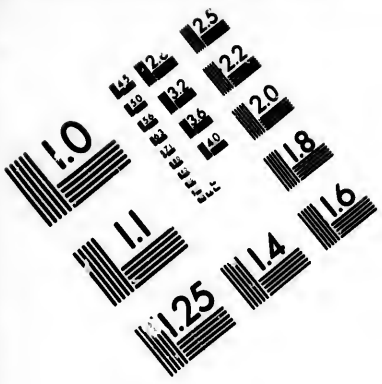

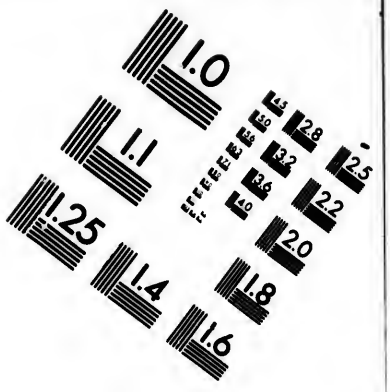

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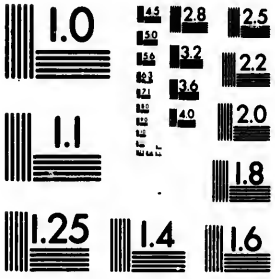

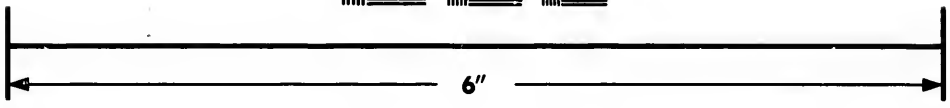

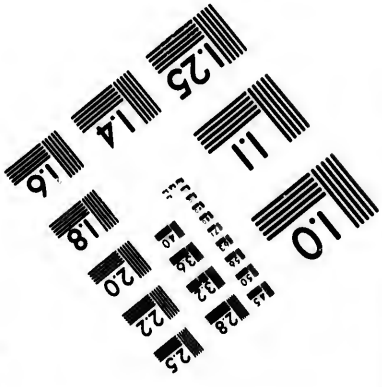

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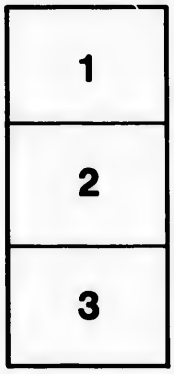

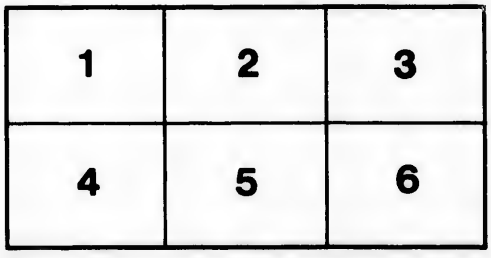

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Canadian Society of Civil Engineers.

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FRASER VALLEY RECLAMATION.

CONSTRUCTION OF TWO SLUICE BOXES AND FLOOD GATES.

To be read Thursday, 8th April, 1897.

By R. E. Palmer, A.M. Can. Soc. C. E.

The freshets or floods of the Fraser River, British Columbia, occur as a rule between the latter end of May and the middle of July, caused principally by the melting of the snow upon the mountains.

In the reclamation of portions of the delta lands of this valley, from these freshets, the most difficult part of the schemes at present adopted is the satisfactory design and building of the sluice boxes and flood gates.

Up to the present time, that portion of the delta reclaimed lies in patches, each portion being protected by itself, and not connected with any other portion. Generally these patches or valleys front on the main river, and are surrounded on all sides, with the exception of the frontage, by high lands, which discharge all their drainage upon the flats. This water finds its way over these flats through sloughs and creeks which discharge into the main river, during the low or ordinary stage of the water, namely, from August to the end of April.

