
REPORT

ON THE

COMMISSION

APPOINTED TO ENQUIRE INTO THE CONDITION OF

NAVIGABLE STREAMS:



OTTAWA:

PRINTED BY I. B. TAYLOR, 29, 31 AND 33, RIDEAU STREET.

1878.

RETURN

To an ADDRESS of *The House of Commons*, dated 26th March, 1873; For the Report made by the Commission appointed to inquire into the condition of navigable streams.

By command,

J. C. AIKINS,

Secretary of State.

Department of the Secretary of State,

OTTAWA, 31st March, 1873.

OTTAWA, March 31st, 1873.

SIR,—I am directed to transmit the accompanying Copy of Report of the Commission appointed to inquire into the Condition of Navigable Streams, called for by an Address of the House of Commons of the 26th inst., which is returned herewith.

I have the honor to be, Sir,

Your obedient servant,

F. BRAUN,

Secretary.

E. Parent, Esq.,

Under Secretary of State.

REPORT OF THE COMMISSIONERS APPOINTED TO ENQUIRE INTO THE ALLEGED OBSTRUCTION OF NAVIGABLE STREAMS AND RIVERS BY SAW-DUST, &c.

OTTAWA, February, 1873.

F. BRAUN, Esq.,

Secretary, Department of Public Works.

SIR,—In laying before the Honorable the Commissioners of Public Works for the Dominion, this our Report upon the results of our examination and enquires into the subject submitted to us, in your letter of the 14th November, 1871, we consider it expedient, in the first place, to quote that letter in full:—

"SIR,—I have the honor to inform you, that by Order in Council, bearing date 6th November inst., with the view of carrying out the recommendation made by the Committee of Parliament on Banking and Commerce, you have been commissioned, conjointly with John Mather, of Chelsea, and R. W. Shephard, of Montreal, Esquires,

"to enquire into and report on the alleged obstructions of navigable streams and rivers, in the Provinces of Quebec and Ontario, by deals, edgings, saw-dust, and other refuse from sawmills.

"The Commission will please ascertain in time to allow the Minister of Public Works to have a report laid before Parliament at its next session (11th April, 1872), whether the complaint made of navigable streams and rivers being so obstructed, are well founded; and what means should be adopted to prevent such obstruction in future, keeping in view the legitimate interests of mill owners and manufacturers.

"I have the honor to be, Sir,

"Your obedient servant,

"F. BRAUN,

"Secretary."

"Honorable H. H. Killaly,
"Toronto."

In reply to this communication "the gentlemen named expressed their willingness to undertake the performance of the duties involved in the Commission"; and Mr. Killaly (elected Chairman of it) added, that all possible diligence would be used so that the report should be made *as soon* as practicable, which, however, in a great measure, must unavoidably be governed by the nature of the weather. He also suggested that time might be saved by the Commissioners being furnished with a copy of the complaints given in evidence before the Parliamentary Committee."

On the 11th January, 1872, the Chairman received the following telegraph from the Department:—

HON. H. KILLALY,

"Please state whether your Commission has commenced *enquiry*, and, if possible "When report may be expected."

F. BRAUN.

The answer to this was that the nature of the matter, and the frozen state of the rivers, had, up to that date, utterly precluded the possibility of our making any examination of them; but that we had been in communication with several parties in Canada and elsewhere, upon the subject, from whom we trusted to receive information of value, and which would facilitate us in the discharge of our duties.

From the importance of the subject and the magnitude of the two great interests (the lumbering and the navigation) specially involved in it, and which seemed to be in some measure antagonistic, we felt fully convinced that mere enquiries on our part could not enable us to make a report that would be entitled to much weight; and that to lay the matter so fully before the Minister, as would enable him to meet the requirements of the Committee of Parliament, a thorough and personal examination of all the important points on the principal rivers was absolutely indispensable, and that such an examination should be attended by a close comparison of the relative heights of the rivers at different times, in reference to extreme low water, as well also by numerous borings, with suitable instruments, by which specimens of the material forming the beds of the rivers, taken from many places and at various depths, could be brought up. It was obvious that such inspections and trials should be made at different stages of the rivers.—First, immediately after high water, upon the "break up," in order to determine whether, as is alleged by some, all the saw mill refuse, thrown in the preceding summer is annually carried off by the floods or not—a similar examination is equally as essential in summer low water, in order to ascertain the nature and extent of the bars (if any) represented to have been made, to the serious detriment of the navigation. Again, shortly before the setting in of winter, when the mills had ceased to work, it is highly desirable to find where the great mass of waste, discharged into the river during the whole of the preceding summer, had lodged;—this point being fully established, a final examination in the suc-

ceeding spring would settle the question, beyond all doubt, as to whether obstructions to the navigation are, or are not, created by the throwing of the waste from the saw mills into the river.

During the portions of the past year whilst the frozen state of the river rendered a practicable inspection of them impossible, we were not remiss in seeking to collect information from several persons in the adjoining States, and the Dominion, whose acquirements and pursuits, we conceived, justly entitled their opinion to careful and unbiassed consideration, in doing this, we have at the same time, spared no pains to satisfy ourselves, by *personal examinations* and close observation of the facts so far as it was possible for us to do in the course of one season.

Our first step, before going upon our inspection, was to send to each member of Parliament of the Provinces of Quebec and Ontario, and also to other parties whom we considered informed or interested in the subject of the enquiry, a copy of the following circular:—

OTTAWA, June 8th, 1872.

To ——— M. P.

"SIR—The undersigned, who have been appointed by the Government, Commissioners to enquire into and report as to the effects produced by the discharge into the navigable streams and rivers of the Provinces of Ontario and Quebec, (as regards the navigation thereof) of the waste from saw mills, saw-dust slabs edgings, &c., take the liberty of requesting you will be so good as to suggest to them, through their Chairman, the names and localities of any such rivets and streams in your County, to which you may consider their attention should be directed.

Yours respectfully,

"HAMILTON H. KILLALY, Chairman, Toronto,
"R. W. SHEPHERD, " Montreal,
"JOHN MATHERS, " Chelsea."

To these circulars we received replies from the following gentlemen, viz:—

J. J. Robitaille, Esq., M. P., County of Bonaventure.	
Charles Clarke, " "	Wellington,
George McManns, " "	Cardwell,
John J. Grange, " "	Lanark,
George Kempt, " "	Victoria, N. B.,
J. C. Wood, " "	Victoria, S. R.,
H. Finlayson, " "	Brant,
S. McCall, " "	South Norfolk,
J. S. Smith, " "	North Middlesex,
Samuel Ault, " "	Stormont,
Thomas Gibson, " "	Huron, N. R.,
Hon. A. McKellar, " "	Bothwell,
William Barber, " "	Halton,
M. P. Ryan, " "	Montreal City,
Thos. Street, " "	Welland,
McKenzie Bowell, " "	Hastings,
Louis Sylvester, " "	Berthier,
R. S. Cartwright, " "	Lennox,
A. Oliver, " "	Oxford.

We commenced our inspections with the River St. Maurice. On our arrival at Three Rivers, we called upon Mr. McDougall, M. P. for the town. He introduced us to Mr. Gerin, M. P., and Mr. Godin, M. P. To all these gentlemen, and to Mr. Symms, Superintendent of the River Works, we are much indebted for the information they afforded us, and also to the Messrs Baptiste, who kindly placed their steamers at our disposal, thereby much facilitating our examination of the River. We were accompanied

on our inspection by Messrs. McDougall, Gerin, Godin, and Symms, and by several of the leading inhabitants of the town. Mr. McDougall informed us that he and his brother are the proprietors of the "Forges," about six miles up from the mouth of the river; that they are deeply interested in the maintenance of the navigation, inasmuch as they carry the greater part of their supplies and iron upon it in batteaux. They have never suffered any inconvenience from the saw dust, slabs, edgings, &c., which are all thrown into the River, at the saw mills of the Messrs. Baptiste, situated at the head of the Grais Rapids, about 9 miles above the "Forges." From the head of the Grais to the Shawenagan Rapids, about 11 miles, the river is unfitted for navigation, by a series of strong currents and rapids. The amount of lumber annually made at this mill is about ten millions of feet; as already stated, all the waste from this mill is thrown into the River. Almost the entire of the slabs and edgings are, in the first instance, caught by the rough rocky bottom of the rapids, which extend some distance down the river, but above the navigable portion of it. They there accumulate, and form "Jams," which, however, never remain for any length of time, being carried away by each succeeding freshet. A portion of the saw dust is deposited upon the shores of the River, all along down to its junction with the St. Lawrence, but none in the channel to the detriment of the navigation. The chief part of it is carried into the St. Lawrence, and no more heard of. The floating slabs and edgings, &c., when freed from the "Jams" in which they had been at first detained, are eagerly collected and carried off for fuel by the poorer people, many of whom we observed so occupied.

The opinion given us by Mr. Symms fully confirmed Mr. McDougall's statements, and were further corroborated by our own soundings and observations. We closely examined several parties, residing in the vicinity,—the uniform answer from each was, that he never had heard of, or known any complaint made of obstructions to the navigation, from saw dust deposits.

We next proceeded to examine that part of the River from the Bridge to the St. Lawrence, a distance of about $1\frac{1}{2}$ mile, taking the opportunity of inspecting the very extensive and fine new saw mill on the west side of the St. Maurice, the property of the Messrs. Stoddart and Company. The gentlemen we found in charge freely gave us all the information we asked for.

The lumber annually made at this mill is about twenty millions of feet.

The small portion of saw-dust not consumed in the furnace, is all carted to form and level the piling ground. The whole of the slabs, edgings, sidings, battings, &c., is converted into fence pickets, sash and other stuff, and fuel wood: this latter item, alone, contributing to the company from twenty to thirty dollars daily, thus conclusively proving that it is perfectly practicable, economical, and the true interest of the proprietors of all such concerns to utilize every portion of their timber; the people in the vicinity are, at the same time, greatly benefited, by being enabled to procure, for the trifling sum of about fifteen cents, a full cartload of firewood.

At the mouth, or, rather, the mouths, of this river, for by islands near the St. Lawrence it is divided into three branches, (hence the name *Three Rivers*,) there are very extensive shoals, obviously formed of the vast quantity of detritus (chiefly fine sand) brought down annually, and deposited in the eddies, which may be said to extend wholly across the entire river. These eddies are caused by what may be termed the struggle of the waters of the St. Maurice with those of the St. Lawrence, where they meet; the strength, position, and direction of these eddies are very much influenced by the constantly occurring variations in the levels of the waters of both rivers, the periods of which do not coincide. They are also much affected by the high winds which occasionally are felt there in great violence. The inevitable consequence of all this is repeated and sudden changes in the position and character of the bars and channels. A navigable channel, which had been on the west side of the river in one year, for some months, will be found in a short time closed up perfectly, and in its place a bank of sand; a channel in a totally different place being cut at the same time. Such changes, to a greater or less degree, are constantly occurring.

On our inspection of Messrs. Stoddart's mill, complaints were made that they were much troubled by bars formed about their boom, which they attributed to the slabs and saw-dust thrown into the river above, being collected and deposited there. We took particular pains to investigate the matter.

We found that in order to collect and retain their logs, a very long boom had been constructed, extending from their mill to a pier above the bridge, sunk for the purpose. This boom is, on an average, about 150 yards from the bank, and parallel to it, or nearly so. The direction of the boom is maintained by a series of piers sunk at certain distances apart, and rather overlapping each other. They are met by the current somewhat obliquely. We observed down stream of each of those piers, a considerable bank of sand was formed. The space between them and the shore was thereby rendered nearly slack-water, and the current all but stopped by the mass of logs, lying on the bottom of the pond, which is, therefore, rapidly filling up, and must continue to do so. The banks of the river are high and perpendicular, and consist of fine sand. In any, even in very moderate winds, great quantities of this sand are blown into and remain in the dead water within the boom.

On examining the bars very carefully, and in several places, we could detect but a very minute portion of woody matter, and we came to the conclusion that the piers are the chief cause of what the Messrs. Stoddart complain. Some few years ago, a deep channel lay nearly in the line of the boom, where, at present, a saw-log can scarcely float; owing, in our opinion, to the effect of the piers upon the current.

On the island in the east channel, are two fine steam saw-mills, owned by Messrs. Baptiste, at which some ten millions feet of lumber are annually produced.

Before leaving Three Rivers, being not far from the Rivers Batiscan, Bécancour, and St. Anne-en-bas, we thought it desirable to extend our enquiries to them, although not referred to in any one of the answers to our Circular.

THE BATISCAN.

Batteaux, capable of carrying from eighty to one hundred cords of firewood, ply in this river as far as St. Geneviève, which is about eleven miles from its mouth.

Mr. Price is the owner of a saw-mill upon this river, situate about five miles higher up it. The produce of this mill is set down at about eight to ten millions of feet, annually. The lumber is carried down from the mill by means of a long shoot or "dahl," of three miles in length. It is then loaded at a wharf into barges, and sent off.

This mill is worked by water, and the waste from it is discharged into the river. It is detained at first in the long rapids, but is carried off by the next floods. No complaints are or have been made of any inconvenience or impediment to the navigation.

THE BÉCANCOUR AND THE ST. ANNE-EN-BAS.

From the information we received as to these rivers, we did not consider that the object of our Commission required our visiting them; we accordingly proceeded thence to Ottawa, to examine that most important river, whether as regards its magnitude, or the importance of its navigation, which it is contemplated to extend, so as to make it a thorough and uninterrupted water communication, connecting Lakes Huron, Michigan and Superior with the cities of Ottawa, Montreal and Quebec.

There being naturally very conflicting opinions entertained and expressed upon the subject of our enquiry, this seems to us a very fitting place to state the order in which we propose to treat it, so that both sides of the question may be impartially considered.

1st. To give a résumé (see page 6) of the allegations in the petition (see Appendix No. 1) presented to the House of Commons, against the Bill, intitled, "An Act for the better protection of Navigable Rivers and Streams," signed by Messrs. Gilmont & Co., and seventeen others.

2nd. Of the opinions and views expressed in their respective reports and answers, laid before us, of all those (many of them gentlemen of high standing) who believe

that no injury accrues, or is likely to accrue, to navigation by the discharge into the rivers of all the saw-dust produced by the mills on the Ottawa and its tributaries (See Appendix 2 to 23, both inclusive.)

3rd. Of the opinions and views of parties, of equal authority, with which we have been furnished, who contend that such disposal of saw-dust is prejudicial to navigation (See Appendix Nos. 24 and 25.)

4th. To show how far those conflicting statements and opinions are corroborated, or otherwise by our own trials and observations.

After doing this, having already stated the results of our enquiry upon the Bécancour, Batiscau, and St. Anne-en-bas, we shall proceed with a statement of the examinations and observations we have ourselves made upon the condition of the

Shannonville River.	Bobcaygean River.
Napanee "	Fenelon Falls "
Moira "	Scugog "
Lower Trent "	Muskoka "

Finally, we shall conclude our Report by explaining the means we recommend to be at once adopted by legislative enactments for the protection of the navigable streams and rivers within the Provinces of Ontario and Quebec, as being, in our opinion, the most expedient under all the circumstances, in the interests of these two great sources of Canadian industry:—The lumbering, and the navigation. In November, 1871, a Bill, intituled, "An Act for the better protection of navigable Streams and Rivers," was introduced into the House of Commons by Richard J. Cartwright, Esq., M.P. for the County of _____ . After the preamble the following enactments were contained:—

Section 1. That from and after the first day of July, 1872, no owner, tenant, &c., &c., of any saw mill shall throw, or cause to be thrown, or permit to be thrown, any saw-dust, edgings, or rubbish of any description into any navigable stream or river, either above or below the point at which such stream or river ceases to be navigable.

Section 2 declared the penalty for violating the preceding section, for the first offence, a fine of not less than twenty dollars, and for the second and each subsequent offence, a fine of not less than fifty dollars for each offence, and by this section also was declared the manner in which the fines were to be summarily recovered.

The third Section made it the duty of the several fishery officers to examine and report upon the state of the navigable streams and rivers, and to prosecute all parties contravening the terms of this Act.

By the fourth Section, it was provided, that in cases where it was clearly shewn to the satisfaction of the Minister of Marine and Fisheries, that no injury is accruing, or likely to accrue to the navigation of any stream or river, he might, by proclamation in the official *Gazette*, exempt from the operation of the Act, the whole, or any part, of such stream or river, lying above the point where it ceases to be navigable.

The introduction of this Bill was immediately followed by a strong petition to the House of Commons (see Appendix No. 1), signed by Gilmour & Co., and seventeen others, chiefly connected with the mills upon the Ottawa, and its tributaries. In accordance with the arrangement which we laid down for making our report (as explained on page 6) we now proceed to give a resumé of the allegations in the petition, viz:—

That petitioners represent a very large capital, invested at the Chaudiere and elsewhere on the Ottawa and its tributaries; employing at least 8,000 men, and 3,000 teams producing a very large addition to the exports of Canada, amounting to four hundred millions feet of lumber, and four millions of dollars of value annually.

That the proposed legislation, with regard to the navigable streams and rivers, will most injuriously affect those interests, as it is impossible to prevent saw-dust from mills, driven by water, falling into the water, and consequently the enforcement of the Bill would compel them to close their mills, and to remove to other localities where steam power can be used.

That they fully recognize the importance of maintaining the navigation of the Ottawa River; but that they are in a position to prove, as well from the result of actual investigation of the River Ottawa, as from the experience of similar operations, of fifty years past on the Hudson and Penobscot Rivers, that navigation is not injured by the falling into them of *saw-dust*, which is yearly carried off by the spring freshets.

That the petitioners therefore prayed the subject might be fully investigated and opportunity be afforded them to submit scientific and practical evidence, in support of the allegations of the petition.

Upon consideration of the Bill, and the arguments and evidence adduced *pro* and *con*, and opportunity afforded to gentlemen to appear and address the Committee in opposition to it. It was moved by the Hon. M. Cameron, member for the County of Peel, "That the Committee are not in possession of sufficient information to pass the Bill now before the Committee, and that they report to the House, that by commission or otherwise, as the Government may determine, information be obtained on the subject, to be laid before the House at a future period." This motion was carried, and the following report (in substance) was made to the House by the Select Standing Committee on Banking and Commerce, signed, Alex. Morris, Chairman *pro tem* :—

"That the Committee had considered the Bill, the object of which is to put an end to the practice of throwing saw-dust, edgings and other mill rubbish into navigable rivers, tending (as assumed by the Bill) to obstruct the navigation; that upon this point the Committee are entirely without evidence, and as it is a matter of serious importance, they report the Bill back to your honorable House, and beg to recommend this subject to the consideration of the Government, with a view to an enquiry by a commission or otherwise." Signed Alex. Morris, Chairman *pro tem*.

During the discussion upon the Bill, Mr. Bronson, a proprietor of extensive mill^s at the Chaudiere appeared before, and addressed the Committee in corroboration of the allegations in the petition, and in opposition to the Bill.

This gentleman had spared no trouble or expense in procuring reports from undoubtedly eminent professional men, in support of the views of the petitioners, and also a large number of affidavits from various parties connected, more or less, with the milling interests, on the Hudson above Troy, and with the navigation of that river, and of the Champlain and Troy Canals.

We follow the arrangement adopted by us (See page 6) in here giving a resumé of the substance of these several reports and affidavits, which are to be found in the Appendix 2 to 23, both inclusive.

In all of them, the most decided opinions and statements, affirmed under oath, will be found, that *saw-dust* is not to be traced in combination with sand in the Bars created from time to time in those rivers and canals, and further, that in no case has the throwing of saw-dust been found to be injurious to the navigation.

The first of the papers in the above list (see Appendix No. 2), is a report, the date not given, made to Mr. Bronson, by Professor Green, treating the subject in a purely Engineering point of view, he puts the questions :—

- 1st. What are the causes which induce the formation of bars in navigable or other Rivers?
- 2nd. What materials usually compose such bars?
- 3rd. What are the specific gravities of these materials?
- 4th. What velocities of current are necessary to take up and transport these materials to the point of final deposit? After these, a fifth is indirectly added, What is the specific gravity of pine saw-dust, and the velocity of current necessary to take it up and transport it?

To these questions, clearly and logically put, Mr Green gives, in their succession, indisputable answers, so far as his theoretic calculations and experiments extend. The entire report, which is very voluminous, exhibits great research, and intimate acquaintance

with the best scientific authorities, both native and foreign, upon the subject on which he writes. This report is concluded thus:—

"In view of my experimental results, together with the facts observed by the U. S. Engineers upon the Hudson River, and in view of the experience of lumbermen and navigators upon the Hudson and Penobscot Rivers, I have formed the following opinions," viz:—

That saturated pine saw-dust will not be permanently deposited in water where the velocity of the current exceeds 0.25 of a foot per second, or one-sixth of a mile per hour. That water-logged chips may be deposited when the velocity of the current is less than 1.00 feet per second, or two-thirds of a mile per hour.

That saw-dust may accumulate in eddies and in still water, or where the velocity of the current is permanently less than 0.20 to 0.25 of a foot per second.

