March 3, 1879 .....	20,000 00	
		\$40,000 00
July 1, 1879, amount expended during fiscal year.....	19,736 96	
July 1, 1879, outstanding liabilities .....	2,672 30	
		22,409 26
July 1, 1879, amount available.....	17,590	
Amount (estimated) required for completion of existing project.....	80,0	
Amount that can be profitably expended in fiscal year ending June 30, 1881.	80,0	

further settlement. As soon as the training works can be got in further upstream this tremendous pressure will probably be relieved and work will be begun at once to effect it. The work of revetment will also be pushed as rapidly as possible and as far as the means at our disposal will allow. The completion of the present plan will require a further appropriation of \$55,000, which can be profitably expended in one season. If the whole amount asked for is not given next year the ultimate cost of the work will probably be greatly increased. For the details of this extremely interesting and instructive work I beg to refer to the accompanying report of Assistant L. E. Cooley.

The work is situated in the collection-district of New Orleans, and the nearest port of delivery is Omaha, Nebr. The nearest fort is at Leavenworth, Kans. Amount of revenue collected at Omaha, Nebr., during fiscal year ending June 30, 1879, was \$2,355.38.

*Money statement.*

July 1, 1878, amount available.....	\$40,000 00	
Amount appropriated by act approved March 3, 1879 .....	30,000 00	
		\$70,000 00
July 1, 1879, amount expended during fiscal year.....	28,076 67	
July 1, 1879, outstanding liabilities .....	13,868 18	
		41,944 85
July 1, 1879, amount available.....	28,055 15	
Amount (estimated) required for completion of existing project.....	55,000 00	
Amount that can be profitably expended in fiscal year ending June 30, 1881.	55,000 00	

REPORT OF MR. L. E. COOLEY, ASSISTANT ENGINEER.

NEBRASKA CITY, August 6, 1879.

MAJOR: I have the honor to submit the following report on the work under my charge at Nebraska City and vicinity during the year 1878-'79:

The details of the methods employed and the appliances used are illustrated by photographs and drawings. A list and description of drawings with incidental remarks, also certain statistics in regard to cost of work will be found in the addenda.

A survey of the river from Wyoming Landing to Nebraska City was made in August, 1878. A second or low-water survey, extending from Jones' Point to 4 miles below Nebraska City, was made in October and November, 1878. These have since been supplemented by additional surveys and by borings.

As a result of these data, a project was submitted September 6, 1878, and supplemented December 19. A preliminary modification, in view of the experience and investigation of the past season, was submitted July 14, 1879.

In accordance with these projects, operations have been conducted. The work constructed in 1878 consisted of 10,374 feet of revetment with necessary headers or roots, 1,600 feet of upper bank protection, and 3,251 feet of sand fence. Of the revetment 4,624 feet were constructed at Eastport Point, commencing with a root that distance above the Transfer Landing and extending thereto; 2,750 feet at the head of Nebraska City Island, 600 feet of which was placed in the slough as a header; and 3,000 feet in Civil Bend, starting with a root 3,500 feet above Blair's and extending to within 500 feet of that point.

Five hundred and six feet of sand fence was built on the bar opposite Wyoming Landing, and 2,745 feet on the bar of Nebraska City Island. Of these works, those on Eastport Point and Nebraska City Island were simply protective in their nature and designed to secure certain vital points while important changes were in progress. Those in the vicinity of Wyoming were part of a scheme for effecting these changes.

The work on Eastport Point started from a root extending some 300 feet inland. The first section of 1,082 feet consisted of mattress-work 50 feet in width, extending out from a point about 3 feet above low-water; the upper bank was here protected for a distance of 1,100 feet. Below this the revetment was 44 feet in width for a distance of 1,588 feet, and thence to the Transfer Landing 1,854 feet, 35 feet in width, ending in a dam 100 feet long, across a slough to an old nest of piling.

Five hundred feet of the sandy upper bank near the Transfer Landing was protected. Borings determined the existence generally of a stratum of coarse sand and gravel at