The system of reclamation adopted up to the present day has been that of the construction of dykes or embankments, of different dimensions, along the banks of the river, from high lands to high lands, and of the building in the creeks or sloughs, over which the dykes would pass, of flood gates, and sluice boxes as they are called, which are so constructed as to close during the high water, preventing the river water from backing up the sloughs and flooding the prairies. They are constructed also to open, so soon as the water in the river begins to fall lower than that in the sloughs, and drain the prairies, the sloughs during the period when the gates are closed acting as reservoirs, to hold the ordinary drainage from the surrounding hills.

In ordinary cases the sloughs have not enough capacity to hold the drainage during the time when the gates are closed, and pumping has to be resorted to, for about a month in the year.

One of the most difficult operations connected with these schemes is the proper designing and construction of these boxes. It is a very difficult matter to keep them tight, and the material in and surrounding these sloughs is such that when once the slightest leakage occurs, under pressure, it is a very short time until the whole box finds its way into the river or up the slough.

Again the many and varied kind of sloughs and creeks, the different classes of material through which they pass, varying from gravel and sand, to silt and clay, the fact that some discharge into the river where there is a regular rise and fall due to the tide, while others discharge at points where the tide does not reach—(the gates of the former having of necessity to close and open during each tide, while in the latter they need only close during the freshet)—all tend to require very careful examination and much experience before deciding upon the proper design for the gates.

In fact, almost every locality requires a gate of a design unique in itself, with some special features differing probably very materially from that required in a locality not half a mile distant. The boxes required for the sloughs located on the river above the effect of the

tides are subjected to a very severe test and strain during high water. They are often subjected to a pressure of water due to a head of from 18 to 20 feet and lasting from a month to six weeks. On the other hand, those located on that part of the river affected,by tidal waters are relieved twice every day during ebb tide.

The writer gives a description of two of these boxes built by him, one in March, April and May, and the other in August and September, 1896, all being under the same contract. They are built in two sloughs discharging into the Fraser, through what is known as the Matsqui Prairie. They were designed in 1893 by Mr. Fred. J. L. Tytler, C.E., at present supervising engineer for reclaiming lands for the Provincial Government of British Columbia, and were built with several changes under contract by the writer. The plans attached with this paper are those upon which they were actually built. It may also be mentioned that in each of these sloughs prior to the construction of the ones described there had been built three different and distinct boxes each of which had succumbed to the effects of the freshets, and had been torn apart or scoured out, and carried by the flood for long distances over the prairies.

One of the present boxes, the only one built at the time, was subjected to a very heavy freshet in July last, the water in the river reaching to a point only 2 feet 11 inches below that reached during the disastrous flood of 1894; but although the work was barely completed, when the flood came, and had in consequence barely reached its true bearing, still there was no sign of leakage, or scour, or damage in any one particular. The lumber used in the boxes was all of rough sound cedar, with the exception of the clappers or doors, which were of dressed Douglas fir. The boxes are identical in design, each being 80 feet long by 26 feet wide by 5 feet 8 inches outside measurement, having four openings each 4 feet by 5 feet. They have also each an entrance apron 30 feet x 40 feet, and a discharge apron 60 feet x 40 feet; each contains about 90,000 feet B.M. The plans attached give a general idea of the timber-work. All spikes were specified to be galvanized.

The most important part of the work is the method of setting the box, and the proper placing of the brush and clay and pickets, and this will be now described.

At this point of the Fraser River, there is an ordinary rise and fall of tide, due to the backing up of the river, of about 4½ feet, while during the freshet no difference of rise and fall is perceptible. Both boxes being identical in design it is only necessary to describe the manner of placing one—the most difficult—and located in what is known as No. 3 slough.

This slough as shown on the plan is about 80 feet wide at the top, and from 25 to 30 feet deep, with water at the time of construction about 10 to 16 feet deep. It drains a large portion of the prairie, besides receiving a large creek from the surrounding hills, and as the weather was very wet at the time, it was necessary for it or the off-take ditch to carry away a large amount of water. The banks of the slough sloped at about ¾ to 1 and were interwoven with roots, and gave signs of sliding from adjacent springs and seepage of water.