That bars of *saw-dust* and sand combined will not be formed under any circumstances, for the reason that when the velocity of the current is diminished so as to permit the deposit of sand, it is still more than twice as great as is necessary to hold and transport saturated saw-dust; and hence,

That saw-dust will not accumulate or be permanently deposited in rivers where sand bars occur, unless their exist expansions of the river below such sand bars, sufficient to make a cross section, more than double that at the side of the bar.

That if in low water saw-dust should accumulate in small quantities, *the accelerated current of the first freshet would take it up and sweep it down stream*; and finally,

That it is extremely improbable that the minimum freshet velocity in the Ottawa River, ever falls below 0.25 of a foot per second, there is no reason to anticipate the formation of permanent or troublesome bars, or accumulation of saw-dust in that river.

"This opinion may be modified or strengthened when more definite and precise information shall have been obtained in relation to the magnitude of the Ottawa River, its water shed and other characteristics.

I am, &c.,

D. M. GREENE,

Civil Engineer.

H. F. BRONSON, Esq.,
Ottawa, Canada.

His reference to the *Penobscot River* is short. "That sworn statements have been obtained of persons who have been engaged upon, and are acquainted with the *Penobscot River*, in the State of Maine, which runs through a pine timber region, upon which very extensive lumbering operations have been conducted for many years, and into the waters of which vast quantities of saw-dust and edgings are and have been cast. These statements shew that accumulations of *saw-dust alone* in the channel of that river, have never been known, and that no injury, impediment, or obstruction to its navigation has ever resulted from the casting of saw-dust into it."

Professor Green's second report, (see Appendix No. 3,) also made to Mr Bronson, is dated 10th March, 1871. He states in the commencement of it, "that since his arrival in Ottawa, he had been put in possession of such information, in regard to the magnitude, character and habits of the Ottawa River, as would enable him to form a more definite and decided opinion as to the possible effect upon navigation, which may be produced by casting the saw-dust into the river at this point."

That the information furnished him by A. J. Russell, Esq., of the Crown Lands Department, shewed, that the extent of territory drained by the Ottawa and its tributaries, above the City of Ottawa, is 43,000 square miles;—that between the City of Ottawa and Grenville, is 19,000 square miles;—and that 4,000 square miles are drained below Grenville;—the extent of territory drained by the Ottawa, and its tributaries above the City of Ottawa, is 43,000 square miles; above Grenville, 62,000 square miles; above Montreal, 66,000 square miles.

Nearly the whole of this second report is taken up with calculations of the velocity the water at various points, between the City of Ottawa and the foot of the Lake of the Two Mountains, and they are principally based by Mr. Greene upon the breadth of the river and lakes, and the soundings shown upon the maps respectively prepared under the direction of Mr. Shanly, and of Mr. T. C. Clarke, civil engineers, to accompany their reports upon the proposed improvements of the navigation of the Ottawa.

In concluding this, his second report, Mr. Greene says, "samples of material, six in number, taken from the shoal places in the Ottawa, between the City of Ottawa and Grenville, have been shown me. These materials are wholly composed of pure clean sand, of different degrees of fineness, not the slightest indication of the presence of k.w.-dust can be detected in any of the samples, even when examined under a glass."

"As the result of this further investigation, together with the examination which I have made of the materials taken (shown to him) from the shoals on the Ottawa River, the opinions which I have expressed in my former communication, are not only confirmed, but are very materially strengthened, and I now feel no hesitation in expressing the opinion:—

"That saw-dust obstructions have not thus far been formed in the channel of the Ottawa River, and

"That there is no reason to apprehend the formation of such obstructions in the future."

Having in the above closed our resumé of the opinions of Professor Greene; as stated in his two reports, (see Appendix 2 and 3,) we proceed to give a similar one of the opinions of Mr. McAlpine, as shewn in an affidavit (see Appendix No. 4) made by him, before E. M. Wood, Esq., a Commissioner of the Circuit Court of the commonwealth of Massachusetts, dated Feb. 16, 1871.

In this affidavit Mr. McAlpine deposes that he has had charge of the enlargement of the Glen's Falls Feeder, and the reconstruction of its locks, and also of the Champlain Canal, and (during his term of office) of the removal of the Castleton bar, in the Hudson River, about six miles below Albany.

That he has had to pass over the Champlain Canal and the feeder frequently during the time the workmen were removing the deposits from the bottom of these canals, the character of which deposits he has accurately noticed.

That he has never seen or heard of any accumulation of saw-dust in any part of the channels of these canals, or of any obstruction from such to the navigation of the Hudson River above Glen's Falls, nor below Fort Edward (the river between these two places being an almost continuous rapid.)

That during the removal of the Castleton Bar, he frequently examined the material excavated, and never observed any deposits of saw-dust, but has seen sunken logs and decayed wood.

That the sand used for the masonry of sundry public works, was, by his directions, taken from the Hudson River bars, in consequence of its entire purity and freedom from woody matter:

That he has also had occasion to examine the deposits made upon many other rivers of the United States, where large lumbering operations were carried on, as on the Delaware, Susquehanna, and some in the Western States.

That he has never seen or heard of any obstructions to navigation, caused by the deposition of saw-dust.

That from the inferior weight of long water-saturated saw-dust, to that of even the finest sand, the former will always be moved forward by a current which just begins to deposit the latter, and hence, that the two would rarely be deposited in the same place.

That saw-dust will never be deposited where there is a current of more than one-fifth of a mile an hour, and only where there is almost no current, as in eddies, &c., and even if it should occur in any navigable channel, it would of itself form almost no obstruction

The next document upon the list is a report (per Appendix No. 5) from the Honorable W. J. McAlpine, made also to Mr. Bronson, dated Albany, March 1st, 1871, commenced by stating:—

That the subject under discussion, namely the effect upon the navigation of the Ottawa River, by discharge of saw-dust into it, had been carefully discussed by him and Mr. Greene, and

That together with his own he sends the report made by that gentleman, dated 10th March, 1871, in which he fully concurs. (See Appendix No. 2.)

"That there being no engineering authority giving the specific gravity of saturated saw-dust, or the velocity of current required to remove it, Mr. Greene had to resort to direct experiments, to determine these two points, necessary to the solution of the question involved. The results of his experiments are, that the specific gravity of water saturated saw-dust, or of its weight compared with water, is 1.05. The velocity necessary to remove coarse saturated white pine saw-dust, lying on a *smooth bottom* of a stream is 0.282 feet per second, equal to about one-fifth of a mile per hour, and of fine saw-dust, is 0.245 foot per second or about four-sixths of a mile an hour."

Here follow nearly verbatim the statements to be found in Professor Greene's report, and it appears therefore unnecessary to quote further in continuation from that of Mr. McAlpine. Towards the conclusion of his report Mr. McAlpine states that he has based his opinion "upon his observations of the upper and lower Hudson Rivers, not having examined the Ottawa; and further,

"That a considerable portion of the saw-dust thrown into the stream will doubtless accumulate in the side bays of still water, and sometimes perhaps, temporarily, in parts of the channel where previous obstructions have been produced by logs, brush, slabs, sand, &c., but in these cases it will be removed by the first freshet."

Mr. McAlpine concludes by reiterating what he had previously stated, that "he never had observed or heard of obstructions to navigation from the deposit of saw-dust."

We have given in the foregoing a just compendium or analysis of the statements and opinion upon all the essential points involved in our inquiry that are to be found, 1st, in the Petition presented against the proposed Bill, and 2nd, in the two reports made by Professor Greene, and in the one made by Mr. McAlpine to Mr. Bronson, as well as in the affidavit made by Mr. McAlpine upon the subject. These four documents, together with eighteen other affidavits were handed to us by Mr. Bronson, for our consideration in special reference to the Ottawa. To these latter eighteen affidavits we think it unnecessary further to advert, than to state, that several of them are made by gentlemen of high standing, and all by respectable parties, more or less connected practically with the lumbering and navigation on the *Hudson River*, and the *Champlain* and *Troy Canals*—also, that the substances of them all, go to substantiate the views and opinions given by Messrs. Greene and McAlpine. All of these documents were submitted in evidence to the Committee. [See Appendix Nos. 5 to 22, both inclusive].

The next step we have now to take is that described under head No 3, (see page 6,) namely, to give a *resumé* of the opinions and views of parties of equally high standing and attainments, who maintain that the *discharge of saw-dust into rivers is injurious to navigation, and should be prohibited.*

On referring to Appendix, Nos. 24 and 25, will be found two such communications, one from General Thom, Brigadier General in the United States Artillery, who was selected, a short time since, by his government, to make an investigation of very much the same character as that involved in the Commission entrusted to us.

The other is from the Hon. Mr. Muirhead, of Miramichi, New Brunswick, a proprietor of extensive saw-mills and wharves on that river.

It may be well here to observe, that the small number of documents affirming that navigation is injuriously affected by saw-dust, contrasted with the number of those to the contrary, we believe is owing to the fact, that much pains were taken to seek for and procure reports, affidavits, &c., in support of the latter, while no exertion whatever appears to have been made on the opposite side; had this been otherwise, it is question-

able whether at least an equal number of opposing affidavits would not have been forthcoming. From General Thom's communication (Appendix No. 24), it will be found the opinions he has formed are the results of his examinations of several rivers (in all cases, tidal rivers like the Hudson), are

" That waste, slabs, edgings and saw-dust, have been accumulating for the last forty years and more, to such an extent, as to have *greatly impaired the navigation* of these rivers.

" That this waste, in being thrown into the rivers, is carried up and down by the tidal currents, until, becoming heavily water soaked, it sinks in *slack water* or *eddies*, and forms *constantly increasing obstructions to navigation*. In all the rivers in the State of Maine, these obstructions, if formed of slabs and edgings, do not extend more than four miles below the head of tide water, as in the Penobscot River, and in the smaller rivers not more than one mile below it, whilst the *saw-dust* is, for the most part, carried by the current several miles further down, and deposited in the *slack water* and eddies of the bends and bays, there *forming extensive shoals*, shifting in their character, and *having narrow and crooked channels*.

" That, in the Penobscot River, these slabs and edgings have accumulated to a depth, in some places, of not less than eighteen feet, with an average depth of about ten feet, over an area of not less than two hundred and seventy-five acres, the solid contents of which are more than four millions of cubic yards.

" That it is but recently that these facts have attracted the public attention, to such a degree, as to have proved the necessity for the prevention in future, by *statute*, of the throwing in of slabs or edgings; but not, it is much to be regretted, that of *saw-dust* also.

" It is, however, believed that this will be prevented at an early day; so great is the damage caused by it, that, during the past two or three years, he has been very successful in the removal of these obstructions, by means of dredging machines, provided with buckets of a peculiar description, in which work, the difficulty consists, not so much in the excavation of the material, as in *disposing* of it afterwards; and to give an idea of the cost of removing the material, he states,

" That he has had a proposal, within the last ten days, made to him to excavate and remove about twenty-five thousand cubic yards, at *seventy-five cents per cubic yard*, by contract, which proposal he will probably accept. For General Thom's communication in full. See Appendix No. 24. Upon this same side of the question, the Hon. Wm. Muir head, of Miramichi, N. B., in substance states:—

" That there are a number of saw-mills, some driven by steam, some by water, on the Miramichi River.

" That some of the *steam mills* have been in the habit, for years, of depositing, and still continue to deposit, a greater part of the saw-dust made by them in the River, as well as bark, slabs, and edgings, most of which do not go far from where they are deposited, till they sink and remain there, which has been proved by the depth of water in the Harbours of the Rivers; especially about the wharves, where it is more perceptible.

" That fifteen to twenty years ago, at any of the wharves, there was twenty feet of water, but now there is not more than from 10 to 12 feet, causing wharf owners to extend their wharves nearer to the channel.

" That the material that composes the filling up is sawdust, *slabs*, and edgings, and other refuse matter, deposited from mills, mixed with a small portion of mud.

" That all the water-mills on the main river, as well as on its branches, deposit the most of their refuse matter in the streams, which has had the effect of *filling up* all *small harbours, coves and creeks* on the river, which is easily perceived by comparing them with what they were like a few years ago.

" That at one time the bed of the river, or at least along the shores and creeks, was composed of sand and gravel, but now is *chiefly refuse matter from sawdust*.

(Mr. Muirhead then proceeds to state the great destruction of the fish, caused by these deposits; of this, similar complaints were made to us upon our inspection of other rivers, but as this subject is not embraced within our commission we do not feel called upon to take any further notice of it.)

"That at some mills slabs and edging are rafted, under pretence of being taken away for fire-wood, but at night are set adrift, and lodge along the wharves and shores. A greater part of them are of pine and sink almost immediately after being put into the water. That the same custom exists all through the Province, but to a greater extent in the northern portion.

"That he strongly recommends the Government to take this matter into their careful consideration, and devise some means of preventing the depositing of all *mill refuse* in our rivers. If not attended to in time it will destroy our fisheries altogether, as well as interfere *seriously* with the navigation of our rivers.

"That the penalty for depositing any mill refuse in the streams should be punishable by imprisonment of the owner of the mill, or the persons in charge of the same, as there is no use in putting on a small fine, as they would sooner run the risk of being fined than be imprisoned."

The above closes our resumé of all the statements, arguments, and opinions, *pro* and *con*, with which we have been furnished.

We now come to report our own examinations and observations made during our inspection of the Ottawa, comparing, as we go on, the results and the conclusions we have formed from them, and shewing where they corroborate or conflict with the various opinions contained in the foregoing.

From Lachine to the foot of the Carillon Rapids we proceeded up the Ottawa in the steamer *Prince of Wales*. From the head of the Grenville Rapids we were conveyed up the river in the steamer *Queen Victoria*. On nearing such wharves as we stopped at we found a good deal of sawdust disturbed by the wheels.

From the very extensive saw mills at Hawkesbury it may be said that nearly the whole of the bark, slate, edgings, sawdust, etc., is discharged into the river; this wast, together with what is brought down from the other mills above Grenville, is soon caught in the rough, rocky bottomed rapids below, and forms, in sandy parts of them, large jams, which the succeeding freshet or flood carries away.—On coming up the river, we observed large quantities of it strewn along the south shore, below the rapids, and saw very little floating sawdust.

In the large bays and eddies above these rapids are very extensive shoals, standing over the surface of the water at the time we passed; from the distance we were at they appeared to be composed of pure sand; we did not examine them, however, as their position is out of the line of channel, and we were anxious to get to the portions of the river where the chief obstructions were alleged to exist.

From Grenville to Ottawa we did not meet with any obstruction whatever. On nearing the city we saw sawdust floating, but not in large quantities.

On arriving in Ottawa, in order to facilitate us in our examination, we engaged the services of the steamer *Fairy*, which we found well adapted to our purpose, and the intimate acquaintance with the river possessed by Captain Nichols, who accompanied us, enabled him to bring us to the several points where it was expected we could find obstructions in the channel.

We found the bay at the entrance to the Rideau Canal to be so fully obstructed and blocked up with logs, square timber, etc., that it was with very much difficulty and by pushing aside the booms and logs, that we could get to the lock. We lost so much time in accomplishing this that we had to postpone making our soundings and bearings.

Early the following morning we steamed down to McKay's Bay. Here we found an enormous mass of *sawdust* accumulated, where previous to it, there had been 40 feet of water. This pile was several feet over the surface of the river when we examined it. The end of a bar of *sawdust*, which runs out from the main mass down stream, lies from

40 to 50 yards within a line drawn from the upper to the lower points of the bay, and is consequently out of the direct course vessels take when going up or down the river. This bank or island of sawdust goes down ~~down~~ pretty rapidly towards the river, to the shore it gradually shoals in, and at present the beach there, that had been a convenient place for repairing vessels, booming lumber, etc., is now rendered useless. This great mass has been for several years accumulating, but in a greatly increased ratio within the last four or five years; during which same period the production of sawdust at the Chaudiere has been almost three fold. The extreme height of flood over low summer water at the site of this mass has been as much as twenty-two feet. Notwithstanding the greatly increased pressure by which it is thereby operated on, as well as its being subjected, more or less, to the influence of the torrent of water then pouring over the Chaudiere, so short a distance above it, the holding of its position, undisturbed by such great forces, is a *convincing proof of the tenacity with which sawdust will keep its place after being some time deposited.* Further proof of which may be found also at the mouths of several of the rivers below Quebec, where considerable deposits of sawdust, carried down from the mills above, remain in a *slimy state on the beach to this day, undisturbed by the roughness of the water in storms, or by the rapid current of the tides daily.*

We next proceeded to the bar near the mouth of the Gatineau; upon this we found from 9 to 10 feet of water; took various soundings, and made numerous borings with our boring irons, having a scoop at the end of them to bring up specimens of the bottom. Found this material to consist of very fine sand, which we consider is debris of Laurentine formation, and had been brought down the Gatineau from a great distance above the Ottawa. This sand, when examined by us immediately after *being taken up*, seemed to contain a very trifling admixture of woody matter; but in *these same specimens*, which we preserved, dried, and subsequently closely examined, we found the proportion of the woody matter or sawdust to be much greater than we could detect at first.

We then steamed down to the end of Kettle Island, and anchored at the head of George's Island for the purpose of examining the immense bank of deposit on the south side of the river, and from 2 to 3 feet over water at the level it then stood at. We found it very difficult to get the boring iron down; we also endeavoured to dig pits in several places, but from the nature of the sand we could not sink beyond 3 feet at most.

The surface of this bank is streaked all over with little seams made by the ripple of the waters. These seams are for the most part filled with sawdust. Over the whole surface of the bank chips and other waste is scattered, which, if the next freshet comes down rapidly will be all carried off, but if quietly, more sand will be deposited over it, as is the case at Petite Blanche. In sinking these pits we found at about one foot under the surface some chips lying in a dark deposit of muddy silt, which, no doubt, had been the surface of the bank at a previous period.

We perceived, here and there, large roots of trees and some saturated logs embedded in the sand, in some places partly over the surface. This sand also is composed, as we found it elsewhere, of debris of Laurentine formation. From the north shore across the river to the great bank of sand the water was too deep to permit of the use of the boring rods, from 20 to 22 feet in length.

Steamed further down to the mouth of the Petits Blanche, anchored here also, about 12 miles below the city of Ottawa.

A very considerable bank has accumulated here; on examination the surface of the bottom appeared to be pure sand, but on testing it with the boring iron in several places, *we found a considerable quantity of saw-dust mixed with the sand*; in one place we discovered, about 2 feet down, a regular *stratum of saw-dust, over which* was deposited pure sand; at three feet down, we found but a very trifling amount of saw-dust, and at four feet none.

From the case of the alternate layers of saw-dust and sand adverted to, we concluded, that although fresh *saw-dust* and sand cannot come down *at once mixed together*, as Messrs Greene and MacAlpine justly reason, still that such mixed deposits, can and do take place. A light freshet may bring down saw-dust, and deposit it, a subsequent one

of more strength will bring down sand; as Professor Greene states it would do, lays it down upon top of the saw-dust, and so on successively. The saw-dust, from its constantly increasing specific gravity and sliminess, will on the occurrence of heavy froshets be mixed up with the sand, but will not be carried off, as it proved in this case beyond doubt.

We now moved down to the mouth of the river La Rivere; there sounded along the navigable channel west side,—the water about 9 feet deep, a clear bottom, principally of coarse gravel,—in the channel east of the Island, about the same depth, the boring iron brought up saw-dust and sand mixed.

In front of the Island is a quantity of slabs, buttings, and saw-dust, but none in the navigable Channel of the river.

We then steamed to the Buckingham wharf, and waited for the *Queen Victoria*. In closing to the wharf we observed much saw-dust upturned by the buckets.

Next morning we proceeded to examine the Ottawa Bay, carefully commencing with that arm of it, from which the Rideau Canal enters.

We took the soundings in the line of the centre of the lock, at pretty even distances of about twenty feet apart.

We found the water on the stop-log of the lock, to be 8 foot 3 inches in depth, the river then being about two feet above low summer level. At 20 feet from the stoplogs, we found the water 8 feet 0 inches; bottom clear, stones, and gravel. At 40 feet from same, the water was 7 feet 9 inches, bottom gravel and stones with some remains of an old dam, not removed. At 60 feet from same, the water was 7 feet 0 inches, with similar bottom.

At 80 feet, water 8 feet, bottom, slabs and mill rubbish.

At 100 feet, water 7 feet 9 inches, bottom, slabs and rubbish embedded in saw-dust.

At 120 feet, water 7 feet 0 inches, bored 6 feet through rubbish, stopped by slabs and logs.

At 140 feet, water 6 feet 3 inches, bored 13 feet through rubbish, could find no bottom to it.

At 160 feet, water 6 feet 6 inches, could find no bottom to it.

At 180 feet, water 7 feet 0 inches, could find no bottom to it.

At about 170 yards from locks, 8 feet 6 inches water, bored 11 feet through rubbish, stopped by slabs.

From this point outwards towards the river the water deepens gradually, until we ceased to find bottom with an 18 feet rod; we had not sufficient depth of iron to test the bottom; below that depth reducing the level of the water as it stood at the time of our inspection to that of low summer level; the above soundings show that the depths, for 70 yards from the lock, would be but as follows, viz.:—6 feet, 5 feet 9 inches, 5 feet, 6 feet, 5 feet 9 inches, 5 feet 6 inches, 4 feet 3 inches, 4 feet 6 inches, 5 feet, 6 feet 6 inches.

In the shallowest places the upper three or four feet of the waste deposit was pretty loose, but at from six to eight feet down we found a very hard crust, difficult to force through, but when pierced with the boring rod a great quantity of very bad smelling gas was forcibly ejected from below. We were informed that this gas occasionally makes its way up violently, so much so that when the water is frozen to a considerable depth over the bank of sawdust, it upheaves the material of the bank with the ice on top of it.

From the Rideau Canal Entrance Bay we went up to near Pine Tree Island; we were accompanied by Captain McNaughton, whose services and assistance we gladly availed ourselves of. He is a practical navigator, possessing a thorough knowledge of the river, and well qualified therefore to guide us, as we requested he would, to all the places where he thought obstructions, caused by saw mill waste, were to be found.

He brought us to an extensive shoal nearly opposite Mr. Gilmour's home, below Pine Tree Island, and extending down the river about 250 yards. On the south side, this deposit of slabs, edgings, &c., in some parts united by sawdust, extends wholly across the river, until it reaches near the shore at the foot of the hill.

The soundings on *this bank*, which a few years ago was a *deep, navigable channel*, taken in a line with the south side of the island, and about 250 feet below it, were as follows:—5 feet water, bored through 14 feet slabs, rubbish, &c., could not force the iron further.

2 feet water, thence down, all slabs, &c., &c.

5 feet water, thence down, all slabs.

4 feet water, thence down, all slabs.

6 feet water, thence down, all slabs.

7 feet, no slabs and deep water, thence as gets closer to the shore, distant about 80 feet.

One hundred yards below the island, in the *very tortuous* channel, now necessarily used, there is 6 feet water, and 10 feet 6 inches of slabs lying on a rock bottom, in a pretty strong current.

Fifty yards below the island, in the channel, is 10 feet 6 inches water, rock bottom, and *strong current*. A short distance further, 8 feet water and 12 feet 6 inches of slabs, sawdust, &c., strong current.

We then went around the Island to the north shore, found no slabs, or sawdust in this channel, which in places is naturally obstructed by crossing reefs in the bottom. On the Island side of it, we observed a jam was commencing.

In this channel, notwithstanding the strength of the current through it, a solid dam of slabs, edgings, &c., bound with sawdust was formed last year; which after breaking off from the shore was swung round by the current, and, as Capt. McNaughton believes, now forms portion of the mass which we examined previously on the south and lower side of the Island.

We moved down the river again below the Island, and found the steam tug "Aid" was stuck on top of the deposit of slabs, &c., in trying to work round in the crooked channel created by the deposit.

We again crossed the river to Messrs. Wright and Batson's wharves, and sounded all along the face of them. We found no deposit.

We continued our examination of the north side of the river, further down, and found nothing in the channel. Capt. McNaughton now informed us that he had shewn us all the obstructions from mill waste, he knew of in that portion of the river.

As an example of the difficulty of determining, in a short time, the real nature of the bottom the following facts are adduced:—

Mr. Girard, a master ship carpenter, was employed last year to prepare "ways" to haul up a steamer for repairs. He laid down the timbers for it about 300 yards below Currier and Batson's mills, upon what he considered to be a solid bank, but upon the vessel being hauled up, her weight forced the timbers through the hard crust, and sank them down several feet, evidently from a large deposit of sawdust having been covered over by a thick stratum of other material.

Having now described the course we took in making our inspection of the Ottawa, the principal ground of our enquiry, we return to notice the allegations in the petition presented against the proposed enactment for the better protection of the navigation; and after that to offer some remarks upon the reports of Messrs. Greene and McAlpine, in support of the petition.

In this petition it is asserted, that by-water cannot possibly be prevented. On the contrary we proceed to state cases established beyond question that it is perfectly possible to do so with the exception of a trifling inappreciable amount.

At Bobcaygean, there is a new and very extensive saw-mill driven by water. In the construction of it, the principle was adopted of preventing the sawdust from getting into the river, and it has been carried out most effectually as none of it can escape, save a portion so trifling as not to be worthy of notice, which must find its way down by the Pitman, connecting the water wheel with the saw gate. It may be said, therefore, that practically, and so far as at all to injure the navigation, the sawdust is excluded from the water of the river.

Mr. Boyd, the proprietor, has it carted off to form service ground and to back the extensive wharves, the fronts of which he builds up with the slabs, &c.

At Lindsay, there is also a saw-mill, driven by water, to which a small furnace for burning the sawdust is directly attached. On our visit, the furnace was found in operation, and it answered the purpose perfectly, when the sawdust is thrown into it; however, when no supervision is expected, there are ample opportunities of getting rid of it by simply discharging it into the river through openings left for the purpose in the floor on which it is collected. As to the portion of sawdust created at steam mills over the quantity used up in the furnaces, there are several creditable instances where it is utilized in the formation of piling ground, backing wharves, &c., among which may be mentioned the extensive mill at the mouth of the Trent, owned by Messrs. Gilmour, and that on the west bank of the St. Maurice, Messrs. Stoddarts, proprietors. The petition under consideration further states, that if an enactment compelling sawdust to be kept out of the river is enforced, it would compel the proprietors of the Chaudière mills to close and remove elsewhere.

From our observation of the very little expense attendant upon the collecting and carrying off the sawdust from those mills where it is practised, although by means very insufficient and very imperfect in comparison with what might easily be devised, we are of opinion that the enforcement of it by legislative enactment, would entail upon the mill proprietors generally, but a very trifling percentage on their profits.

The principal difficulty to be dealt with, is the case of the Chaudière mills. Here unfortunately many extensive mills have been crowded upon a space so small as barely to afford room for the piling of two or three days' produce. In more than one case, it is stated that there is no piling ground attached at all. The possibility of depositing further sawdust around those mills is utterly out of the question.

Three or four reasons may fairly be given for all those mills having been (as it appears now) so imprudently crowded together. Firstly a steam-saw-mill at that time was scarcely thought of. It is now admitted by some of the principal men in the trade, that had they again to erect mills, they would adopt steam mills, from the power of placing them exactly in the spot they considered most eligible, and the economy, and certainty of their steady working, irrespective of climate, &c. Secondly, the locality appeared to afford an opportunity of obtaining their working power at a trifling outlay, and to dispose of their waste by simply throwing it into the river, as there was no prohibition to the contrary; and, Thirdly, that until a very late period, there was no facile route by which their produce could be sent to market, but by the river; at the head of the navigation of which, they naturally desired to have their mills.

The several additional routes afforded by railways now constructed, and about to be constructed, will doubtless very much determine the sites of mills hereafter, and the adoption in most cases of steam instead of water for motive power.

Had stringent regulations existed against the deposit of the waste in the river, there is little doubt, that even for water mills, a number of sites, along the river, would have been found, from time to time quite sufficient for the demands of the trade.

It appears to us, that the case of the Chaudière is the only one where any difficulty is to be met with, in regard to the depositing of the waste. As already stated there is no room for further deposit of it on the ground.

The proposition to get rid of it by combustion in cupola furnaces, with tall chimneys grated on top, and in convenient positions, is scouted by the proprietors as being in their opinion, very likely to be the cause of not only endangering their properties, but also the safety of the city. Of this we are not convinced from the fact that no such consequences have attended the burning of all the sawdust consumed in the Steam mills, and much greater safety, might be obtained by means of proper cupolas. But leaving that question aside, we believe that should it be eventually decided by the legislature, on more extended information than has yet been adduced, as to the injurious effects of saw-

dust upon navigation, that none of it shall, in any case, be allowed to be thrown into the rivers, these larger capitalists would soon devise means for otherwise getting rid of the nuisance, than by closing up and removing their establishments.

At Bello Ewart on Lake Simcoe, much the larger portion of all the waste produced by steam mills situated there, and producing as we are informed about forty millions of feet annually, has been for years and is still burned on the ground, without any accident having occurred; of course we do not intend, by any means, to say that such a system is advisable, but simply to shew that proprietors, so deeply interested, are not apprehensive. It is further stated in the Petition under consideration, that the practice for fifty years, of throwing all the waste from the mills upon the Penobscot and Hudson Rivers into the water, has not injured the navigation.

We were desirous of visiting the Penobscot, Miramichi, St. John, and the St. Croix Rivers, but had not sufficient time. Those rivers, however are *all tidal rivers*, and so far as the influence of the tides extends, we did not consider their cases analogous to those of the rivers we had to report upon: but there may be some rivers in the States upon which lumbering is carried on, similar, as regards their constant down currents to the Ottawa, from an examination of which, and of the upper portions of the rivers named, valuable information might be had to be a guide for the course to be adopted here.

Opposed to the statement in the Petition respecting the Penobscot, we have quoted from General Thom's report (see page 42) that such disposal of the waste *has greatly impaired the navigation of the Penobscot River*—that the waste is *forming constantly, increasing obstructions* to the navigation, and had attracted public attention so strongly that the throwing in of slabs and sidings is now *positively prohibited by statute*, and that it was *very much to be regretted* that sawdust was not included, but it is believed *that it will be at an early day*.

That similar injurious effects are produced in the Miramichi River, from the same causes, is distinctly shewn in the communication of the Hon. Mr. Muirhead (see pages 44, 45, 46, and 47), and so strong is his feeling as to the great necessity of effectually stopping the discharge of mill waste into rivers, that he recommends that the penalty for doing so should be the imprisonment of the proprietor or the person in charge of the mill.

The views of Professor Greene, upon the subject under discussion, are based partly on a long series of ably arranged theoretic calculations, in which Mr. McAlpine expresses his full concurrence.

Indeed the views of the two gentlemen are alike, and expressed in nearly the same words, so that it appears to us unnecessary for our purpose to do more than compare Professor Greene's conclusions, with those we have drawn from the results of our own examinations, more especially as his views are shewn from the reports to be diametrically opposed to those of General Thom, and the Hon. Mr. Muirhead.

Besides the calculations adverted to, the correctness of which is not to be disputed, Professor Greene states, he is confirmed in his opinion also by the *experiments* he has made, to which, with great respect, we cannot attach much weight. The results which could be deduced from the *diminutive scale* upon which his experiments were made, namely by *passing sawdust and water through a shoot of but 4 feet in length, 3 inches square in section, and made of smooth boards* appears to us very insufficient to determine the real practical effects of the vast volume of water, passing down a river such as the Ottawa, varying as it does, so immensely, during its course, in breadth, depth, and velocity; its bottom in some places crossed by projecting ledges of rock, and throughout varying in its character, of which Professor Greene has made no examination. No one will deny that to obtain with certainty the true velocity at any one point, the *actual section* of the water there, must be accurately ascertained, as it together with various other concurrent circumstances, viz; nature of bottom, the directions of and turns in the channel &c., &c.; &c., must govern the velocity.

In aiming to obtain this section, Professor Greene assumed breadths and depths, which he took from *Maps that had been some years before made at different periods* under the direction of Messrs. Shanty, and J. C. Clarke, Civil Engineers, whose services had been

engaged by Government, to submit plans &c., for the improvement and extension of the Ottawa River Navigation. These maps were, no doubt, perfectly reliable for the purpose for which they were made. They are drawn in part from actual survey of intricate portions of the line, necessary for the determining of the position, and nature of the works of construction; for the remainder, they were but compilations from maps previously extant.

It is reasonable, therefore, to infer that, as the maximum depth proposed for navigation was about ten or twelve feet, they did not permit time to be unnecessarily lost in determining the depth much below that. The same observations apply with even more force to the determining of the breadth. In those parts of the river where by a glance the breadths were seen to be far in excess of that required, they certainly would not waste time in ascertaining whether it was 1,000 or 10,000 feet. If this inference is received, the correctness of the data assumed by Mr. Greene, in determining the sections and velocities of the current at the various points so minutely as down to the fraction of 0.20th feet per second, is to us very questionable.

Before or since making their reports, we are not aware that either of these gentlemen had ever examined the Ottawa River.

Professor Greene, from his theoretic calculations, states that sawdust and sand combined cannot be found under any circumstances; and further, that, when sawdust may be temporarily lodged in a channel, it is swept off by the next freshet. Our examination (see pages 17 and 18,) shew the contrary,

Professor Greene further says, that sawdust alone can never form obstructions in the channel. Our examinations do not shew that there are any bars, up to the present, of sawdust in the navigable channels, which obstruct the navigation of them. But those examinations, as well as the various authorities quoted herein on both sides, of the question, establish clearly the fact, that the admixture of sawdust has a very considerable and injurious effect in binding together, and converting into a permanent dam or bank, the slabs, edgings, &c., which in the first instance merely lodged on the bottom.

General Thom illustrates forcibly, in the case of the Penobscot, the injurious effects of sawdust thrown into the rivers, by its forming, in the slack-water parts of the navigation, extensive and shifting shoals, with narrow and crooked channels. These effects have not yet been produced in the Ottawa; but it is not easy to foresee what the result may be hereafter, from the discharge into it annually, as at present, of about eight millions of cubic feet of sawdust alone, irrespective of the slabs, edgings, sidings, &c.

As to the correctness of the conclusions of Professor Greene, derived from his calculations of the velocity of the current in several parts of the Ottawa, as well as also upon his own experiments, we have ventured to express our doubts. First, because the data upon which his calculations are founded do not appear to us to be derived from distinctly established facts as to breadths, depths, &c.; and, secondly, because we look upon the scale upon which his experiments were made as being much too diminutive to derive reliable conclusions from. (See pages 72, 73, and 74.)

As before stated, neither Professor Greene nor Mr. McAlpine has ever examined the Ottawa; they, therefore, cannot be supposed to be acquainted personally with the character and irregularities of the bottom, and a variety of the circumstances which must materially affect the nature and places of the deposits.

The six specimens of the bottom, which Professor Greene says he examined and could not find any traces of sawdust in, were furnished to him, not taken up by himself.

Mr. McAlpine states he had many occasions of seeing the material taken from the bottom of the canals, and never saw any sawdust in them.

To ascertain with certainty whether sawdust does exist in such materials after long immersion, requires very close attention.

Several of the specimens we ourselves collected from the bottom, at the Petite Blanche, Le Lievre, and elsewhere, when examined immediately on being taken out of the

water, we set down as containing but a very small proportion of sawdust; but subsequently, on examining the same specimens when dry, we found the proportion of sawdust combined with the sand to be much greater.

After having made the examinations (detailed in the foregoing) of the River Ottawa, at and below the city, we went by rail to Arraprior.

On arriving there, we met Mr. McLachlan, of the firm of Messrs. McLachlan and Brothers, who are the proprietors of mills at that place. This gentleman arranged to meet us next morning, at his mill. We did not find him there, but we met Messrs. Meech and Kingston, who respectively manage the concerns of Messrs. Conroy and the Hon. James Skead on the Madawaska, by whom we were conducted to the extensive Government boom at the mouth of that river. Most of the waste from these mills appears to be discharged into the water, at the lower end of the boom, near a small island. There is a great accumulation of sawdust brought down from Messrs. McLachlan's mills, and lodged there. The depth of water on this bank, at the period of our visit, varied from eight inches to five feet. The water in the lake then stood, as we were informed, one foot six inches over low summer level. This filling-up of the boom seriously interferes with the lumbering operations within it. We saw a very large number of heavy logs lying on top of the bank so formed within the boom.

A little more out in the lake, and parallel with the boom, there is a sand bar stretching down a considerable distance, and upon the shallow part of this bar, and between it and the shore, the sawdust has gathered, and continues down along it. Should this deposit of sawdust continue in its present position, the booms will in a little time be rendered useless.

The amount of lumber produced annually at Mr. McLachlan's mills is about twenty millions of feet.

We next visited Carleton Place, and examined the mills there; a steam mill owned by Mr. Caldwell, and water mills owned by Messrs. Gillies & McLaren. Mr. Caldwell is building and Messrs. Gillies & McLaren have built a cupola furnace for the burning of the waste, which works satisfactorily at a very trifling expense, and gives no trouble.

By a simple contrivance, the slabs, edgings, &c., are put in cars which run on a tramway to the mouth of the furnace. On arriving there the load is tipped or dumped by a boy into the fire. Below the mills, the river is clear of waste of every kind, except sawdust. The mills of Mr. Caldwell, and of Messrs. Gillies and McLaren produce annually about twenty five millions of feet of lumber.

We next proceeded to Napanee, and at once put ourselves into communication with the Mayor, and several other gentlemen interested in the navigation of that river.

At the foot of the rapids, immediately below the mill in the town, there is a very great amount of waste for some distance down, in fact the course of the river has been all but closed, and the navigation stopped.

A channel has lately been dredged through it which is very narrow, not allowing two vessels to pass each other. The stuff brought up was composed of stones, gravel, sunken logs, slabs, and some sawdust, but a considerable area of the river, over which there was formerly from 8 to 10 feet of water, and which, within the recollection of Mr. Herring, was available for steamers and other craft, is at present filled up and dry.

We drove up the river to a large saw water-mill, about 8 miles above the town, worked by the Rathbone and Sons. It would appear, that, for some time past, appliances, but of a very imperfect nature, have been made use of for carrying away the slabs, sawdust, &c., for the formation of service ground, &c., and the making of wharves. This was the case at the period of our visit; but from the several banks of refuse we observed at sundry parts of the river below the mills there is no doubt that a large quantity of the waste is occasionally thrown in.

There are eight saw mills above the town of Napanee, nearly all of which deposit waste in the river.

We then obtained a small boat and went about a mile down the river to a new steam mill; a bar has been formed there also, but it is chiefly of sand. A large bank of sawdust

has been formed along the side of the river, there being but little current in it. In the centre of the river, except at the places already mentioned, there is no collection. The bottom is pure sand from which it is to be inferred that the sawdust not deposited on the bank above mentioned is carried into the Bay or arm of the lake leading to Belleville.

A large proportion of the deposit directly at the foot of the rapids at the town, is water logged bark. This accumulation of bark is owing to most of the logs being boomed in the river for two years, the smallness of the stream not permitting it to be (as the lumbermen say) *driven* in one season.

The logs in the river are in a great part stripped of their bark, which being very heavy sinks on falling into the water. The lower part of the bar is much mixed with slabs, edgings, &c., and with but little sawdust. In the opinion of the gentlemen of the town accompanying us, but little sawdust would remain in the river, but for the slabs, &c., which collect in it.

After finishing our examination at Nananee, we proceeded to Belleville. We arrived there in the evening, and early next morning waited on Mr. Flint, the Mayor, and also upon the Mr. McKenzie Bowell, the representative of the County; upon Messrs. Brown and White, M.P.s; Mr. Vandusen and others.

Having procured a boat and crew, we commenced our examination of the harbor and entrance to it, attended by the Captain of a schooner, who had traded to this part for many years; we were informed by him that the entrance channel from the *shifting of the sand*, has to be buoyed out every year, that when this is done, a fair but not straight channel, with sufficient water is obtained.

SOUNDINGS AT BELLEVILLE.

Outside the harbor, in a direct line with Front street, at intervals of about 100 yards :

1st 14 feet of water, 12 feet of sawdust down to hard bottom.

2nd 6 " " 5 " " "

3rd 4 " " 5 " " "

Ship Channel :—11 feet of water—4 feet sawdust.

East Side Channel :—6 feet water—3 feet sawdust.

6 " 2 " "

Channel near entrance to Harbor :—10 feet 6 in. water—3 feet sawdust in hard bottom.

9 6 " 2 " "

11 0 " no sawdust—hard rock.

Near Island :—9 feet water—no sawdust—gravel.

6 " " rock.

West Side Harbor :—6 feet to hard bottom—no sawdust—gravel.

Main Channel in the Harbor, East Side :—10½ feet water—no sawdust—gravel.

10½ " " "

11 " " "

11½ " 3 feet pine bark.

Opposite to Mills, East Side of Harbor :—8·6 water—3 feet pine bark—no sawdust.

8·6 " 3 " "

7·0 " 2 " "

7·6 " 1 " "

7·6 " 2 " "

4·6 " 4 " "

8·0 " gravel " "

8·0 " rock " "

7·0 " " "

5·6 " " "

In the roadstead, the deposit is *pure sawdust*, at the entrance to the Harbor it is *mixed bark* and sawdust, and within the piers it is chiefly *bark* with some sawdust and gravel.

There is a very extensive boom, close to Belleville, anchored immediately at the foot of the rapids there, and a very large collection of logs, off which the bark is stripped in their passage through the rough rapids. This bark is carried down the rapids, and from its weight sinks at once in the inner harbor. It is chiefly by the lodgment of this bark, and by the stones and gravel brought down on the break up of the ice, that this harbor suffers. It is the outer portions of the harbor, and the *entrance* and *channels leading to it*, that are principally affected by the deposit of sawdust. And notwithstanding that the deposits in these channels is annually found to be sufficient for navigation, yet much inconvenience results from the variations in their courses and directions, caused by this deposit of sawdust, thereby creating the necessity of buoying them out anew every spring.