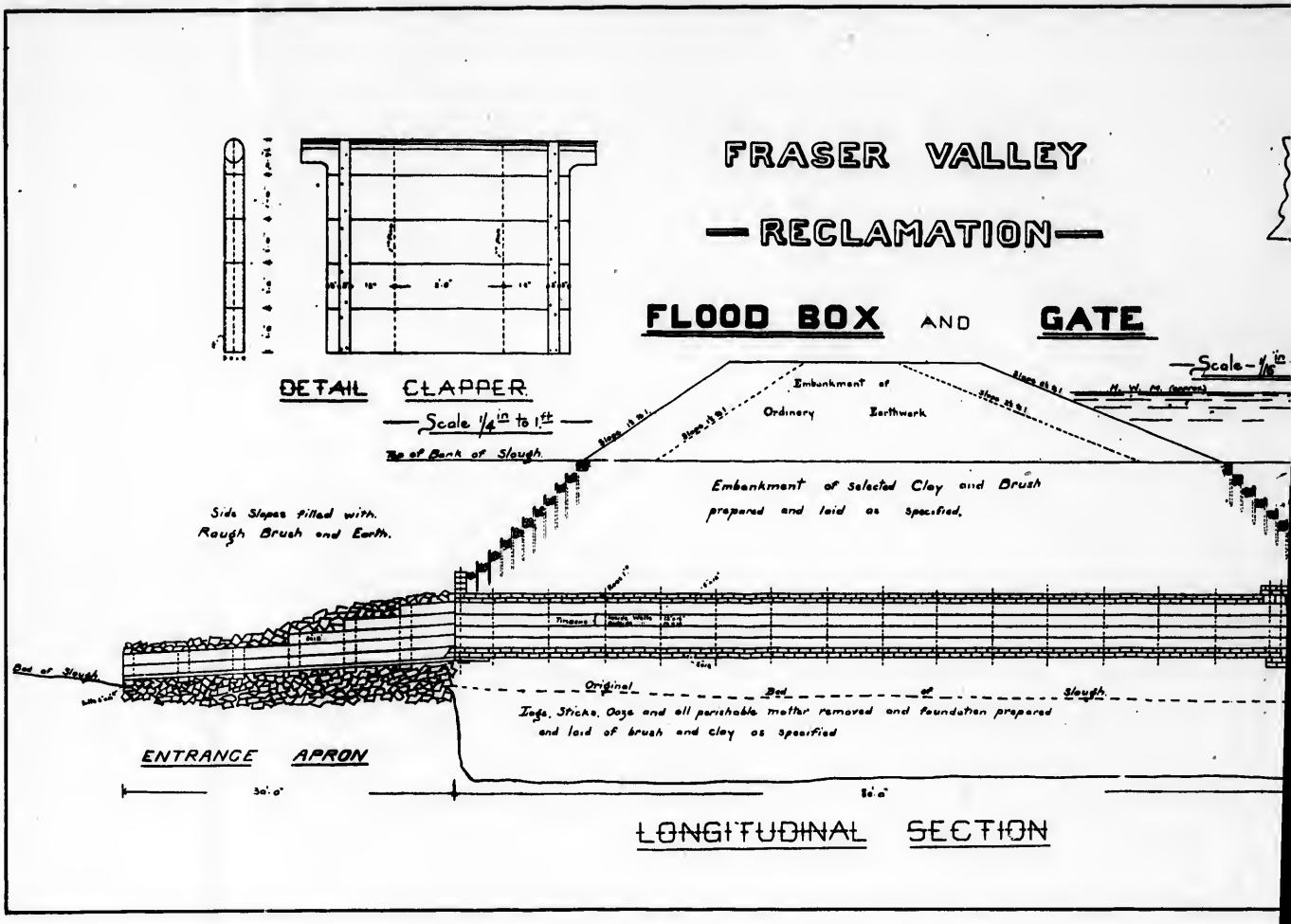
The method devised and afterwards adopted for placing the box was to build a temporary dam a short distance above the site of the box, another a short distance below the site, excavate an off-take ditch, and having pumped out the portion of the slough between the dams, to commence operations. The off-take ditch was excavated through fairly good clay, being about 12 feet wide at the bottom, with side slopes of about 1 to 1, and varying in depth from 4 to 14 feet.

In constructing the upper dam a crib of logs was first built across, notched down and securely drift-bolted together, the logs on the upper side having a batter of about 6 inches to the foot. Along the upper side were driven sheet piles, consisting of 3 and 4 inches plank which penetrated from 4 to 8 feet into the bottom, but on account of the presence of many sunken logs and stumps, it was impossible to get all the plank down to a proper bearing, but they were intended merely to

of sand being fine. This when left in its natural bed, and not disturbed, is impervious to water, but once it is moved and displaced, and exposed to the action of water under pressure, it becomes a veritable quick-sand. Beneath this was a bed of fairly coarse red sand.

After having made this examination, the cause of the former boxes having been scoured out was apparent to the writer. They had been constructed in the form of coffer-dams built by driving rows of sheet piles braced to ordinary piles, and filling the intervening space with earth or clay. These piles had penetrated this bluish silt, and were driven into the red sand. When the water acquired the necessary head on the outside, after the closing of the gates, it followed down the piles through the silt, into the sand and up again on the other side. The intervening earth was soon washed out, and with it the bottom of the piles, until a channel was formed underneath, and very little time elapsed before the whole structure was scoured out.

After having been enlightened as to the nature of the bottom, it was decided to lay the foundation upon this bed of bluish silt, without disturbing it more than necessary. This was done after all the decayed material—logs, ooze, etc.—had been removed from the bottom,