Having concluded our examination at Belleville, we drove up to the mouth of the Trent, where the Messrs. Gilmour & Co., of Ottawa, own one of the finest steam mills probably in the Dominion. It has all the modern improvements; the arrangement by which the waste, required for the furnaces, is conveyed to them, is very complete, and such of it as is not required for fuel is otherwise utilized. None of it is allowed to escape into the water.

The place next visited in this section was Shannonville, to which we were kindly accompanied by Messrs. Bowell and White, M. P.s. The river at this place is affected by the discharge of sawdust in much the same manner as the river at Nanawee, and although in a smaller degree on account of its lesser size, its navigation is equally impaired. Some years ago, as stated by Mr. Holden, an old resident of the village, barges and steam tugs could ascend the river to within 80 rods of the village, and lie alongside the bank to load with staves, &c., for the Quebec market. No vessel can now get up within half a mile of the old dock. From the present head of navigation, for a length of from half to three-quarters of a mile on each side of the stream, are large deposits of slabs, &c., the channel is thereby rendered narrow and crooked.

From the saw-mills below the village some of the waste is carried away during the day. From the head of the present navigation down to the lake, a vessel drawing eight feet of water can at present freely pass up and down, but at this point a large bar of sand extends quite across, with a small portion of sawdust intermixed.

The channel there is so narrow and crooked that it is scarcely possible to get a scow up through it. In low water, a great deposit of sawdust takes place on it, which in freshets or a gale from the lake is removed.

The remains of these deposits of sawdust, on our visit, were visible along the shore for a considerable distance. Upon the bar there was not over five feet of water at the time of our inspection.

By some of the replies we received to the circulars we had addressed to members of Parliament, and other parties interested in the maintenance of the navigation of the line of waters, usually understood to come under the head of the "Trent Navigation," these are Bobcaygean, Fenelon Falls, Balsam Lake and Lindsay.

The engagements of two of the undersigned rendering it absolutely necessary that they should return to their homes, it was settled that Mr. Killaly should proceed alone and make an examination of the above-named places. The following are the results of it:—

Having hired a boat, he commenced up-stream at the village of Coboconk in the "Gull River," an extension of the Trent. At this village a dam was constructed across the river, creating a fall of from six to eight feet, by which a sawmill was worked.

The whole of the waste from this mill was thrown into the water. It is no longer worked and is in ruins, but it is understood that a new and extensive one is about to be erected. About six miles above Coboconk, on the river, is McLaughlin's sawmills, also depositing all the waste in the river. From Coboconk down to the upper entrance of Balsam Lake (about two miles) slabs, edgings, &c., are to be seen, in some cases in large quantities along the shore; but little sawdust was observed, and the navigation was unobstructed by it. From this point across Balsam Lake, about four miles, the navigation is not interfered with. Immediately at the lower entrance to this lake, across that

part of the river which connects Balsam Lake and Cameron's Lake, there is a swing bridge, the span of which is very insufficient for the passage of steamers and barges. Close above and below this bridge there is a shoal with not more than four feet of water upon it, at the time when the level of the river was about 18 inches higher than extreme low summer water.

Three-quarters of a mile below the bridge a lock and a dam across the river were constructed a few years ago; the fall at which is from two to three feet. Below this lock and dam to the upper entrance of Cameron's Lake, there is, in several places, a quantity of slabs but no sawdust. What the parties interested in the navigation complain of here, is, that the tortuous branches of the river are in spring so completely boomed up and filled with logs, and that for a considerable time they had to suspend the running of their steamers and barges, and finally to withdraw them from that portion of the navigation altogether.

A short cross cut from a sudden bend of the river to the lake would completely remove the cause of this complaint. It also could be used for navigation, leaving the whole of the river to be boomed off in such a way as to suit the requirements of the several lumbering parties. From the head of Cameron's Lake down to Fenelon Falls, about three miles, the navigation is unobstructed. At the falls the water drops down perpendicularly over a ledge of limestone rock about twelve feet; this fall is increased a few feet by the dam which has been built upon the top of the natural ledge of rock for the purpose of increasing the depth of water above. If this dam had been raised a few feet more the navigation would have been much improved, and the building of the present lock near Balsam Lake rendered unnecessary.

FENELON FALLS.

There is a considerable and rapidly increasing village here, and two water sawmills, one on each side of the river immediately at the town; that on the south side is a new mill, producing in the season from eight to nine millions of feet of lumber. In this establishment they profess to dispose of the waste by carting it away and burning it; however, but very little traces, if any, are to be found of this being done, but on the contrary, every facility afforded for the direct discharge of it into the water underneath, through openings left in the floor under each gang of saws. The foreman stated that the sawdust is gathered, filled into large wheelbarrows, wheeled to and tipped into a hopper in the corner of the mill, from which it is drawn up by a contrivance for that purpose (very imperfect and insufficient), and is ultimately thrown into waggons, carted off and burned.

On inspection the traps in the floors were found all open, and one entire side of the hopper was knocked out, thus presenting a large aperture for the sawdust, if wheeled to it, to fall into the river. The whole of the bark—no inconsiderable quantity—is thrown from an opening in the upper floor into the river. In the mill on the town side of the river, the produce of which is stated to be about six millions of feet of lumber annually, it is not pretended that any means are taken to dispose of all the waste, otherwise, than by throwing it into the river. Near the entrance into the lake, there are two large steam saw mills, one on each side of the river. Most of the sawdust is consumed in the furnaces, but the remainder, and a large part of the waste generally, seems to find its way into the river. Besides these mills there are two small steam mills at which shingles, &c., are produced. The aggregate produce of the mills below the falls is estimated at 34 millions of feet annually. In the spring the river from the town to the lake is almost wholly blocked up with logs, and the steamers have to stop at the lower mill, near the lake, and land their passengers on rafts or logs lying there.

Over a large area at the head of this (Sturgeon) Lake, slabs and sidings, &c., have sunk, seriously interfering with the navigation, when the water in the lake is low—thence to Bobcaygean there are no impediments to be found.

BOBCAYGEAN.

The former mill at this place was located in the line of navigation and discharged a large part of its waste into the river, directly at the tail of the lock, thereby causing considerable and constant obstruction to the navigation. The old mill is no longer worked. Mr. Boyd, the proprietor, having erected in its stead a splendid water mill, on the other side of the river.

This mill was constructed on the principle to admit of no waste from it getting into the river, and it has been most effectually and satisfactorily carried out—as it may justly be said that the trifling amount of it that finds its way down by the "Pitman" is unworthy of notice—the whole of the waste of every description is utilized.

SCUGOG RIVER.

Across the lake no impediment is found until reaching the mouth of the Scugog River, thence up to the town of Lindsay in the comparatively still water of the circuitous channel of the Scugog, and throughout, a quantity of slabs, &c., is found. Some very bad bends in the river leading to it have been improved by Government, but there are others equally in need of such improvement.

The Scugog navigation passes through the town of Lindsay, immediately thereat is a lock and a dam across the river, and on it a flour mill and saw mill, both driven by water. The saw mill produces about two millions of feet of lumber annually. It has a small furnace immediately attached to it, which, when used, answers the purpose well; but appearances below it but too surely indicate that this furnace is not constantly resorted to.

The proprietors of the saw mills below it complain that the quantity of sawdust going down seriously interferes with their feed pipes. The interests of this navigation, of no little importance, appears to have been very much overlooked. Independently of the impediments from slabs, &c., this neglect is shown by the manner in which the wharves constructed by the respective saw mill owners, for their own use and convenience, have been allowed to encroach on the river, and also by the very awkward direction, so far as navigation is concerned, of the railway bridge across it, to steer through which, in the narrow breadth of the river, the steamer or barge has to steer nearly across the stream, and almost before her stern is free of the bridge, she is stem on a saw mill wharf, projecting into the river on the opposite side. The free use of the Canal also for the town purposes is greatly obstructed by the manner in which the railway, with its freight sheds, &c., have been allowed to be located.

It is further complained of, that it lies within the power (which is often exercised) of the mill proprietors at Bobcaygean, and of the owner of the mills on the dam, across the river in the town of Lindsay, to draw down the water below the level required for navigation (both above and below the town), much obstruction to which is thereby frequently caused.

RIVER MUSKOKA.

The navigation of the three considerable Lakes, St. Joseph, Rosseau and Muskoka, has been connected by means of a lock, &c., lately constructed, a short distance below the west or lower end of Lake Muskoka; at the upper end of it the River Muskoka enters; at a distance of 7 or 8 miles it divides into two branches. On the east one, about two miles up, are the "High Falls," of about 160 feet. The north branch continues navigable up to Bracebridge, the county town, of respectable size, and rapidly increasing. Here also are considerable falls, the foot of which is the head of navigation.

In the immediate vicinity of the town are two steam saw mills, and a water saw mill; within a few miles of the town, further up the river, are three more water saw mills. The waste from all the water saw mills has hitherto been thrown into the river.

in consequence of which the fine basin at the foot of the falls, in the town, in which steamers, &c., could formerly lie and swing round, is now completely blocked and rendered useless, by the accumulation of a large shoal in it, consisting of slabs, and other such mill waste, sand and saw dust.

A wharf at the head of this basin at which the vessels used to be moored, had to be abandoned and another built at the lower end of the basin. The Muskoka River brings down every spring heavy floods, and it is believed that if the throwing in of the saw mill waste was put a stop to, this basin could easily be restored to its original useful state.

It now only remains for us, after submitting a few general remarks upon the subject of our Commission, to state the means we respectfully recommend for putting a stop to obstructions in navigable streams and rivers.

Having represented the extent and importance of the lumbering interests on the Ottawa, we deem it but proper to shew also the present extent and importance of its navigation interests.

The capital invested in steamers and barges engaged on it was, in April 1872, one million two hundred and fifty thousand dollars; the number of steamers forty-five, and of barges two hundred and fifty-one, the number of men about two thousand.

In the year 1871 there were conveyed down the Ottawa by those steamers and barges, two hundred and sixty millions of feet of lumber. The quantity produced is largely increasing annually, and the number of vessels increases correspondingly.

From the above it is evident that the parties engaged in lumbering are deeply interested in the navigation, but unfortunately it seems only so far as the keeping of the Channel open.

The tolls paid to the Government in 1871, from the Ottawa Canals alone, amounted to about \$100,000, and from the up freight about \$50,000.

The amount to be expended on the improvements of the navigation from the city of Ottawa to the River St. Lawrence is calculated at about two millions and fifty thousand dollars.

The views and opinions submitted in this report, of all those who maintain that the discharge of sawdust alone cannot and does not impair the navigation, it may be observed, are confined specially to the Channel of the river; as, for instance, if a sufficient depth for the passage of vessels from the Chaudiere to the St. Lawrence is left in the Channel, the navigation of the river is not impaired. They all admit, and truly, that the sawdust is in the first place lodged in the quiet bays and eddies generally along the river, (the very places where, as the country and trade increases, may be found the best suited for the various wharves, &c., which may from time to time be required) and that as these become filled up, the current increased by the contraction of the river, will then carry the sawdust, still continued to be thrown into the river (at present at the rate of about eight millions of cubic feet annually of sawdust alone, independent of slabs, &c., &c., further down, until it is finally deposited, no one knows where.

That the sawdust is so lodged, it is only necessary to inspect McKay's Bay, the shoal at the mouth of the Petite Blanche, and the Bay at the entrance of the Rideau Canal, which may be fairly looked on as the natural inner harbor for the city, to which it presents the easiest access. On this Bay had been the principal landing place until the blocking up of it, made it comparatively useless.

The state of the entrance to Belleville Harbor, at the mouth of the river Moira, is a further and strong illustration of the injuries resulting from the deposit of sawdust.

For the interests of the city of Ottawa, it is most important that all the river frontages adjoining the city should be kept from being filled up. As leaving aside any consideration founded upon the probability of a through water communication being opened at some future day, by the line of the Ottawa, from the cities of Quebec, Montreal, and Ottawa to the "Great West," it is certain a vast increase in the trade of this city and river, must keep pace with the rapidly increasing prosperity of the country, and that every portion of river frontage in the neighborhood of the city, must become daily of more value, as it will all be required for shipyards, building and repairing slips, wharves, landing places, &c.

Finally—after careful consideration of all the circumstances, and keeping in view the importance of both the great interests involved, we respectfully recommend :—

First.—That a Bill be introduced into the House of Commons, by which it would be enacted that the throwing into any lake, river or stream whatever, of any refuse from sawmills, except sawdust, shall be strictly prohibited, under severe penalties, to be fixed on, and that such prohibition shall be enforced from the date of the passing of such Bill.

Second.—That no opening whatever, shall be permitted to be in the floors or walls of any mills now in existence, or to be erected, except those required for lighting and ventilation, and all such openings shall be fitted with gratings, well and permanently secured and fixed, the openings through such gratings not to exceed one inch square.

Third.—That an officer should be appointed under this Act, whose duty it should be to see that the provisions of this Act were strictly carried out, such officer to be empowered to summon before any magistrate of the vicinity any party he would detect, or have satisfactory evidence against of having contravened the provisions of this Act.

After all descriptions of sawmill waste, except sawdust, have been prevented by this Act from being thrown into any lake, river or stream whatever, should it be proved to the satisfaction of the Government, that the continued discharge of pure sawdust does and will impair the navigation, or create impediments there to in any manner, the Government shall have the power in such case to exclude it in the same manner as provided against the deposit of the other refuse. Six months' notice thereof to be given to the mill proprietors.

All of which is respectfully submitted.

HAMILTON H. KILLALY,
Chairman.

R. W. SHEPHERD.

JOHN MATHER.

 LIST OF APPENDICES.

1. Copy of a Petition signed by Messrs. Gilmour & Co. and 17 others, against the Bill introduced into the House of Commons by R. J. Cartwright, Esq., M.P. for County of Lennox.
2. Copy of 1st Report of Prof. Greene to Mr. Bronson, on subject of Commission.
3. do 2nd do do do do
4. Copy of Affidavit of Hon. W. J. McAlpine.
5. do Report do do
6. do Affidavit of Thomas McManus.
7. do do Jeremiah Finch.
8. do do Levi Young.
9. do do Henry Swalley.
10. do do J. M. Wilson.
11. do do John Keenan.
12. do do David Underwood.
13. do do Joseph Russell.
14. do Letter from Geo. Richards to Mr. Bronson.
15. do do Judge Rosekran to Commissioner of Public Works, Ontario.
16. do Affidavit of D. H. Sullivan.
17. do do A. Sherman.
18. do do Geo. Satterlee.
19. do do Col. J. W. Morgan.
20. do do Geo. W. Nelson.
21. do do W. Coleman.
22. do do Orson Richard.
23. do Memorandum from A. J. Russell, Crown Land Department, on the Water Shed, &c. of the River Ottawa.
24. Communication from General Thom, Bt. Brigadier General, U. S. Artillery, to Hon. H. H. Killaly on subject of Commission.
25. Communication from Hon. M. Muirhead to Hon. H. H. Killaly on subject of Commission.

APPENDIX No. 1.

To the House of Commons of Canada in Parliament assembled.

The Petition of the Undersigned, humbly sheweth :—

THAT, your Petitioners represent a very large capital invested at the Chaudière, and elsewhere on the Ottawa and its tributaries, by themselves and others employing at least 8,000 men, and 3,000 teams, and producing a very large addition to the exports of Canada, amounting to 400 millions of feet of lumber, and four millions of dollars of value annually.

THAT, the proposed legislation, with regard to navigable rivers and streams, will act most injuriously on the important interests your Petitioners represent, inasmuch as the mills they work, being water mills, it is impossible to prevent sawdust falling into the river, and that the enforcement of the Bill will, as your Petitioners believe, compel them to close their mills, and remove their operations to other localities, where steam power can be used, thus injuring your Petitioners, and also the City and other districts affected.

THAT, your Petitioners recognize fully the importance of maintaining the navigation of the Ottawa River, in which they are largely interested, but they represent they are in a position to prove, as well from the result of actual investigation of the River Ottawa, as from the experience of similar operations during fifty years past on the Hurlon and Penobscot Rivers, that navigation is not injured by the falling into them of sawdust, which is carried off and dispersed yearly by the spring freshets.

Your Petitioners therefore pray that the subject may be fully investigated, and that opportunity be afforded them to submit scientific and practical evidence in support of the allegations of this Petition, in order that a grave injury and injustice to a great industry, may not be unwittingly perpetrated. And your Petitioners, &c.

(Signed,)

GILMOUR & Co., and 17 others.

True Copy.

"

W. B. LINDSAY,

Clerk H. of Commons.

Clerk's Office, House of Commons, 29th November, 1871.

APPENDIX No. 2.

(Copy)

H. F. BRONSON, Esq.,
Ottawa, Canada.

SIR,—I have examined the question submitted by you, as to whether there is any reason to apprehend the formation of obstructions to the navigation in the Ottawa River, as the result of the deposition of the saw dust made by the mills at and above the City of Ottawa, when the same is cast into the river.

Before and during the investigation I conferred with the Hon. W. J. McAlpine, with whom I have had the honor to be associated, and with whom I consulted as to the line of investigation to be pursued. The conclusions to which I have been led have been submitted to and discussed with Mr. McAlpine, who, I am happy to say, entirely concurs with me, and who will so report to you.

In considering this as a purely engineering question, the following questions naturally present themselves.

First.—What are the causes which induce the formation of bars and obstructions in navigable and other streams?

Second.—What materials usually compose such bars and obstructions?

Third.—What are the specific gravities of these materials? and

Fourth.—What velocities of current are necessary to take up and transport these materials to the point of final deposition in the bar?

Having answered the several questions, it will next be necessary to enquire in regard to the specific gravity of saturated pine saw dust, and the velocity of current necessary to take it up and transport it.

These questions will be considered in the order in which they are stated.

CAUSES OF THE FORMATION OF BARS.

When the velocity of the current in any stream is sufficient to enable the water to scour or abrade the materials composing the bottom and sides thereof, these materials will be taken up by the moving waters, held in suspension in it, and transported down stream, until, by a widening or deepening of the channel, or both combined, the section of the stream becomes so much enlarged, and the velocity of current so much reduced, that the floating materials can no longer be held in suspension or transported.

When this occurs, a deposit takes place, which continues to increase, so long as the water arriving at the point continues to be charged with the heavy materials. In time, if this process be continued, the result is the formation of a bar, which if the stream be used for navigation purposes, may prove to be a serious obstruction, and one requiring removal by artificial means.

In some streams the formation of bars is a continual process; in others, bars are only formed during freshets; when the velocity of the current, ordinarily too low to effect a disturbance of the material of the bed, becomes temporarily sufficient to take up and remove large quantities of this material to deeper and wider streams lower down.

These deposits occur, not only in the channel and its immediate vicinity, but also in eddies near the margin, and in eddies formed by artificial structures, such as bridge piers, and abutments, which serve not only to obstruct the free flow of the water, but to divert it from its natural course.

MATERIALS DEPOSITED IN BARS.

The materials usually deposited in bars and other obstructions to navigation, are mud, coarse and fine sand and gravel, to which are sometimes added water-logged timber chips, sticks, leaves, and other detrital matter.

Generally, however, bars are principally composed of mud, sand and gravel.

SPECIFIC GRAVITIES OF THE MATERIALS.

Before giving these, it is well to note, that the ultimate particles of sand and gravel may be quartz, feldspar, mica or slate, or these materials may be all combined in the same specimens of sand or gravel. Pebbles also of different kinds may be mingled with gravel. It will therefore be necessary to present the specific gravities of a considerable number of substances, in order to include all that may be found in a deposit of sand or gravel.

The following table gives the specific gravities of a sufficient number of these materials, and includes also some others which have been found in motion, near the bottom of the Hudson River :--

Material.	Specific Gravity.	Material.	Specific Gravity.
Clay in bulk.....	1.93	Limestone.....	3.18
Common soil in bulk.....	1.98	Marble.....	2.70
Coal, bituminous.....	1.27	do.....	2.80
Coal, anthracite.....	1.44	Mica.....	2.80
do.....	1.64	Sand, in bulk.....	1.80
Earth loose.....	1.50	Slate.....	2.67
Granite.....	2.62	Stone, common.....	2.52
do.....	2.70		

In regard to those materials designated in the above table as "in bulk," such as clay, common soil, loose earth and sand, it is to be remarked that the ultimate particles, except such as are of vegetable origin, are much heavier than is indicated by the tabular numbers.

The sand, for instance being made of quartz, feldspar, mica and slate, whose specific gravities vary from, say 2.50 to 2.80, we should not expect it to be disturbed by the same current which would take up single particles of the same magnitude, whose specific gravities were only 1.80 or equal to that of sand in bulk.

VELOCITIES OF CURRENT REQUIRED TO TAKE UP AND TRANSPORT DIFFERENT MATERIALS.

Upon this subject there are many authorities, D'Hubuisson, an eminent French authority says:—"When a proper relation is established, so that the channel contains all the water brought down by the river in its great freshets without injury, it is said to have acquired *stability*, and the *regime* of the river is established"—"The velocity of the *regime* is strictly related to the species or rather size of the substances which form its channel." Du Buat has made some experiments upon this subject of great interest. He has taken different kinds of earths, sands and stones, which he placed in succession upon the bottom of a wooden canal; by inclining it differently he has varied the velocity of the water passed through it, and has verified how much is necessary to put each substance in motion, he had for

Potter's Clay.....	0.264	feet per second.
Fine sand.....	0.5249	do
Gravel from the Seine, (size of peas)	0.6233	do
Pebbles from the sea, 1 in. in dia ...	2.132	do
Flint stones, size of hen's eggs.....	3.281	do

He then spread a bed of sand upon the bottom of the canal, and caused the water to run over it with a velocity of 0.984 feet per second.

Under these conditions the particles of sand were found to be moved forward at the rate of nineteen feet in twenty-four hours.

The velocities given are those which are just sufficient to disturb the various materials; higher velocities would be required to take up and carry off these materials.

David Stevenson, C. E. in his work on "Canal and River Engineering," page 143 gives the following as the results of experiments made by Bossuet, Du Buat, and others on the size of detrital particles, which streams flowing with different velocities are capable of carrying:—

0.25ft. per second=	0.70	mile per hour	will just begin to work on fine clay.	
0.50	do	0.34	do	will lift fine sand.
0.67	do	0.45	do	will lift sand as coarse as linseed.
1.00	do	0.65	do	will sweep along fine gravel.
2.00	do	1.36	do	will roll along rounded pebbles, 1 inch in diameter.
3.00	do	2.045	do	will sweep along slippery angulated stones, size of an egg.

Lewis Gordon, Regius Professor of Civil Engineering and Mechanics, in the University of Glasgow, in his synopsis of lectures on Civil Engineering, page 16, says:—
 “The relation between the velocity and the quality of detritus carried along the rivers is illustrated by the following facts:—

MATERIAL TRANSPORTED.

VELOCITY OF STREAM AND SURFACE.

Fine clay and lime.....	0.67 feet per second.
Fine sand	1.00 do
Rough sand.....	1.50 do
Very fine gravel.....	2.00 do
Gravel 1 inch diameter	3.00 do
Gravel 2 inches diameter.....	5.00 do
Stones $\frac{1}{2}$ cubic foot.....	7.00 do
Stones of 1 cubic foot.....	10.00 do
Stones of 2 cubic feet	15.00 do
Stones of 10 to 15 cubic feet	30.00 do

Prof. Julius Weisbach, in his “Mechanics and Engineering,” vol. 2, p. 156, says;—
 “A velocity of 7 to 8 inches per second is necessary to prevent deposit of slime and
 “growth of weeds, and $1\frac{1}{2}$ feet per second is necessary to prevent deposit of sand.” “The
 maximum velocity of water in canals depends on the nature of the channel's bed.”

On a slimy bed, the velocity should not exceed...	0.25 feet.
On a clay bed,	“ 0.50 “
On a sandy bed	“ 1.00 “
On a gravelly bed	“ 2.00 “
On a shingle bed	“ 4.00 “
On a conglomerate bed	“ 5.00 “
On a hard stone	“ 10.00 “

This applies to the mean velocity.

The above velocities are such, as according to this eminent German authority, may be allowed without endangering the integrity of the beds of canals (or rivers), when those beds are composed of the materials set opposite the several velocities respectively.

The velocities generally given in the preceding tables are those which are just sufficient to disturb the condition of the bottom, and in time to permanently change its character, by the slow removal of materials in some points, and its subsequent deposition at others; they are not such velocities as will produce sudden changes by the rapid removal of materials. In short, they are intended as guides to the engineers, and indicate the limits of velocity for the several materials, beyond which the current should never be permitted to run in artificial channels.

Much valuable information, bearing directly upon the case in hand, has been obtained from the charts of that portion of the Hudson River, lying between the city of Troy and the village of New Baltimore, embracing a distance of about 20 miles, and including all that portion of the river where troublesome bars and other impediments to navigation occur.

These charts were constructed from surveys made during the years 1867-68, under the direction of the U. S. Engineer Department, and for the purpose of obtaining information upon which to base plans for the permanent improvement of the navigation of the river, by the removal of the then existing obstructions, and by the adoption of measures to prevent the formation of like obstructions in the future. During the progress of the survey, attention was naturally directed to the velocity of the current of the river and to the kind and character of the materials which were being moved down stream, at and near the bottom. Careful observations were made for the purpose of obtaining reliable information upon these points. The velocity of the current was ascertained at

nearly one hundred different points, and at each of these points an instrument, designated the "Sand Collector," was sunk to the bottom and allowed to remain there 15 minutes; after which it was removed carefully and the quantity, kind and character of the materials collected, carefully noted. The results of these examinations, the officer in charge of the U. S. Engineers office in Albany, has kindly permitted me to copy from the charts in that office.

They are embraced in the following table. :—

OBSERVATIONS WITH "SAND COLLECTOR."

Velocity per second.	Quarter of Tide.	Sounding.	Wind.	Description of Deposit.
1.67 ft.	2nd	9.3 ft.	1 with..	Very small quantity of sand and gravel; largest, size of a pea.
1.43 "	"	10.3 "	"	Nothing.
1.39 "	"	13.2 "	"	A few pebbles; largest, size of a pea.
1.14 "	"	11.6 "	"	A few small pebbles.
0.83 "	"	13.6 "	"	Nothing.
0.67 "	3rd	12.8 "	2 with..	do
0.91 "	"	11.0 "	1 " ..	A few small pebbles.
1.03 "	"	11.2 "	"	Nothing.
1.05 "	"	10.2 "	calm.	One small pebble and several pieces of water logged wood.
1.39 "	"	9.3 "	"	Small quantity of pebbles; largest, size of a grain of coffee.
1.64 "	"	8.0 "	"	A few small pebbles.
1.72 "	4th	10.0 "	"	do do
1.54 "	"	12.2 "	"	Nothing.
1.67 "	"	8.1 "	"	do
1.14 "	2nd	10.0 "	"	do
1.11 "	"	9.8 "	"	do
1.45 "	"	8.1 "	"	A few grains of coarse sand.
1.69 "	3rd	9.4 "	"	2 cub. inches of sand and gravel; largest, size of a coffee grain.
1.61 "	"	8.2 "	"	Small quantity of coarse sand and gravel.
1.59 "	"	8.6 "	"	10 cub. inches of coarse do do
1.82 "	"	7.9 "	"	3 cub. inches sand and gravel; largest, size of a coffee ped.
1.79 "	"	9.6 "	"	do do do pea.
1.61 "	4th	8.7 "	calm.	Nothing.
1.67 "	"	8.7 "	"	2 cub. inches of fine sand.
1.82 "	"	7.4 "	"	Small quantity of fine sand.
1.36 "	"	8.7 "	"	Very small quantity of fine sand.
2.00 "	3rd	20.8 "	"	{ Considerable quantity of water logged pieces of wood and small quantity of fine sand.
1.75 "	2nd	1.00 "	"	do do do do
0.12 "	"	18.6 "	"	Small quantity of very coarse sand and water logged wood.
0.94 "	"	10.4 "	"	Nothing.
1.67 "	"	12.5 "	"	Small quantity of coarse sand and a few small pebbles.
1.61 "	3rd	9.8 "	"	{ Coarse sand and small pieces of wood and coal; largest piece of coal size of a grain of coffee.
2.08 "	2nd	12.4 "	"	Nothing.
1.80 "	1st	14.8 "	"	{ Small quantity of coarse sand and pebbles, size and shape of a 3 cent piece.
1.67 "	3rd	11.4 "	"	{ Coarse sand, pebbles and debris of various kinds; largest pebble size of a pea.
1.79 "	1st	10.7 "	"	Nothing.
1.74 "	3rd	13.4 "	"	do
1.63 "	4th	11.2 "	"	Coarse sand.
1.63 "	"	10.0 "	"	Very small quantity of fine sand.
1.65 "	"	12.5 "	"	{ Fine sand, cinders, and coal; largest piece of coal the size of an almond.
.00 "	1st of T. O.	10.4 "	"	{ Small quantity of fine sand and pebbles; largest pebble size of a coffee grain.
1.33 "	L. W. St.	11.4 "	"	Medium fine sand and small pieces of coal; largest, size of a pea.
1.41 "	4th	8.8 "	"	Coarse sand and very small pieces of wood.
1.59 "	"	7.7 "	"	Fine sand.
1.74 "	3rd	16.4 "	"	Fine sand and small pieces of wood, varying from 2 1/2 inches long downwards.
.48 "	3rd	15.2 "	calm.	Fine sand.
.43 "	4th	8.3 "	"	Coarse sand, coal, and cinders; largest, size of a pecan nut.

OBSERVATIONS with "Sand Collector."—Continued.

Velocity per second.	Quarter of Tide.	Sounding.	Wind.	Description of Deposit.
1.39	"	4th 13.0 ft.	calm.	Medium fine sand and gravel; largest, the size of a small pea.
1.48	"	13.4 "	"	Coarse sand and pebbles; largest, size of a grain of coffee.
1.68	"	L.W.St. 11.7 "	against	Coarse sand.
1.56	"	4th 9.1 "	"	Coarse sand and one pebble the size of $\frac{1}{4}$ of a pea.
1.49	"	" 10.6 "	"	Sand and gravel, largest the size of 2 coffee grains.
1.48	"	" 12.5 "	calm.	{ Fine sand, water logged chips and a few small pebbles the size of { $\frac{1}{4}$ of a pea.
1.36	"	3rd 11.0 "	"	Very fine sand.
1.62	"	2nd 11.3 "	"	Fine sand and gravel; largest, the size of a split pea.
1.10	"	" 13.9 "	"	Very fine sand.
1.01	"	1st 12.5 "	"	Nothing.
1.63	"	2nd 20.2 "	"	Medium fine sand.
1.50	"	3rd 15.3 "	"	Coarse sand and small pieces of wood.
1.50	"	" 15.3 "	"	{ 2 cub. inches of coarse sand and large proportion of small pieces { wood.
2.19	"	" 18.0 "	"	6 $\frac{1}{2}$ inches of coarse sand and small pieces of wood.
2.21	"	" 20.3 "	"	6 do do do
2.36	"	4th	"	45 do do do
2.27	"	" 13.1 "	"	16 do of fine sand and one small shell.
2.64	"	"	"	252 do coarse sand and pieces of wood.
2.86	"	" 12.1 "	"	30 do medium fine sand.
2.46	"	"	"	18 do fine sand and small pieces of wood.
2.29	"	" 9.8 "	"	216 do medium fine sand and small pieces of wood.
2.26	"	J.W.St.	"	54 do medium fine sand and a few pieces of wood.

The results given in the preceding table are given in their regular order, commencing just below the state dam in the City of Troy, and terminating at the village of New Baltimore.

An examination of this table shows, that the observed velocities varied from 0.67 of a foot per second as a minimum, of 2.86 feet per second as a maximum; or from about half a mile to about 2 miles per hour; that the materials found moving at the bottom were fine and coarse sand, gravel, pebbles, from the size of a quarter of a pea to the size of an almond, shells, coals, cinders, and pieces of water-logged wood; that small pebbles were found moving where the velocity of the current was as low as 0.91 of a foot per second, that the lowest velocity of current found to carry pieces of water-logged wood was 1.05 of a foot per second; pebbles as large as peas were found moving. That 1.36 feet was the lowest velocity of current in which fine sand was found; and that in no single instance within the 20 miles, was a particle of saw-dust observed among the materials brought up from the bottom.

In this connection, it is important to note that upon a small stream emptying into the Hudson, at Albany and near its mouth, there is an extensive saw-mill; that there is a large saw-mill on Green Island, at the west end of the State Dam, and opposite to the City of Troy, and that at both of these mills the saw-dust is cast into the river.

It is also important to note that, at Fort Edward, Sandy Hill, Glen's Falls, Warrensburgh, each of which points is located on the Hudson River, at distances varying from 40 to 75 miles above the City of Troy, the manufacture of lumber is and has been for nearly a century carried on, the annual product for the last ten years being estimated by experts at from 150,000,000 to 200,000,000 B. M.

At all these points, the saw-dust, together with large quantities of slabs and edging, are and have been, from the beginning, cast into the river.

At Glen's Falls, water is taken from the Hudson River to feed the Champlain Canal, and in dry seasons nearly the entire flow of the river is thus diverted.

Diligent enquiry has been made of gentlemen engaged in the lumber business, of canal officials, of persons who for many years were charged with, and gave their personal attention to keeping the Champlain and the Hudson River free from obstructions to navigation, and of persons engaged in navigating the river, and in transporting merchandise thereon; but I have failed to learn that bars or other obstructions to navigation, composed wholly or in part of saw-dust, have ever been formed either in the Champlain Canal or in the Channel of the Hudson River. In order to find an explanation of the real or apparent absence of saw-dust in the Hudson River, I have been compelled to resort to experiment; there being no engineering authorities upon the subject of the specific gravity of saturated saw-dust or upon the velocity of current necessary to take it up and transport it.

SPECIFIC GRAVITY OF PINE.

My experiments have been wholly confined to white pine wood, in blocks and in the condition of saw-dust, both dry and saturated with water. I have thus limited myself, for the reason that white pine constitutes the principal part, if not the entire product at the City of Ottawa; and for the reason, that, upon the Hudson, for many years, little else than pine lumber was manufactured.

Blocks of white pine unseasoned have, according to different authorities, specific gravities varying from 0.46 to 0.65, depending in some degree upon the locality in which it is grown.

According to my experiments, the specific gravity of white pine, in different conditions as to dryness, is as follows:—

Unseasoned, specific gravity	=	0.466
Partly seasoned “ “	=	0.418
Dry “ “	=	0.337

It would therefore seem that this wood, when reduced to the condition of saw-dust as well as in mass, should float upon the surface of water; but our observations generally, as well as observations made for the specific purpose of ascertaining its behaviour in water, teach us that when unseasoned coarse pine saw-dust is placed in still water, a large portion will immediately sink, and that within three days the whole will sink to the bottom.

This is generally attributed to the fact, that the finely divided wood readily absorbs water and becomes water-logged. But it is to be borne in mind that since a particle of saw-dust, when thoroughly water soaked, is heavier than water, and since the absorbed water can be no more dense than an equivalent volume of water at any other point in the mass, the ultimate fibre of the wood must be heavier than water, else the water soaked particle would not sink. This appears to be the case also from the fact that some of the particles sink immediately; while the wood, in its normal condition, invariably floats on the surface of the water.

I explain this apparent anomaly by saying, that those particles which sink immediately are such as have been condensed by the action of the saw in cutting them from the wood, and thus reduced to less than half their original volume when in the natural state.

Having satisfied ourselves, then, that the fibre of pine wood is heavier than water, it becomes necessary to ascertain precisely how much heavier than water it is; for it is upon this fact, together with the specific gravity of the dry wood (in the block), that we must base our conclusions as to the probable behaviour of saturated saw-dust in water, as compared with that of the usual constituents of bars.

Careful experiment, undertaken for the express purpose of determining this point, shows that the specific gravity of the fibre of pine wood is 1.2624, or that the fibre is about 26 per cent heavier than water. But the saturated particle of saw dust, consisting as it does of a bundle of these fibres with the interstices filled with water has a still different specific gravity.

To ascertain this approximately, we take thoroughly seasoned white pine wood, assume that the mass of wood is made up of a definite volume of woody fibre of known specific gravity, and that sufficient void space is enclosed in the mass to reduce its specific gravity as a whole to what has been determined for it, viz. 0.337.

Since then, the specific gravity of the mass is only 0.337, and that of the fibre 1.2624, it follows that only $\frac{0.337}{1.2624} = 0.267$ of the wood is made up of woody fibre, while the remainder $1.00 - 0.267 = 0.733$ of the entire volume is void of space, which is capable of receiving and retaining water. We have then in saturated sawdust a compound of 0.267 of woody fibre, specific gravity 1.2624 and 0.733 of water, specific gravity 1.00.

The specific gravity of the compound or of the saturated particle of sawdust, is determined as follows :

$$\begin{array}{r} 0.733 \times 1.00 = 0.733 \\ 0.267 \times 1.26 = 0.33642 \\ \hline 1.000 \qquad 1.06942 \end{array}$$

Thus it appears that the volume of the wood remaining unchanged during the process of absorption, the specific gravity of the saturated particle will be 1.06, or about 7 per cent heavier than that of water. But as there is always an enlargement of volume during absorption, the saturated particle will contain a larger proportion of water than we have used; and hence, the actual specific gravity of the saturated particle will be even less than 1.069.

In my opinion 1.05 will more nearly represent the specific gravity sought; indeed this is indicated by certain weights observed for other purposes during the progress of my experiments.

Whatever may be the precise specific gravity of the saturated particle, the fact is established that it is only very slightly in excess of that of water; and hence, that the velocity of current required to lift and transport it after it has been once sunk must be very slight.

VELOCITY OF CURRENT REQUIRED

For the purpose of ascertaining what velocity of current will take up and remove deposits of saturated saw-dust, a wooden trough was procured, which was *four feet long, three inches wide, and three inches deep*. Three inches from one end of this trough, a bulk-head was placed, forming a compartment of 27 cubic inches capacity for the reception of the water. The bulk-head was perforated with a large number of small holes, designed to allow the water to flow through into the trough without producing undue agitation or disturbance of the water flowing below. At the other end of the trough, a weir was placed, which was finally regulated to such a height, as to just discharge the water flowing in the trough when the requisite velocity had been obtained. The height of this weir, as it was finally adjusted, was one inch, and it extended entirely across the end of the trough.

The depth of the flowing stream in the trough was generally about one inch and a half; the precise depth being however measured during the progress of each experiment. The trough having been carefully levelled, water was admitted into the upper compartment, from a hose attached to a hydrant, and the flow was adjusted by a cock at the hydrant. Thoroughly saturated, coarse, white pine saw-dust was then scattered into the trough in such quantity as to entirely cover the bottom where it remained at rest.

The flow of water was then gradually increased until the particles of saw-dust manifested a decided tendency to rise and move down stream to and over the weir. The rate of flow was such that about a teacupful of the saturated saw-dust was removed in from twenty to thirty minutes.

It is proper to remark, however, that the particles were moved slowly, at a velocity considerably less than that finally established for the experiments.

During the progress of the experiments the water discharged over the weir was repeatedly collected and weighed, and the section of the flowing stream measured.

From data thus obtained, the following velocities have been calculated for coarse sawdust :—

1st Observation, velocity	=	0.290	feet	per	second.
2nd " "	=	0.283	"	"	
3rd " "	=	0.280	"	"	
4th " "	=	0.281	"	"	

From which we obtain a mean of 0.2835 feet per second; or less than $\frac{1}{4}$ of a mile per hour.

At the conclusion of these observations, a very small accumulation of sawdust remained just above the weir; which, by the way, was slowly disappearing. The flow then gradually increased to such an extent that the accumulation referred to was taken up and entirely removed in about one minute.

Under this condition of things the velocity of the current was found to be only 0.382 of a foot per second, or about $\frac{1}{4}$ of a mile per hour. At this point, then, we have established the following facts, viz. :—That a current velocity, considerably less than one-fifth of a mile per hour, suffices to take up and transport slowly, coarse saturated pine sawdust; that a velocity of one-fifth of a mile per hour produces a very decided movement down stream of such particles, and that a velocity of one-fourth of a mile per hour suffices for their entire and instantaneous removal. Experiments were also made with very fine saturated sawdust, and it was found that the decided movement of the particles was effected by a current velocity of 0.246 of a foot per second; also, that the instantaneous removal of the very small accumulation just above the weir was accomplished by a current of 0.288 feet per second, or very nearly a quarter of a mile per hour.

Thus it appears that with saturated sawdust, as with gravel, stones, pebbles of different sizes, and other materials of nearly the same specific gravity, the velocity required to remove the particles varies with the size of those particles, in other words, the larger the volume of the particle, the greater the velocity of current required to transport it.

The accuracy of the determination in regard to coarse sawdust was verified by other experiments with that material; as the result of which the velocity promptly moved the particles was found to be 0.290 of a foot per second.

In the case of particles of materials of different specific gravities, but of the same size, it is clear that the force or velocity of current required to move them will vary with their specific gravities, and hence, we can readily understand why a current, which carries pieces of water-logged wood, may only be able to carry coarse sand or fine gravel stones; and why, as in the case of the observations on the Hudson River, both these materials, together with fine sand, may be found in motion at the bottom of the same place, and at the same time.

The absence of bars or accumulations of sawdust in the channel of the Hudson River is therefore readily accounted for.

It will be remembered that the minimum velocity of current found by the U. S. Engineers, between the head of navigation and the village of New Baltimore, was more than double that which we have found to be capable of transporting saturated sawdust (0.67 to 0.28.)

From the lumber manufacturing region to the head of navigation, the fall in the river is over 100 feet, the velocity of the current must therefore be greater than that upon that portion of the river embraced in the Government surveys.