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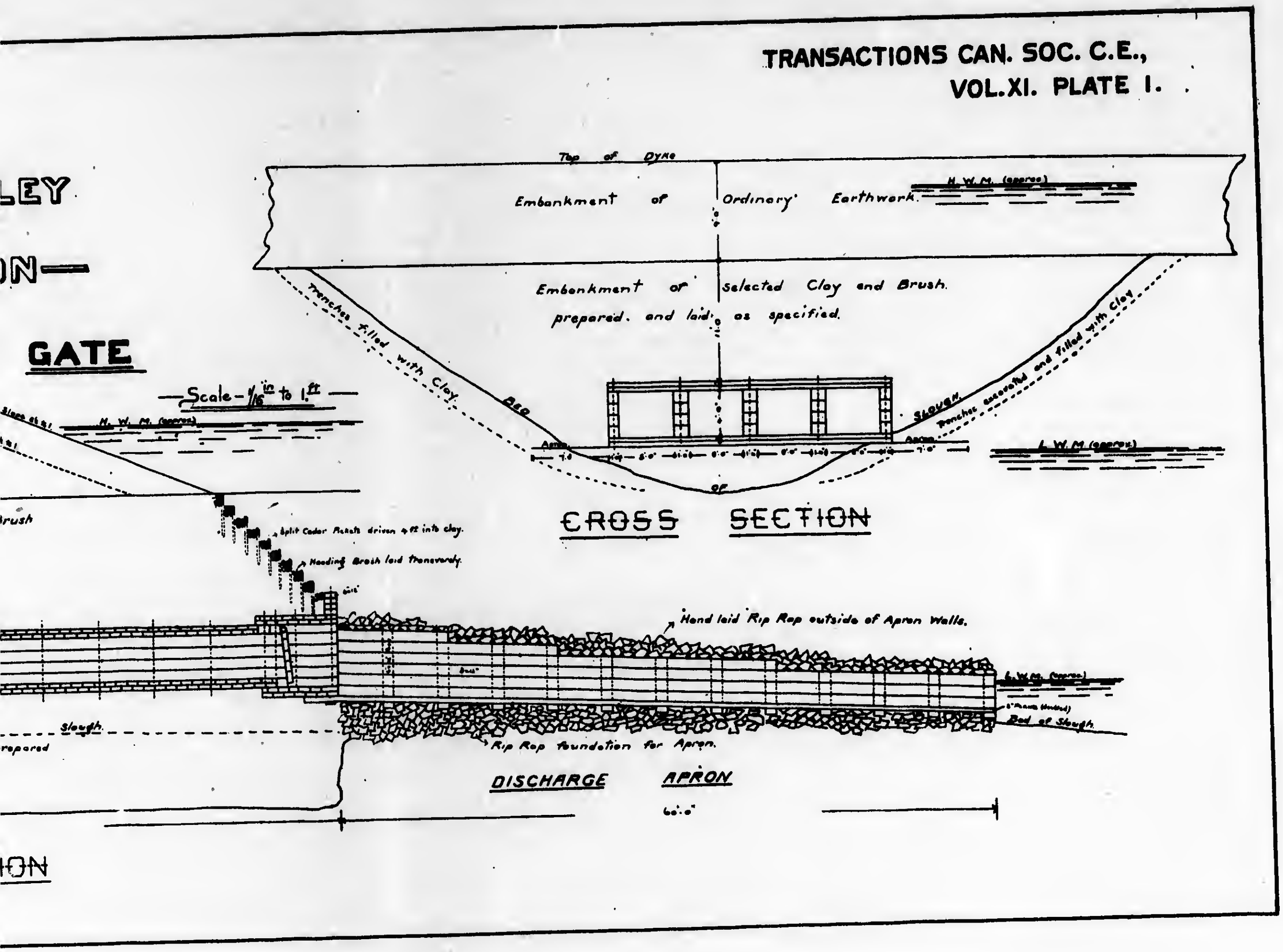
TRANSACTIONS CAN. SOC. C.E.,
VOL.XI. PLATE I.
LEY
ON—
GATE
Scale - 1/16 in to 1 ft
Top of Dyke
Embankment of Ordinary Earthwork.
H. W. M. (approx.)
Embankment of selected Clay and Brush.
prepared. and laid as specified.
Trenches filled with Clay.
Trenches excavated and filled with Clay.
SLOUGH
L. W. M. (approx.)
CROSS SECTION
Split Cedar Pickets driven 4 ft into clay.
Heading Brush laid transversely.
Hand laid Rip Rap outside of Apron Walls.
Slough
Rip Rap foundation for Apron.
Bed of Slough
DISCHARGE APRON
60'-0"
ION

... lls, and as the

of sand being fine. This when left in its natural bed, and not dis-
turbed is impervious to water but once it is moved and displaced

tides are subjected to a very severe test and strain during high water. They are often subjected to a pressure of water due to a head of from 18 to 20 feet and lasting from a month to six weeks. On the other hand, those located on that part of the river affected by tidal waters are relieved twice every day during ebb tide.

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hold the brush and earth, afterwards conveyed in, from being swept down by the current so soon as it was deposited.

At first it was considered practicable to commence this sheet piling at one side, and continue along, finishing at the other, but it was found that the banks were of such a treacherous nature, that the increased current due to the narrowing of the channel would scour away the banks more quickly than the sheet piles could be driven, and thus destroy the location of the box. It was then decided to commence at both ends, make them thoroughly secure, and work toward the center. This was done, the sheet piling from each side being closely followed by labourers dumping earth to form an embankment on the upper side of the crib, keeping plenty of brush on the outside, to prevent the earth being scoured away by the current. After having proceeded thus toward the center, and when the current became too strong due to the narrow opening to hold the earth from being washed away, the gap in the sheet piling was closed, and the backing deposited as soon as possible. But the material in the bottom of the slough was of such a treacherous nature, that no sooner had the water on the upper side begun to rise on the piling than it broke through underneath, the water following the piles down, where it encountered a coarse red sand, which was soon scoured out, and in a very short time an open channel was made underneath the piling.

Sacks were immediately obtained and filled with earth (about 1,200 of them), and these dumped into the channel or hole with loose hay and earth, finally held the current until a large earth embankment was built across. No more trouble was afterwards encountered, although it was subjected at one time to a pressure due to a 27 foot head. The lower dam was built in much the same way, but with less difficulty, there being only a 4 feet tide to contend against.

The specifications required all ooze, logs, sticks or perishable matter to be removed from the bottom of the slough, between the two dams, to a maximum depth of 6 feet below the bottom of the box, in order to secure a proper foundation on which to lay the brush and clay. Should the material below that be soft and mushy, then wild hay was to be tramped in below that again, until a firm bed was obtained. But it was to be left to the judgment of the engineer as to how deep up to the six feet the excavation was to be made.

After having pumped out the location—a centrifugal pump with a 4 inch discharge having been used with a maximum lift of about 15 feet—the bottom of the slough was carefully examined and the material tested. The first 2 feet or thereabouts consisted of ooze, slime, brush, logs, stumps and every imaginable kind of worthless matter. Beneath this for from 4 to 6 feet was a bed of silt, of a bluish color, containing minute particles of mica, and very gritty to the touch, but the particles of sand being fine. This when left in its natural bed, and not disturbed, is impervious to water, but once it is moved and displaced, and exposed to the action of water under pressure, it becomes a veritable quick-sand. Beneath this was a bed of fairly course red sand.

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After having been enlightened as to the nature of the bottom, it was decided to lay the foundation upon this bed of bluish silt, without disturbing it more than necessary. This was done after all the decayed material—logs, ooze, etc.—had been removed from the bottom,

and all roots, slides and loose material cleaned off the sides of the banks, and proper slopes of about 1½ to 1 excavated from them. The foundation under the box proper was built up of clay and brush, that under each apron of rip-rap.

CLAY.—The specifications for the clay read as follows:—"To be of first class quality, and when kneaded stiff into a pyramid of an inch or so in height, and immersed in water, will remain intact for 24 hours without crumbling."

BRUSH.—"To be of green bushy fir or cedar trees, of young growth, not more than 15 feet in length, when the stem is cut close to the head, which it shall be, or limbs similar in character."

The separate limbs were afterwards practically excluded, and brush allowed much longer than specified, which served the purpose better. The first intention of the writer was to obtain the clay from a bed about a mile up the slough, above the site of the box; but after the temporary dams had been built, a great quantity of rain fell, and as the off-take never was intended to carry off all the drainage, the water backed up, so that the clay could not be reached. Another bed of blue clay of excellent quality was then located on the river bank, about two miles below the mouth of the slough, and was conveyed by steamer and scows at a heavy expense.

FOUNDATION.—This was laid as follows:—A bed of this clay was deposited on the bottom of the slough about 2 feet in thickness, and 80 feet in length, that is under the site for the box proper. This was laid in layers a few inches in thickness, carefully spread and levelled, and well tramped and pounded down. On top of this was laid a row of brush with butts to the end. These small trees were laid close together longitudinally, from one side of the slough to the other, and at one end of the foundation. The branches standing up were "nicked" in order to let them lie close. After the first row was laid, another was placed on top partially covering the first layer, similar to shingling a roof, butts all lying out in the same way as number one row. Then another row was laid in a similar manner, until the layer of clay below (80 feet in length) was covered for about two-thirds the distance from one end, or between 50 or 60 feet. After this had been completed a layer of clay was laid on top from 1½ to 2 feet in thickness, covering the whole foundation. This was thoroughly compacted, and tramped down with horses and then levelled up. Upon the top of this clay was laid another layer of brush similar to the lower layer, but this time commencing at the opposite end of the foundation butts out, and extending for about two-thirds of the way towards the first end, and thus overlapping a portion of the first layer of brush, but care being taken that there was a good layer of clay between, so that the brush in no instance would be continuous through the entire length of the foundation. Upon the top of this was laid another layer of clay similar to the previous layer and so on, until the proper height was obtained to lay the box.