We should expect then that the sawdust cast into the river would be carried down the river by the current; while the total absence of any accumulation of sawdust in the Champlain Canal, proves that whatever refuse from the mills, at and above Glen's Falls, finds its way into it through the Glen's Falls feeder, must be carried down by its current, and be ultimately discharged, with the waters of the canal, into the Hudson River at Troy and Albany, whence it is finally carried to the sea.

That there is nothing inconsistent with this theory in the immense quantity of sawdust annually produced on the Hudson River may be readily shewn.

Taking the annual production of lumber on the Hudson River at 160,000,000 feet, and assuming, as we are authorized to do, that the average thickness of this lumber will not exceed $1\frac{1}{2}$ inch, and also taking the thickness of material cut out by the saw at $\frac{3}{16}$ of an inch, it appears that a cubic foot of solid wood is reduced to the condition of sawdust for every 80 feet of lumber sawed.

In a year, then, the aggregate volume of wood reduced to saw dust, will be $160,000,000 \div 80 = 2,000,000$ cubic feet. At 30 pounds to 80 cubic feet, this volume of pine wood, will weigh 60,000,000 pounds or 30,000 tons.

The water shed of the Hudson River, above Fort Edward, has been estimated by the State Engineers at 1,374,500, acres. A fair estimate of the rain-fall collected into and carried off by the river, is a volume equivalent to a depth of 20 inches of water on the entire water shed each year. This gives, for the annual flow of the river at Fort Edward, 99,788,700,000 cubic feet, whence it follows, that the ratio of the volume of wood reduced to saw dust, to the volume of water flowing in the river is 1 to 49,894.

Assuming now that the saw dust is uniformly distributed throughout the water, let us, in order to make the comparison more intelligible, see what volume of wood will be contained in a barrel of water. The computation shows that in a barrel of $31\frac{1}{2}$ gallons there will be just $\frac{1}{1000}$ of a cubic inch of wood.

By weight the relation between the wood and water is as 1 to $\frac{49894}{0.5}$ or as 1 to 99,878 in which, for convenience, we take the specific gravity of the wood at 0.5, which is sufficiently near the truth for our purpose.

Now, in a wine gallon of water, there are about 64,051 grains, whence it follows that in case of the assumed uniform distribution of the saw dust, there would be in a wine gallon of the river water, at Fort Edward, only $\frac{64051}{99878} = 0.641$ of a grain of saw dust.

At Troy, below the junction of the Mohawk River, the flow of the river is fully three times as great as it is at Fort Edward. Here, then the relative quantity of saw dust is only one-third as great as at Fort Edward, or, 0.214 of a grain to the gallon.

Further down the river, as at Ploughkeepsie, the flow of the river is fully four times as great as at Fort Edward, and, as a consequence of the continued dilution, the quantity of saw dust at this point would be only 0.160 of a grain to the gallon.

Specimens of the water from the river at Ploughkeepsie, taken from a point 60 feet from the surface and 10 from the bottom, have been recently analyzed by Professor Chandler, of Columbia College. Professor Chandler's analysis shews that a wine gallon of this water contained 1.239 grain of organic and volatile matter. Croton water contained only 0.67 of a grain.

Hudson River water contained 0.373 of a grain of organic carbon to the gallon. Croton water only 0.287 of a grain.

The excess of organic and carbonaceous matter in the Hudson River water is accounted for by the sawdust, which our experiments, together with the current observations of the United States Engineers, show may be, and undoubtedly is, carried not only to that point, but still further onward to the sea.

We can readily understand, also, in view of the very small quantity of sawdust, as compared with the flow of the river, that it may be floated downward with the water, without attracting attention, even from those directly charged with ascertaining what material were held in suspension in the water at and near the bottom, and were being carried down by the current.

Another important fact worthy of note, as shewing that in the vicinity of Albany, at least, the bars and accumulations which obstruct navigation, are entirely free from sawdust, is, that the sand used in the masonry of the Erie Canal, between Albany and Cohoes, as well as that used in the masonry of the foundations of the new State Capitol, was taken from those bars, on account of its extreme purity and freedom from organic matter.

I have been thus particular in the examination of the Hudson River, in reference to the question of sawdust deposits, for the reason, that it is in many respects a parallel case to that of the Ottawa River, and hence, that the experience on the former would serve, in some degree, to indicate what may be expected to occur on the latter.

Both are large rivers, and upon both large quantities of lumber are manufactured.

Upon the Hudson, the bulk of the pine was manufactured into lumber many years ago; while now, the lumber made is principally hemlock and spruce. Upon the Ottawa, the bulk of the lumber thus far made has been from white pine.

The quantities of lumber manufactured annually on the two rivers are about the same, the product upon the Hudson being probably somewhat in excess of that upon the Ottawa. In the length of time, however, during which lumbering operations have been carried on upon the two rivers, there is a marked difference upon the Hudson; there operations have been carried on for nearly a century, and, from the best information attainable, it is probable that during that time an average of nearly 20,000 tons of sawdust have been cast into the river annually, besides large quantities of slabs and edgings, so that the aggregate quantity of refuse from the mills, thus cast into the river, may be safely put at 2,000,000 tons. As sawdust, this would occupy a space of about 400,000,000 cubic feet, equivalent to a cubical pile 1,000 feet square at its base, and 400 feet deep.

Upon the Ottawa, on the contrary, extensive lumbering operations were only commenced at a comparatively recent period. Again, the saw mills upon the Hudson are more than 200 miles from its mouth, while upon the Ottawa, they are less than half that distance; both are, for the most part, comparatively sluggish streams.

Thus it appears that the very question under consideration has been subjected upon the Hudson River to a very severe practical test, covering a period of nearly a century; and yet that sawdust obstructions in the navigable channel, or in the canals fed from the river, have never been known.

THE PENOBSCOT RIVER IN MAINE.

Sworn statements have been obtained of persons who have been engaged upon and are acquainted with the Penobscot River, in the State of Maine, which runs through a pine timber region, upon which very extensive lumbering operations have been conducted for many years, and into the waters of which vast quantities of sawdust and edgings are and have been cast.

These statements shew that accumulations of sawdust alone in the channel of that river have never been known; and that no injury, impediment or obstruction to its navigation has ever resulted from the casting of sawdust into it.

CONCLUSION.

In view of my experimental results, together with the facts observed by the United States Engineers upon the Hudson River, and in view of the experience of lumbermen and navigators upon the Hudson and Penobscot Rivers, I have formed the following, viz:

That saturated pine sawdust will not be permanently deposited in the water where the velocity of the current exceeds 0.25 of a foot per second, or one-sixth of a mile per hour; that water-logged chips may be deposited when the velocity of the current is less than 1.00 foot per second, or about two-thirds of a mile per hour; that sawdust may accumulate in eddies and in still water, or where the velocity of the current is permanently less than 0.20 to 0.25 of a foot per second; that bars of sand and sawdust combined, will not be formed under any circumstances; for the reason, that when the velocity of the current is diminished so as to permit the deposit of sand, it is still more than twice as great as is necessary to hold and transport saturated sawdust, and hence, that sawdust will not accumulate or be permanently deposited in rivers where sand-bars occur, unless there exist expansions of the river, below such sand-bars, sufficient to make a cross section, more than double that at the site of the bar; that if, in low water, sawdust should accumulate

in small quantities, the accumulated current of the first freshet would take it up and sweep it down stream; and finally, as it is extremely improbable that the minimum freshet, velocity in the Ottawa River ever falls below 0.25 of a foot per second, there is no reason to anticipate the permanent formation of troublesome bars or accumulations in that river.

This opinion may be modified or strengthened when more definite and precise information shall have been obtained in relation to the magnitude of the Ottawa River, its watershed and other characteristics.

I am, Sir, very respectfully,
(Signed,)

D. M. GREENE,
Civil Engineer.

APPENDIX No. 3.

H. F. BRONSON, Esq.

DEAR SIR,—Since my arrival in Ottawa, I have been put in possession of such information as to the magnitude, character, and habits of the Ottawa River, as will enable me to form more definite and decided opinions as to the possible effect upon navigation which may be produced by casting sawdust into the river at this point.

I learn from a paper, signed A. J. Russell, that the extent of territory drained by the Ottawa and its tributaries above the city of Ottawa, is 43,000 square miles; that between the city of Ottawa and Grenville, the territory drained is 19,000 square miles; and that 4,000 square miles additional territory is drained below Grenville.

The total territory drained by the Ottawa and its tributaries is then as follows:—

Above the City of Ottawa	43,000 square miles.
" " Grenville.....	62,000 " "
" " Montreal	66,000 " "

From the same source, I learn that by the report of the Canadian Legislature of T. C. Clarke, Esq., O.E., of his survey for the Ottawa Canal navigation, the mean discharge of the Ottawa (by a series of observations) at Grenville is 85,000 cubic feet per second; that at low water the discharge is 35,000 cubic feet per second; and that at high water the discharge is 150,000 cubic feet per second; also that the annual precipitation of rain and snow in this part of the Dominion may be safely taken at 40 inches of water.

That the foregoing data are sufficiently reliable for our purpose, or that the territory drained and the rainfall are equally in error in the same direction (which is extremely improbable), is indicated by the relation which the mean flow of the river bears to the rainfall. 85,000 cubic feet per second for a year represents a volume of water equivalent to 18.2 inches deep over the entire drainage territory above Grenville, or $\frac{18.2 \times 100}{40} = 45\frac{1}{2}$ per cent. of the rainfall. This being substantially the usual estimate of engineers for the volume of water flowing in streams of this character, I feel warranted in assuming that the information furnished by Mr. Russell is reliable.

It appears then that the Ottawa River at the city of Ottawa is $\frac{43,000 \times 10}{19,000} = 20$ times as large as the Hudson at Fort Edward, and $6\frac{2}{3}$ times as large as the Hudson at Troy.

Comparing the Ottawa at Grenville with the Hudson at Troy, we find that the former is ten times as large as the latter.

It follows, then, since the minimum observed velocity at that point in the Hudson was $2\frac{1}{2}$ times that required to transport saturated saw-dust, that no deposit can occur in the channel of the Ottawa unless some point can be found where the cross section of the river is $10 \times 2\frac{1}{2} = 25$ times as large as that of the Hudson at Troy.

Those who are acquainted with both rivers will scarcely admit the existence of such a point on the Ottawa.

In the absence of precise data as to the width and depth of the Hudson at Troy, I have been compelled to resort to the determination of velocities at various points upon the Ottawa between the cities of Ottawa and Montreal; for this purpose I have had recourse to the maps constructed from the surveys of the Ottawa River, made in 1856-7-8, under the direction of W. Shanly, C.E., facilities for the examination of which were kindly furnished by the Deputy Commissioner of Public Works.

These maps show that between the city of Ottawa and the head of the lake above Grenville the maximum width of the river is 4,000 feet, and that its minimum width is about 1,400 feet, while the maximum depth of water recorded was 30 feet.

The maximum width of the lake referred to is about 7,600 feet, and the maximum depth of water recorded 30 feet.

Two miles above Grenville the width is 2,400 feet and the maximum depth 30 feet. Three miles above Grenville the width is 1,800 feet, and the maximum depth 30 feet. One mile above Grenville the width at the time of the survey was 1,200 feet, and the maximum depth 26 feet.

At Grenville the width was 1,600 feet, and the maximum depth 30 feet. Just above Grenville, the maximum width between banks, is about 8,000 feet, and here, in consequence of the extreme width of the river in high water, together with an abrupt change in the direction of the channel, a large sand shoal has been formed, which was bare at the time of the survey. The existence of other "sand shoals" is indicated at points further down the river. In a distance of four miles below Grenville, the maximum width is about 3,600 feet; the depth, however, is not indicated, I shall assume that it is thirty feet or over.

Below the Chute à Blondeau, in a distance of five miles, the maximum width is about 3,000 feet, and the depth will be taken at thirty feet or over (Mr. Clarke puts it at from thirteen to thirty feet.)

A careful examination of all the depths recorded upon the maps, and reference to the report of Messrs. Clarke & Shanly, satisfy me that although the depths of water sometimes exceed thirty feet, the excess cannot be great.

In order, however, to cover any possible excess over thirty feet, I shall assume in computing the sections of the river, at the various points where the widths have been given, that the depths given and assumed are the *average* depths of the sections.

It will be seen that while I shall thus obtain sectional areas largely in excess of the true areas, where the soundings were frequent, and the maximum depth of water definitely ascertained, I shall provide for a large margin for safety, wherever there is any uncertainty as to the maximum depth of water. In this manner I shall obtain velocities which, if they vary in either direction, will fall below the actual velocities.

APPROXIMATE SECTIONS AND VELOCITIES AT LOW WATER.

By the process indicated above, I find the maximum cross-section, and the minimum mean velocity, between the city of Ottawa and the head of Lake Original, to be 120,000 square feet, and 0.30 of a foot per second respectively, while the minimum section and the maximum velocity are 42,000 square feet and 0.83 of a foot per second respectively.

In Lake Original the maximum section and the minimum velocity are 228,000 square feet, and 0.154 of a foot per second respectively.

At a point four miles above Grenville the section and velocity are 96,000 square feet, and 0.37 of a foot per second respectively.

Three miles above Grenville the section and velocity are 54,000 square feet, and 0.65 of a foot per second respectively.

Two miles above Grenville the section and velocity are 52,000 square feet, and 0.50 of a foot per second respectively.

One mile above Grenville the section and velocity are 31,200 square feet, and 1.12 feet per second respectively.

At Grenville the section and velocity are 48,000 square feet, and 0.73 of a foot per second.

In a distance of four miles below Grenville the maximum section and the minimum velocity are 108,000 square feet, and 0.32 of a foot per second respectively.

In a distance of five miles below the Chute à Blondeau the maximum section and the minimum velocity are 90,000 square feet, and 0.39 of a foot per second respectively.

In Lake of Two Mountains the maximum section and the minimum velocity, by the process adopted, appear to be 315,000 square feet, and 0.11 of a foot per second respectively; but here, as in Lake Original, our section, judging from Mr. Clarke's statement in regard to depth of water and the natural formation of the bed in such cases, is much larger than the actual section, and our velocity as much too small. Half the section found, and double the velocity would, in my judgment, more nearly accord with the actual section and velocity.

However, we will let the results stand as we have found them, and proceed to the determination of the approximate velocities at high water.

APPROXIMATE VELOCITIES AT HIGH WATER.

The volume of water flowing in the Ottawa River, at Grenville, at high water, is about four times as great as that flowing in time of low water; more accurately it is $\frac{180,000}{37,000} = 4.29$ times as great.

Taking now the average depth between the city of Ottawa and Grenville, at high water, at fifty per cent. greater than that at low water, the sections will also be fifty per cent. greater in high water than they are in low water.

The minimum velocity then between Ottawa and Grenville, in high water, will be $\frac{4.29}{1.5} \times 0.37 = 1.06$ feet per second; a velocity sufficient to carry small gravel stones, and four times as great as that required to take up and transport saturated pine sawdust.

In the widest portion of Lake Original, the velocity will be $\frac{4.29}{1.5} \times 0.154 = 0.44$ of a foot per second, or more than 50 per cent more than is required to move sawdust, and sufficient to move fine sand.

Below Grenville, taking the depth at high water at 40 per cent greater than that at low water, the minimum velocity in a distance of 4 miles will be $\frac{4.29}{1.4} \times 0.39 = 1.20$ feet per second.

In the Lake of Two Mountains, taking the depth at high water at 30 per cent greater than that at low water, the minimum velocity will be $\frac{4.29}{1.3} \times 0.11 = 0.34$ of a foot per second, or more than 20 per cent greater than that required to move saturated pine sawdust.

That the velocities which we have thus deduced are none too high, but that they are in all probability much too low, especially in Lake Original and in Lake of Two Mountains, by the fact that "sand shoal" occur below these points, which could not have been formed had not the velocities above them been at least 0.50 to 0.60 of a foot per second, or sufficient to have taken up and transported the sand to the point of its final deposition.

The current which was capable of doing this, was still able, after a reduction of velocity, which permitted the deposit of the sand to sweep the sawdust forward and into the more rapid currents below, which would hurry it on with varying speed until the waters of the Ottawa mingle with those of the St. Lawrence at Montreal.

Thus it appears that while it is barely possible (though altogether improbable) that in extreme low water slight deposits of sawdust may accumulate in the deep water, in Lake Original, and in Lake of Two Mountains, the first succeeding high water would inevitably sweep such possible accumulations forward to the St. Lawrence.

As a matter of curiosity, suppose we admit that no sawdust is carried below Grenville, or that it is wholly deposited in Lake Original, and ascertain, if possible, what the result would be at the end of a century.

Taking the annual manufacture of lumber at the City of Ottawa at 16,000,000 feet B.M., and assuming, as we have already shewn, that a cubic foot of solid wood is reduced to the condition of sawdust for every 80 feet of lumber sawed, we get for the volume of wood annually reduced to sawdust $\frac{160,000,000}{80} = 2,000,000$ cubic feet.

This, as sawdust, would make 6,000,000 cubic feet annually. Then, in a century, the accumulation would be 600,000,000 cubic feet.

The length of lake is about 6 miles; if, then, we assume that this mass of sawdust is spread over a portion of the river bed 6 miles long, and 4,000 feet average width, the depth of the accumulation would be only $\frac{600,000,000}{1600 \times 6 \times 5280} = 4.74$ feet deep, and would reduce the depth from 30 feet to 25.26 feet.

If the width of the accumulation be assumed at only 2,000 feet (maximum width of the lake is 7,600 feet), the depth of the accumulation would be 9.48 feet, and the effective depth of the channel would be reduced to from 30 to 20.52 feet.

If this process of accumulation were to go on, the section of the stream would be gradually reduced, and the velocity increased, until at length it would become sufficiently great to carry down not only sawdust, but heavier material as well.

A channel 2,000 feet wide, and having an average depth of $17\frac{1}{2}$ feet, is required to discharge the minimum flow of the river at Grenville with a mean velocity. If the average depth remained constant, and the width be reduced to 1,000 feet, the requisite mean velocity would be 2.00 feet per second.

Thus, in this view of the case, it appears that a serious obstruction to the navigation of the river, as the result of the floating and subsequent deposition of loose material, would be next to impossible—except at such points as, on account of great width of section, afforded the requisite cross-section with a depth less than that required for the purposes of navigation.

Samples of material, six in number, taken from the shoal places between the City of Ottawa and Grenville, have been shewn me. These materials are wholly composed of pure, clean sand, of different degrees of fineness. Not the slightest indication of the presence of sawdust can be detected in any of the samples, even when examined under a glass.

As the result of this further investigation, together with the examination I have made of the materials taken from the shoals in the Ottawa River, the opinions which I expressed in my former communication are not only confirmed, but are very materially strengthened; and I now feel no hesitation in expressing the opinion that sawdust obstructions have not thus far been formed in the channel of the Ottawa River, and that there is no reason whatever to apprehend the formation of such obstructions in the future.

I am, Sir,

Very respectfully,

D. M. GREENE,
Civil Engineer.

Ottawa, Ontario,
March 10th, 1871.

APPENDIX NO. 4.

William J. McAlpine, of the City of Albany, State of New York, being duly sworn deposes and says,—That he is a Civil Engineer, and has been practising as such for the last forty-five years; and from eighteen hundred and thirty-four to eighteen hundred and fifty-four, on the eastern division of the canals of New York, embracing the Champlain and Glens' Falls Feeder Canal, in the capacity of Resident Chief, and State Engineer.

That he has had charge of the enlargement of the Glens' Falls Feeder, and the reconstruction of its locks, and also of the Champlain Canal, and (during his term of office as State Engineer) of the removal of the Castleton bar on the Hudson River, about six miles below Albany.

That while in the State Service, he has had occasion to pass over the Champlain Canal and Feeder almost every spring, during the time that the workmen were engaged in removing the deposits from the bottom of these canals, the character of which deposits he has carefully noted. That he has been familiar with the traffic upon the said canals for the period above mentioned, and also with the vast amount of lumber manufactured on the Hudson River above, at and below the said Feeder Canal.

That in the removal of these deposits from the said canals, he has never seen or heard of any accumulation of sawdust in any part or place in the channels of these canals, and has never heard of any complaint having been made of any such obstruction to the navigation of the Hudson River above Glens' Falls, nor below Fort Edward (the river between those two places being an almost continuous rapid.)

That during the removal of the Castleton bar, by the direction of the Legislature in eighteen hundred and fifty-two, he has had occasion to frequently visit and examine the material excavated, and never observed, or heard of any deposits of sawdust at that place, but that he has seen so removed, sunken logs and decayed wood.

He further deposes and says that much of the sand used for the masonry of the enlargement of the Erie Canal, between Cohoes and Albany, was (by his direction) taken from the Hudson River bars, in consequence of its great purity and entire freedom from woody or organic matter, and more recently, viz., in eighteen hundred and sixty-nine, he directed that the sand for the twenty-five thousand cubic yards of masonry in the foundations of the new Capital at Albany, should be taken from the sand bars in the said river, opposite and below that city, for the reasons first above stated.

That he has had occasion to examine the deposits made upon many other rivers in the United States, where large lumbering operations were carried on, as on the Delaware, Susquehanna, those in the State of Maine, and some in the Western States, and that he has never seen or heard of any obstruction or impediment to navigation on those rivers from the deposition of sawdust.

That he believes from the inferior weight of long water-saturated sawdust, to that of even the finest sand, the former will always be moved forward by a current, which will just begin to deposit the latter, and hence that the two would rarely be deposited in the same place, and never on a bar where there is a current of more than one fifth of a mile an hour, and in a running stream, it will only be deposited where there is almost no current, such as in eddies or in every wide expanses of the stream; and even if it should happen to be left in any regular navigable channel, it would, of itself, form almost no obstruction to a vessel, which would only stir it up, and then it would be floated forward and deposited in another place, where it would do no injury to the navigation. And further, his deponent sayeth not.

United States of America.
Commonwealth of Massachusetts, Berkshire, S.S.,
16th February, 1871.

Subscribed and sworn to before Mr. Edgar W. Wood.
Commission of the Circuit Court of the United States.

W. J. McALPINE,

APPENDIX No. 5.

To H. Bronson, Esq., Ottawa.

ALBANY, March 1st, 1871.

DEAR SIR.—Professor D. N. Greene and myself have discussed the question which you have presented to us, viz: The effect upon the navigation of the Ottawa River, of discharging therein the sawdust from the manufactures at and above Ottawa.

With this you will receive an exhaustive and elaborate report upon the subject from Professor Greene, which I have carefully examined and discussed with him, and as I

entirely concur therein, I will only state the leading points and will add thereto the results of my own observation and experience in regard to this subject.

As there is no engineering authority which furnishes the specific gravity of saturated sawdust, or of the velocity of the current required to remove it, Professor Greene has been compelled to resort to direct experiment to determine these two points both of which are necessary to the solution of the question involved. The results of his experiments are that the specific gravity of water saturated sawdust (or of its weight compared with water) is 1.05 +. The velocity necessary to move coarse saturated white pine sawdust, lying on a smooth bottom of a stream, is 0.282 feet per second, equal to about one fifth of a mile per hour, and of pine saw dust is 0.246 feet per second, or about one sixth of a mile an hour.

The United States Government engineers ascertained that the sand and even small gravel stones in the Hudson River near Albany, were moved along the bottom by velocities of 1.4 to 1.7 feet per second, and in a few cases with those of even one foot velocity.

Other standard authorities agree substantially with these results.

The specific gravity of the individual particles of the Hudson River sand is from 2.25 to 2.66, as they may happen to be of slate, mica, teldspar or quartz.

As sand or fine gravel, with a specific gravity of, say 1.5 feet per second, these experiments and authorities shew that Professor Greene's results may be relied upon as substantially correct, as applicable to the case in hand, and therefore that no permanent deposit of saw dust will take place, where the velocity of the current exceeds 0.25 feet per second.

The mean annual volume of the saw dust cast into the Hudson is but one hundred thousandth part of the volume of the water passing at Albany, or about half a grain to the gallon, while it is well known that a portion of such sawdust is deposited above low water mark and is decomposed, all of the remainder (except that which is not deposited in the shallow side basins) is undoubtedly carried forward to the sea.

Analysis of the water from the very deep places toward the mouth of the Hudson, show the presence of even larger quantities of material of this character, and therefore that this sawdust is carried thus far seaward, and a similar analysis would doubtless shew its presence at the mouth of the river.

That the velocity of water in the Ottawa river generally exceeds that required to move sawdust forward, is evident from the well known fact that the bars in the wide expansions of the river are composed of clay, sand and gravel, all of which required a much greater velocity to transport them to these places, and whenever this velocity was lessened enough to permit of the disposition of these materials, it still greatly exceeded that necessary to carry the sawdust onward.

If a deposition of sawdust should happen to be made in the channel, its small excessive weight compared with that of the water would render it almost no impediment to the first vessel which passed, and that would clear the channel for the next one, while the first freshet in the river would doubtless entirely sweep it out.

A considerable portion of the sawdust which is thrown into the stream will doubtless accumulate in the side bays of still water, and sometimes, perhaps temporarily in parts of the channel, where previous obstructions have been produced by logs, brush, slabs, leaves, sand, &c., but in these cases, it will again be removed by the first freshet.

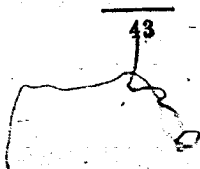
I have not examined the navigable channel of the Ottawa with reference to this particular question, and have therefore based my opinion upon my observations for many years of the Upper and Lower Hudson, the Delaware, and Susquehanna, the rivers in the State of Maine, and those in some of the Western States, where very large sawmills have been in use for many years.

In all of these cases, I have never observed, nor heard of complaints made of any obstruction or impediment to the navigation, by vessels or floats, from the deposition of saw-dust.

The present investigation satisfactorily explains why no such deposits or obstructions to the navigation of those rivers have occurred.

Respectfully yours,

WM. J. McALPINE.



APPENDIX No. 6.

STATE OF NEW YORK,
Rensselaer County. }

Thomas McManus being duly sworn, deposes and says:—That he resides in the city of Troy, and is the senior member of "the Hudson River Transportation Company," whose offices are at No. 191 River street, in said City, and the business of said Company consist in the transportation of merchandize upon barges and otherwise in the Hudson River between the cities of New York and Troy and intermediate points.

Deponent further says: that he has been acquainted with the said Hudson River and its navigation for the period of twenty-five years, and that he has been actively engaged in the navigation thereof for the twenty-three years last past.

Deponent further says: that he has been an alderman of said city of Troy; that during the time he served as such alderman, he was Chairman of the Committee on Navigation, the chief duty of which was to keep the Hudson River in navigable condition, within the limits of the said city; that said Committee had charge of the city dredge; and also had control of its operations.

Deponent further says: that he has a large acquaintance with persons engaged in the navigation of the said Hudson River; and that such acquaintance, together with his own personal experience and observation, have afforded him unusual facilities for knowing the location, magnitude and character of the bars and other obstructions to navigation in said Hudson River, and of the kind of material of which they are and have been composed. Deponent further says: that said obstruction and bars are caused by the deposit or accumulation of sand and gravel, together with sunken logs and pieces of timber, the latter being, in deponent's opinion, an active primary cause of these obstructions which contain them. Deponent has never seen or heard of any obstruction or impediment to navigation which were caused by the deposit or accumulation of sawdust alone; nor had he ever heard of any complaint or objection having been made that sawdust cast into the river from saw-mills on its banks or elsewhere become deposited in bars, or that it had a tendency to be so deposited, or that it injured or impeded navigation in any manner whatever.

Deponent further says: that he does not believe that sawdust alone has been or will be deposited, or that it will accumulate on the bottom of a channel of a navigable river like the Hudson to such an extent and of such consistency as to produce any impediment or obstruction to the free navigation of such river.

Subscribed and sworn to, before me, this }
18th day of February, 1871. }

(Signed), F. McMANUS.

(Signed),

D. M. GREENE,
Commissioner of Deeds.

APPENDIX No. 7.

STATE OF NEW YORK,
Warren County. }

Jeremiah W. Finch being duly sworn, deposeseth and saith, that he resides in Glens Falls, in said County, is President of the Glens Falls National Bank, and is engaged in the business of manufacturing lumber, and has been for twenty years on the Hudson River, and is now part owner of three large saw-mills on the said river, and is familiar with the business of manufacturing lumber in all its branches, from the cutting the timber on the stump to the sale of the lumber in the market.

That the firm of which deponent is a member, transports most of the lumber they manufacture to the cities of Brooklyn, New York and other places intermediate, Glens Falls and New York.

Deponent further says: That most of the lumber has been cut off the Hudson River proper, and the principal part is now obtained from the tributaries of said river, and much of it from quite small brooks and creeks, and so small that the timber can only be floated out by means of dams, ponds, and artificial flooding, the effect of which is to wash the banks of the streams very much, and thereby fill the waters with much earth, which is carried down into the main stream, and some of it into the canal, and which gradually settles and is deposited on the banks and bed of said river and canal. That all or nearly all the mills cast more or less edgings and other refuse into the river, as well as sawdust. That in the eddies of the river the edgings have in some few instances lodged, and by means thereof sawdust, sand, and other deposit collected and settled around, between, and upon them but that no accumulations have formed in the *channel* of the river, and that the sawdust alone does and will not accumulate or form any obstruction to navigation whatever; that deponent has never heard or known of any collection or accumulation of sawdust alone in the canal or Hudson River, nor of any accumulation or collection of edgings with sawdust and earth that was an obstruction, or which impeded or impaired the navigation of said river or canal. That no one in this community, so far as deponent knows or has ever heard, claims or has ever claimed that sawdust made by the saw-mills was injurious to navigation, or tended to injure the same either in the canal or river, nor has any objection been made to sawdust being discharged into the river so far as deponent knows or has any information or belief. Deponent further says: That upon his information he firmly believes that sawed lumber has been manufactured on the Hudson River for the last seventy five to one hundred years; that deponent's belief is founded as well upon the general statements, traditions and history of this portion of the country, as the fact that some of the ancient title deeds, forming a link in the chain of the title of some of deponent's mill property and which were made in the seventeenth century recognizing then existing saw-mills, and defining the rights and privileges of the same respectively as well as to the use of water and other rights in common as the boundaries of the mill sites. Deponent further says, that Glen's Falls is located on the Hudson River, about fifty miles above Troy and Albany; and also in deponent's opinion and belief, that for the last ten years there has been manufactured on said river, on an average, annually, not less than from one hundred and fifty to one hundred and seventy-five millions feet of sawed lumber, and before that time not quite as much.

(Signed,) S. W. FINCH.

Subscribed and sworn to before me, this }
11th day of February, 1871.

(Signed,) S. BROWN,
County Judge of Warren County.

APPENDIX No. 8.

City of Ottawa, Province of Ontario, }
Canada.

Levi Young, of the City of Ottawa, being duly sworn, deposes and says, that he is acquainted with the *character* of the Penobscot River, in the State of Maine; that he was engaged in navigating said river and in attending booms upon it from 1832 to the year 1854; that during that period he enjoyed every facility for learning the capacity of said river, and for making himself familiar with the business transacted upon it. Deponent further says that said river runs through an extensive pine region; that for many years the timber of this region has been sawed into lumber upon the banks of said river, and that the sawdust has been cast into the said river. Deponent further says, that he never saw any deposit of sawdust in the *channel* of said river, and that he never heard of any bars or obstructions to navigation of any kind resulting from the deposition of sawdust.

Deponent further deposes and says, that when large quantities of slabs and edgings are cast into a stream with saw dust, and especially where shoals and eddies occur, bars or accumulations may occur, but that his experience with navigable streams and in the manufacture of lumber on such streams has taught him, and that he vorily believes that sawdust alone has not been and will not be deposited in such a manner as to obstruct or impede navigation, or to obstruct the ordinary flow of the water.

(Signed) LEVI YOUNG.

Sworn before me, at Ottawa, this 20th day }
of February, 1871.

GEO. HAY, J. P.

APPENDIX No. 9.

STATE OF NEW YORK, }
Rensselaer County. }

Henry Swally being duly sworn, deposes and says, that he is a resident of the City of Troy, in said County; that said City of Troy is located upon the Hudson River, about fifty miles below the village of Glen's Falls in the County of Warren, in said State, and about one hundred and fifty miles above the City of New York, and that large volumes of the water of the Erie and Champlain Canals, together with the sediment therein contained, are deposited in said Hudson River within the limits of the said City of Troy.

Deponent further deposes and says that, he has been familiar with and has been engaged in navigating said Hudson River for the period of sixty years; that from 1849 to 1870, a period of about twenty years, he was employed as captain of Troy City Dredge. That while so employed, he had occasion to remove from the channel of the said Hudson River within the limits of the said City of Troy all deposits tending to obstruct or impede the navigation of the same; that he personally saw and knew the character of the materials dredged from the channel of said river within the limits aforesaid, and that said materials so removed consisted almost exclusively of mud, sand and gravel.

Deponent further deposes and says that, he never saw or heard of any deposit or accumulation of sawdust in the channel of said Hudson River which did, or could, in his opinion, obstruct or impede navigation in the same, and that he never heard of any complaint from persons engaged in navigating said Hudson River that their business had been or was in any way injured or affected by deposit or accumulation of sawdust. Deponent further deposes and says, that he has seen in still water and eddies such accumulations of sawdust which were held by accumulation of water-logged timber, leaves and other debris previously formed, and which served as a nucleus or bar for the retention of said sawdust, but that in every instance these accumulations of sawdust as aforesaid were of a semifluid character, and so nearly of the same specific gravity as water, as to yield to the slightest disturbing cause.

Deponent further deposes and says, that in his opinion sawdust alone will not and cannot accumulate in the channel of a navigable river in such masses or of such density as to prevent, obstruct or impede the navigation of the same.

Deponent further says that the effect of the tide is felt at the said City of Troy, the rise and fall of the water in said Hudson River. At the said city of Troy as the direct result of the tides being from twelve to twenty-four inches daily.

(Signed) H. SWALLY.

Subscribed and sworn to before me this }
11th day of February, 1871.

(Signed) D. M. GREENE,
Comr. of Deeds.

APPENDIX No. 10.

Mr. D. M. Greene, C.E., Troy, N. Y.

MY DEAR SIR,—Your letter of the 10th inst. reached me yesterday, having been forwarded from Oswego, which place I left to avail myself of a short leave of absence on the 9th inst.

In reply to your question, I beg to state that the subject of sawdust in the river was never brought to my attention, from the fact that many of the mills along the Hudson made use of their dust as fuel. I was on duty upon the Hudson River improvement for over four years, and during that time we excavated over 500,000 cub. yards of mud, ashes, cinders, &c., from the channel, and while there may have been sawdust present, and it might have been noticed by others, I never saw any myself.

Trusting that this information may be of benefit to you, although it amounts to but little.

I am, Yours very truly,
(Signed), JOHN M. WILSON,
Magnaging Engineer, Brevet-Col. U. S. A.

APPENDIX No. 11.

State of New York, }
Warren County. }

John Keenan being duly sworn, says that he resides in Glens Falls, in said county, and has known the Hudson River and Champlain Feeder Canal since 1832; that deponent is senior co-partner of the Joint Line Company and President of the Glens' Falls Transportation Company, which runs boats from Glens' Falls to Troy, Albany, New York and other places; that Deponent and his co-partners have done work by the job on said canal in deepening and enlarging the same, and deponent has been familiar with the navigation and condition of said canal since the year 1832. That in the summer season, when the water is lowest in said river, the Feeder Canal draws the whole volume of water from the river, so that the channel of the river is practically turned into the canal during such period of low water, that deponent has never known or heard of any sawdust collecting or accumulating in any part or portion of said canal. That deponent has repeatedly seen the workmen engaged at various times cleaning the sediment out of the canals, but has never seen any sawdust among it, that deponent has never known or heard of any injury arising from sawdust in the river or canal to the navigation thereof. That the parties engaged in the navigation on said river and canal have not considered and do not consider that the sawdust from the saw mills do any injury to navigation whatever; so far as deponent has any knowledge or belief, parties engaged in navigation have never made any objection, and do not object to sawdust being cast in the river.

(Signed) JOHN KEENAN.

Subscribed and sworn to before me this 31st }
day January, 1871. }

(Signed) S. BROWN,
County Judge of Warren County.

APPENDIX No. 12.

State of New York, }
Warren County. } (S.S.)

David Underwood, being duly sworn, says that he resides in Fort Edward, Washington County, New York, and has represented his district in the Legislature of the State of New York. Deponent further says, that he is a saw-mill owner and manufacturer of lumber on the Hudson River, and has been practically engaged in the business for the last 29 years; that deponent's mills are located at Fort Edward, about six miles below Glen's Falls; that in deponent's judgment and belief there have been 200,000,000 feet of sawed lumber at least manufactured annually on the Hudson River and on an average during the past ten years.

That deponent has been acquainted with the Hudson River, the business thereon, and navigation thereof, for almost 40 years; and in deponent's judgment and opinion, for the 30 years next preceding the last ten years, there was sawed lumber manufactured on said Hudson River, annually, on an average from 125,000,000 to 150,000,000 feet of lumber; that formerly the timber manufactured into lumber on the Hudson River was mostly white pine, but lately it is mostly spruce and hemlock; that in deponent's belief the average thickness of lumber cut on the said river during the time aforesaid does not exceed one inch and one-eighth of an inch in thickness; that deponent has never heard or known any complaint, trouble or inconvenience arising from sawdust to navigation on the Hudson River and in the canal; that from deponent's position and business, deponent thinks it impossible that any obstruction or inconvenience could have occurred from sawdust without Deponent having known or heard of it.

(Signed,) DAVID UNDERWOOD.

Subscribed and sworn to before me, this }
31st day of January, 1871, }
(Signed,) S. BROWN. }

APPENDIX NO. 13.

STATE OF NEW YORK, }
Warren County. } (S.S.)

Honorable Joseph Russell, being duly sworn, says, that at present he resides in Glen's Falls, and until lately resided in Warrensburgh, in said County, and which place is also located upon the Hudson River, that deponent has been actually engaged in the business of manufacturing sawed lumber for the last 50 years on the Hudson River, except that deponent's lumber business for the last ten years or about that time has been elsewhere, and not on said river. That deponent commenced lumbering about 50 years ago on the east branch of the Hudson River six miles above Warrensburgh. That at that time, in deponent's opinion and belief, there were 75,000,000 feet of sawed lumber and upwards manufactured annually on the Hudson River, and its tributaries, and that the manufacture of sawed lumber has been gradually increasing on said river and its tributaries exceeds 200,000,000 and in deponent's opinion and belief will average annually at least from 175,000,000 to 200,000,000 for the last ten years. That when deponent first commenced lumbering on the river, not only edgings but more or less slabs were thrown in the river, and the whole waste aside from the sawdust was at least four times as much as at present. That the change or diminution of waste thrown in the rivers has been caused by the increased value of the material and the improvement in mills and machinery. That there has never been any restriction, by public law or otherwise, so far as deponent has any knowledge or information, upon the mill owners and manufacturers casting into the rivers as much refuse stuff as they chose; but on the contrary they have always disposed

of the refuse stuff including sawdust as their convenience and interest required, and generally by casting the same into the river. That deponent has never known or heard of any obstruction or injury to the navigation of said river or the canal, by reason of the sawdust and refuse stuff cast in the river, nor has deponent ever known or heard of any obstruction being made to such refuse stuff being cast into the river. Deponent further says that he represented this district in the Congress of the United States, two terms of two years each. Deponent was first elected in 1844, and the last time in 1850.

(Signed,)

JOSEPH RUSSELL.

Subscribed and sworn to before me, on }
this 1st day of July, 1871. }

(Signed,)

S. BROWN,
County Judge of Warren County.

APPENDIX No. 14.

POTSDAM, New York, February 22, 1871.

Professor D. M. GREENE.

DEAR SIR,—The writer is surviving partner of the late firm of G. and S. T. Richards, who were up to a recent time engaged in the lumber manufacturing business, and operated mills propelled by water power, on the Schroon or east branch of the Hudson River, which is the main branch of that river above the Mohawk. In common with all the other mills on the Hudson and Schroon Rivers, the sawdust made at our mill was always dropped into the river, and carried down the streams by the water. The firm of G. and S. T. Richards commenced such business in the year 1848, and continued in it to and including the year 1869, during all of which time they were acquainted with the other parties doing a similar business on such rivers, and it was known that the mills disposed of their sawdust in the manner above mentioned, and during all of which time the said firm of G. and S. T. Richards put their slabs, edgings and buttings, as well as sawdust into the river. The lumber manufactured by us was mainly put on canal boats at Glen's Falls, and transported through the Champlain Canal to Troy and Albany, and other markets below those points on the Hudson River.

The mills aforesaid of G. and S. T. Richards manufactured on an average one and three-quarters millions feet, board measure, of pine, spruce, hemlock, and bass and ash, and some other kinds of lumber. Our mill was located six miles above the village of Warrensburgh (over twelve miles by the river, which has very little fall for that distance), to which place we moved our lumber by rafting or running down the river. We were never troubled in the least by the presence or accumulation of sawdust in the river canal, in transporting our lumber to market. Soon after the building of the large leather tanneries on the river and branches above our mill, we had considerable fears that the accumulation of exhaust ground tan-bark, large quantities of which were thrown into the river above us, might seriously interfere with the navigation of the river. In fact, the tan-bark was our greatest danger; but it was found that the spring freshets had the effect to throw the bark and sawdust into bars above ordinary water, where, after the bars got dried out, the owners of the land burned the accumulations, and got a very good manure for their lands.

In the opinion of the writer, founded on his experience in the business, no danger need be apprehended of the obstruction of the navigation of a river, on account of the accumulation of sawdust thrown into it.

Respectfully,

(Signed,)

GEO. RICHARDS.