The accompanying plate is intended to show a longitudinal section through the foundation.

When the foundation reached the required height, it was carefully levelled off and made ready for the box. The lower planks of the box floor (5 x 12 x 26 feet) were then laid close together, each one being levelled up and pounded down with a heavy pounder, until it lay on an even bed throughout, in contact with the clay. Upon the top of this floor was built the box as shown on the plan.

From the box to each bank of the slough was laid clay and brush in a similar manner to that in the foundation, care being taken that in no case should the brush extend in a continuous layer right through the embankment, or that it should touch the sides of the box. The clay was laid in thin layers and thoroughly tamped and pounded down, especially close to the box, and also carefully knitted into the banks on each side by key walls. A brush and clay embankment laid in this manner was carried up on each side and on the top of the box, until the top of the banks of the slough were reached, with the exception that,

after the top of the box level was reached, the slopes on each end were carried up by driving split cedar pickets about 3 inches in diameter and 6 inches apart, 4 feet into the embankment,—each row being 1 foot higher than the preceding one, and 1 foot nearer the center of the box, thus making a slope of 1 to 1 at the ends. Behind, or inside each row of pickets, was laid "heading brush" or brush laid transversely with the box to keep the clay in place. From the top of the bank of the slough, a dyke of ordinary earth work was built to the height of the river dyke, about two feet above maximum high water.

The aprons were built as shown on the plan, the walls flaring out from the ends of the box to the end of the apron, and rip-rap being hand laid outside of the walls upon the floor, to load it down. From the rip-rap walls to the banks, the slopes were built of rough brush and ordinary earth, laid in a similar manner to the clay and brush.

GATES OR CLAPPERS.

The gates or clappers used on the box, a detail of one of which is shown on the plan, are of the "top hung" pattern. A difference of opinion seems to exist among the engineers of this district, as to advantages derived from that style over the "side hung" gate. The trouble experienced with the gates on this box was as follows: when the freshet first begins to come, the river only rises a few inches in 24 hours, and, according to the state of the weather, may in its steady rise never exceed 6 to 12 inches in one day. Consequently, the gates not being hung perpendicularly, but when closed have a batter of about 1 inch in 12,—the water keeps running in underneath the clapper, filling the slough inside, as quickly or nearly so, as the river rises outside, and the clapper to all intents and purposes floats on the stream, there being practically no pressure against it, at least not enough to close it. Weights were attached to the bottom of the clapper which assisted materially in closing them. In the case where the water rises rapidly outside, as in tidal waters, no trouble is encountered, for once it begins to rise, a head very rapidly forms, and the gates will close with a sound as of the discharge of a cannon. Another disadvantage of the "top hung" gate is this: when the slough is discharging, the water inside as a rule is very slightly higher than the falling water outside. Also there are always more or less branches of fallen trees, sticks, pieces of logs, etc., being carried out through the boxes. These must necessarily pass underneath the slightly opened clappers, and in many cases are caught between the floor of the box and the bottom of the gate. Then when the tide changes, and the water turns to flow back into the slough, the debris prevents the particular gate from closing. Well designed grillages both above and below the gates ward off much of the debris, but notwithstanding this it is impossible to keep some branches, fence rails, etc., from passing through.

In the "side-hung" gates, less trouble is encountered from this. Here the gates are hung in pairs, closing at the center of the openings, the debris can then float upon the top of the water, and not being dragged along the bottom of the box, has only the two edges of the gates to encounter, and the gates being evenly balanced, will open enough to allow the debris to pass through. This difficulty of course is only encountered when the head on either side is small, and the gates in consequence are very slightly opened. In "side hung" gates there is a slight disadvantage in that it is very difficult to prevent the gates from sagging through length of time, which prevents them from closing tightly. They must be well designed with very heavy and strong hinges.

In many of these boxes on the Fraser, the gates are hung on the outside of the box, and have an advantage that they are more easily reached should anything prevent their closing during high water.

These gates cost practically $10,000 each.