APPENDIX No. 15.

GLEN'S FALLS, NEW YORK,
February 1st, 1871.

To the Hon. the Commissioner of Public Works
of the Province of Ontario.

Since January, 1832, I have resided at this place. I was a member of the bar until 1857, and since then have been a Justice of the Supreme Court. During all this time I have been familiar with the lumbermen upon the Hudson River, and have observed their mode of operations in the manufacturing of lumber from the village of Warrensburgh, a distance of about 35 miles by the course of the stream above Glen's Falls, to Fort Millac, about 18 miles below Glen's Falls. For twenty years I was counsel to parties owning water power at this place in actions relating to such water power.

I have read the affidavit of Augustus Sherman in relation to the quantity of lumber manufactured at different points upon the Hudson River for fifty years last past, and I concur with him in his statement so far as it relates to the time that I have resided here.

All the mills at which lumber has been manufactured have been operated by water, and have discharged their saw dust and edgings into the stream. During the season of low water in the summer the principal part of the water in the river is required, and is used for canal navigation through the Glen's Falls Feeder, the head of which is a mile and a half above Glen's Falls. During the whole time that I have resided here, I have never observed that any obstruction to navigation or to the use of the Hudson River for floating logs or for water power has been occasioned by the discharge of sawdust and edgings from saw-mills into the stream; nor have I ever heard any objection made or of objection being made to such use of the stream—nor have I ever heard any complaint made by navigators of the canals, or by those interested in the navigation, or by officers having the same in charge, that the sawdust or edgings from the saw mills above the feeder dam have had any tendency to obstruct the use or to diminish the supply of water in the canal.

I write this statement at the request of my friend, Mr. H. F. Bronson, of Ottawa.

Respectfully,

(Signed,)

E. H. ROSEKRAM,
Justice of the Supreme Court.

APPENDIX No. 16.

STATE OF NEW YORK, }
Rensselaer County. } (S.S.)

Daniel H. Sullivan being duly sworn, deposes and says, that he resides in the city of Troy; that he has been acquainted with the Hudson River and its navigation for 28 years; that he had been engaged in the navigation of the said river in various capacities during the greater part of that period, and that he is now and has been for 14 years the Superintendent of the Hudson River Transportation Company. Deponent further says that the offices of the said Company are located in the said city of Troy, and that its business consists in the transportation of merchandise upon barges or otherwise upon said line between the cities of New York and Troy and intermediate points. That during the time deponent has been employed on said line, and especially during the time he has acted in the capacity of superintendent as aforesaid, he has been personally familiar with the location, magnitude and character of the bars and other obstructions to navigation which have from time to time been formed in said river, and has observed the kind of materials of which they were formed in said river, and that said materials were mud, sand and gravel, together with oak logs or hard wood sticks, but that deponent never saw pine logs removed from said bars. Deponent further says, that he never saw any deposit or accumulation of sawdust in the channel of said river, and that he never experienced any difficulty or met with any obstruction or impediment in the navigation thereof, which was caused by sawdust. Deponent further says that he has a large acquaintance among per-

ons engaged in the navigation of said Hudson River, and that in his intercourse with such persons so engaged he has never heard of any bars, deposit or accumulation of sawdust in the channel thereof, which interfered with or impeded navigation in the least; nor has deponent ever heard of any complaint or objections having been made to the casting of saw dust into said river, that it obstructed or impeded, or that it had a tendency to obstruct or impede navigation, or that it was objectionable in any way whatever. Deponent further says, that he was for six years employed in a ship yard at the village of Athens; that said village of Athens is situated on the west bank of the Hudson River, about 25 miles below the city of Albany, and about 31 miles from the city of Troy; that in the said ship-yard the saw mill was located over a small bay where there was no perceptible motion of the water, except such currents as were by the tides, and where the bottom was of soft mud; that the sawdust from said mill was deposited into the water of said bay; that there was never, so far as deponent knows, any accumulation of sawdust upon the bottom of the river at that point, but that the sawdust so deposited or cast into the river was floated off, and as deponent verily believes, was carried by the current to the sea. Finally, deponent says, that in his opinion (which is based upon his experience and observation upon the said Hudson River) sawdust when cast into a navigable river like the Hudson in such quantities and at such rates as it would naturally be produced in the manufacture of lumber, will not produce bars or obstructions to navigation on the channel thereof.

(Signed,)

DANIEL SULLIVAN.

Subscribed and sworn to before me this }
17th day of February, 1871. }

(Signed,) D. N. GREENE,
Comr. of Deeds.

APPENDIX No. 17.

(Copy.)

STATE OF NEW YORK.

County of Warren.

Augustus Sherman being sworn, says that he resides in Glen's Falls, in said County, and is engaged practically in the business of manufacturing lumber on the Hudson River, about fifty miles above the Cities of Troy and Albany, and has been so engaged in said business for the last 45 years and upwards. That during said time deponent has been the owner or lessee of one or more saw-mills, run and operated by deponent in said business. That deponent owns timber lands on said river, and its tributaries, and has cut the timber therefrom, manufactured the same into lumber and transported the same to Troy, Albany and other markets, and is well acquainted with the Hudson river, its size, capacity, channel and currents, as well between Glen's Falls aforesaid, and Troy and Albany, as above Glen's Falls. Deponent is also well acquainted with the different saw-mills on said river, and their capacity. That the principal part of the lumber manufactured by deponent has been manufactured by the mills known as the Sherman mills, and the Swarttrout mill, (the latter leased by deponent) which are situated on said river about one mile, and one half a mile above Glen's Falls aforesaid.

That during the last ten years, deponent has manufactured at said mills about 15,000,000 feet of sawed lumber annually, the most of which has been cut into boards, about one inch thick, and some into scantling 3 inches by 4 inches, and some into plank, 1½ thick, the whole on an average, in deponent's opinion, would not average over 1½ in thickness.

That in deponent's opinion and belief there has been manufactured annually on an average on the Hudson River, and principally at Glen's Falls, Sandy Hill and Fort Edward (all within a distance of eight miles), during the last ten years 160,000,000 feet of sawed lumber. That for the last fifty years, large quantities of sawed lumber have been

manufactured every year in said mill, and in deponent's opinion and belief, for the forty years next prior to the last ten years, not less than 100,000,000 to 115,000,000 feet of sawed lumber were manufactured annually on average. That from deponent's earliest recollections there has been a large business done on said rivers in manufacturing sawed lumber (and which extend back upwards of sixty years), and with some fluctuations has been gradually increasing. That formerly, say thirty-five years ago, nearly all the lumber manufactured on said river was firm white pine timber and spruce, but white pine timber became more and more scarce, and has been manufactured less and less until the principal part of the lumber now cut on said river is spruce and hemlock. Deponent further says that he has not seen and does not know of any accumulation of sawdust in said river to impede or in any manner inconvenience navigation on said river whatsoever.

That edgings have, more or less as well as the sawdust, been cast into the Hudson River; that deponent has seen in some of the eddies in said river small collections of edgings and sawdust and flood wood and debris, but for the edgings, slabs, or other firm substance to hold or confine the sawdust in one place, it moves and floats about readily in the water, and is easily moved by any disturbing substance in the eddies, and will not remain in the channel of said river. That the feeder canal extends from the Hudson River to the Champlain, and intersects at the points where deponent's said mill is located on said river, and that in deponent's opinion and belief there has been for the last forty years about 35,000,000 or 40,000,000 feet of sawed lumber manufactured annually on the Hudson River above said canal. That deponent has owned and run canal boats on said canal, and transported lumber thereon ever since it was navigable and more than thirty years, and that deponent has never known or heard of any obstructions from accumulation or collection of sawdust on said canal. That from deponent's experience in the use of said river and canal, and the manufacture of lumber, deponent has no doubt whatever that sawdust alone will not accumulate or collect in sufficient quantities to impede or impair navigation in the least. That Deponent is now President of the first National Bank of Glen's Falls.

(Signed,)

A. SHERMAN.

Subscribed and sworn to before me,
this 31st day of Jan., 1871. }

(Signed,)

G. BROWN,
County Judge.

APPENDIX No. 18.

(Copy.)

STATE OF NEW YORK, } S.S.
Warren County. }

George Satterlee being duly sworn, says that he resides in the village of Fort Edward, in Washington county, in the State of New York, and is and for the last year has been the superintendent of the Glen's Fall Feeder Canal, and also of about 25 miles of the Champlain Canal, and of that part thereof into which the waters of said Feeder are discharged. Deponent further says that in the spring of the year 1870, deponent caused said portion of said canals, of which he is superintendent, to be cleared from deposit of whatever had accumulated therein.

That deponent was personally engaged in superintending the work, but did not find any deposit or accumulation of any sawdust in either of said canals.

That deponent has resided in Fort Edward, through which said canal and the Hudson River both pass, for the last 20 years and upwards, and deponent has never known or heard of any accumulation or deposit of any sawdust in either said river or canal to injure or inconvenience navigation in the least in either of them.

(Signed,)

GEORGE SATTERLEE.

APPENDIX No. 19.

(Copy.) STATE OF NEW YORK, } S.S.
Warren County.

Colonel Alonzo W. Morgan being duly sworn, says that he is a resident of Glen's Falls, in said county, and has resided since the year 1813, and had charge of the Feeder Canal and about 15 miles of the Champlain Canal as superintendent for three years some 20 to 25 years ago, and as such superintendent had charge of making repairs on said portions of canal (and which portions included about 14 miles of the summit level of the Champlain Canal), and keeping it clear and free from obstructions, and every spring during said three years cleared out the deposit from the bottom of the canal, but that such deposit did not consist in any part of sawdust. That no sawdust ever collected or accumulated in said canal so far as deponent has any knowledge or belief. Deponent further says that when he first became acquainted with Glen's Falls there were four saw mills at Glen's Falls; and also saw mills all along for 30 or 40 miles above, and large quantities of white pine lumber were then being manufactured, but as to what quantity deponent is not able to say, as deponent is not a lumberman. That, as deponent understands and believes, saw mills were erected on the Hudson and Glen's Falls and vicinity, and the manufacture of lumber commenced about 90 years ago or upwards, and has been continued ever since. That deponent never heard of any complaint or trouble as to navigation on the Canal or Hudson River from sawdust, and never knew of any injury therefrom, and deponent does not believe navigation has been injured in the least by sawdust.

(Signed,)

COL. A. K. MORGAN.

Submitted and sworn to before me, this }
31st day of June, 1871. }

(Signed,)

S. BROWN,

County Judge, of Warren County.

APPENDIX No. 20.

(Copy.) STATE OF NEW YORK, } (S.S.)
Warren County

George Nelson being duly sworn, deposes and saith, that he resides in Still Water, in Saratoga County, New York, and is Superintendent of all that part of the Champlain Canal in the State of New York, southerly of that part thereof which G. Satterlee is Superintendent, and has been such Superintendent for the last year. Deponent further says that he has resided near said canal, and been familiar with it and its condition and the business done thereon for the last thirty-five years. Deponent further says that in the spring of the year 1870, deponent, as such Superintendent, caused that portion of said canal in his charge as aforesaid to be quite thoroughly cleared of the sediment and deposit thereon, and deponent superintended the work personally, to the extent of his whole time thereon. That said Still Water is located on the west bank of the Hudson River, about thirty miles below Glen's Falls, in Warren County, New York. Deponent further says that he found no sawdust in said canal in cleaning out the same, and deponent has never known or heard of any accumulation of sawdust in said river or canal, or any injury or inconvenience resulting to navigation in said river or canal therefore at any place or time.

(Signed,)

GEORGE W. NELSON.

Subscribed and sworn to before me }
this first day of July, 1871. }

(Signed,)

S. BROWN,

County Judge, of Warren County.

APPENDIX No. 21.

(Copy.) STATE OF NEW YORK, }
Warren County }

William Coleman being duly sworn, saith that he resides in the town of Kingsbury, Washington County, and State of New York, and in the immediate vicinity of the Feeder Canal, and has so resided for thirty years last past. That deponent has been Superintendent of said Feeder Canal and that part of Champlain Canal which the Feeder Canal discharges its waters into for about eight years.

That among others, it was deponent's duty to keep said canal free and clear from all obstructions, and occasionally deponent caused the sediment to be cleared from the bottom of the said canals of which deponent was such Superintendent, but never found any accumulation of sawdust in said canal, but did find sand, dirt and mud. That deponent has been well and familiarly acquainted with said canal and its navigation for over thirty years last past. That the canal has never been obstructed, filled, nor partially filled with sawdust (*except as the same flowed with the currents of the water*) nor has the navigation thereof been in the least impeded or interfered with by sawdust. Deponent further says that he has never heard of any trouble from the sawdust in the Hudson River, relative to navigation, nor any complaint against or objection to its being deposited or cast into the rivers by forwarders, boatmen or any one connected with the navigation of said Canals, or River; in deponent's opinion and belief there is no objection whatever to said sawdust being cast into the water so far as navigation is concerned. That deponent qualifies the above statement as to deponent's being superintendent by saying that deponent held the office but two years, but was agent for Mr. Sherwood (now dead) who was superintendent for the rest of the time (said eight years), and had the actual management and control of the business in relation to the canals, Mr. Sherwood not giving much personal attention to the business.

(Signed,) }
Subscribed and sworn to before me this }
31st of January, 1871. }

WILLIAM COLEMAN,

(Signed,) S. BROWN,
County Judge, of Warren County.

APPENDIX No. 22.

(Copy.) }
State of New York, }
Washington County. }

Orson Richards having been duly sworn, states—That he resides in the town of Kingsbury, in Washington County, and State of New York. That deponent is engaged in the business of manufacturing lumber on the Hudson River, and has been for the last thirty years; that deponent has one sawmill which runs over two hundred saws, and is partner of four other mills, and is familiar not only with the sawing business, but also with all the other branches of the trade, as well the running the logs to the mills as transporting the lumber to market by boating the same on the canal and otherwise; that deponent's largest mill is located on the said Hudson River, about thirteen miles below Glen's Falls; that deponent has been familiar with the said river and the business done thereon for the last thirty years and upwards. In deponent's opinion and belief there has been manufactured on the said river, annually, on an average of the last ten years, at least 150,000,000 or more of sawed lumber, and before ten years last past for the last twenty years, an average of not less than 120,000,000 or upwards of sawed lumber;

that in deponent's opinion and belief, prior to fifteen years ago, there has been as much as of sawed lumber cut up on said river and its tributaries per year (and which would average perhaps about one on it, and one-eighth of an inch in thickness) above the point where the Feeder Canal intersects the river, and the sawdust made therefrom, as well as more or less of the other refuse cast into the waters to be carried off. Deponent further says, that he has never known or heard of any obstruction, hindrance or injury to boating, rafting, or navigation from such sawdust refusion on the river or canal. Deponent says; that he has never heard or known of any accumulation of sawdust in said canal or river, whatever, alone, nor with other substances, except that in some of the eddies of the river, the edgings and slabs have collected, and more or less sawdust has been stopped and held by the accumulation of such firm substances, nor has deponent ever heard or known of any such accumulations as last described being found at any place or places in the least injurious to the use of the river for all floating and navigable purposes. Nor has deponent ever known or heard of any complaint by boatmen or others of sawdust being put in the rivers, nor has any objection ever been made to sawdust and other refuse being cast into the waters, so far as he has any knowledge, information or belief in the premises. That deponent discharges large quantities of sawdust and some edgings into the river every year. That as to the other refuse, sawdust, there has been less and less cast into the river in proportion to the lumber manufactured, as such refuse has become more and more valuable for other purposes, and it became the interest of the manufacturer to save it. That so far as deponent has any knowledge, information and belief on the subject, all manufacturers of sawed lumber in said river have been guided and controlled as to casting and throwing into the waters thereof the sawdust and refuse of and from sawed lumber manufacturers by their own interest and wishes, and that no injury has arisen therefrom, or at least none so far as deponent knows or has ever heard of to navigability of said river or canal.

(Signed,)

ORSON RICHARDS.

Sworn before me this 11th day of }
February, 1878. }

(Signed,)

W. McCOLLIN,
Notary Public.

APPENDIX No. 23.

Area of territory drained by the River Ottawa and tributaries above the city of Ottawa, is 43,000 square miles; add 19,000 square miles for area drained below Ottawa and above Grenville, making a total area of 62,000 square miles, not including about 4,000 square miles more below Grenville.

By the Report to the Canadian Legislature by J. O. Clarke, Esq., C. E., of his survey for the Ottawa canal navigation, the *mean* discharge of the Ottawa (by a series of obstructions) at Grenville is 85,000 cubic feet at low water, and 150,000 cubic feet at high water.

Forty inches may safely be taken as the average precipitation of rain and snow in Canada on the Ottawa.

It would seem necessary to assume a greater average, in order to account for the great delivery of the Ottawa, compared with the area it drains.

(Signed,)

A. J. RUSSELL.

APPENDIX No. 24.

(Copy.)

PORTLAND, ME., August 27, 1872.

Hon. H. H. Killaly, &c., &c., &c., }
 Toronto, Ontario.

DEAR SIR,—I have the pleasure to acknowledge the receipt of your letter of the 13th instant, making enquiry concerning the condition of the Penobscott and other rivers, the navigation of which has been more or less injured by the "waste" (slabs, edgings and sawdust) from saw-mills; and, in reply, to state that in my examination of several rivers (in all cases tidal rivers) I have found that this "waste" has been accumulating for the last forty years and more, and to such an extent as to have *greatly impaired the navigation* of those rivers. This "waste" on being thrown into the rivers is carried up and down by the tidal currents until becoming heavily water-soaked, it sinks in slack water or eddies and *forms constantly increasing obstacles to navigation*. In all the rivers in the State of Maine, these obstructions if formed by slabs and edgings, don't extend more than four miles below the head of tide water, as in the Penobscot River, and in the smaller rivers not more than one mile below, whilst the *sawdust* is, for the most part, carried by the current several miles further down and deposited on the slack water and *eddies of the bends and bays, these forming extensive shoals, shifting in their character and having narrow and crooked channels*.

In Penobscot River these slabs and edgings have accumulated, in some places, if not less than eighteen feet, with an average depth of about ten feet, over an area of not less than two hundred and seventy-five acres, the solid contents of which are more than four millions of cubic yards.

It is but recently that these facts have attracted public attention to such a degree, as to have proved the necessity, for the prevention in future, by statute, of the throwing in of *slabs* and edgings; but *not yet*, it is much to be regretted that of sawdust also. It is, however, believed that this will be prevented, at an early day, so great is the damage caused by it.

During the past two or three years I have been very successful in the removal of these obstructions by means of dredging machines, provided with clam-hell (skeleton) buckets: in which work the difficulty consists not so much in the excavation of the material as in the disposing of it afterwards.

To give you an idea of the cost of the removal of this material, I will state that within the past ten days a proposal has been made to excavate and remove about twenty-five thousand cubic yards of this material, at seventy-five cents per cubic yard, by contract, which proposal I shall probably accept.

I regret that I have no special report on this subject to send to you, and that the information herein furnished you is so meagre in its character.

If I can be of any further service to you in this matter, I beg that you will let me know.

I am, Sir,

Very respectfully yours,

(Signed), — GEORGE THOM,
 Brev. Brigadier General, U. S. A.

APPENDIX No. 25.

(COPY.)

H. H. Killaly, Esq., }
Toronto.

MIRAMICHI, 16th May, 1872.

DEAR SIR,—In reply to your's of the 27th ult., in reference to the state of the rivers in this Province, I beg leave to say that on the Miramichi River and its tributaries, there are a number of mills, some driven by steam and others by water. Some of the steam mills have been in the habit for years of depositing and still continue to deposit a greater part of the sawdust made by them into the river, as well as bark, slabs and edgings, most of which don't go far from where they were deposited till they sink and remain there, which has been proved by the depth of water in the harbors of this river, especially about our wharves, where it is more perceptible.

Fifteen to twenty years ago, at any of our wharves, there was twenty feet of water, but now there is not more than from ten to twelve feet, causing wharf-owners to extend their wharves nearer to the channel. The material that composes the filling up is sawdust, slabs, edgings and other refuse matter deposited from mills, mixed with a small portion of mud. I may safely state that all the water-mills on the main river, as well as its branches, deposit the most of the refuse matter with the streams, which has had the effect of filling up all the small harbors, coves and creeks on the river, which is readily perceived by comparing them with what they were a few years ago. At one time the bed of the river, or at least along the shores and creeks was composed of sand and gravel, but now it is chiefly refuse matter from sawmill. This practice has also had an injurious effect on fishing.

Where a large quantity of alewives, salmon and bass used to be caught, now the catch is very small, and the bass have entirely disappeared from the south branch of the Miramichi. On the north west branch they are still caught in large quantities, which is accounted for by only one mill being in operation on the north-west branch for several years past, on the south-west branch there are several mills in operation.

Our harbour master is supposed to look after the river and protect it against all injurious deposits; in the town of Chatham and Newcastle he prevents such deposits but there are so many mills strewn along the river that it is difficult for him to watch them all. At some mills slabs and edgings are rafted under pretence of being taken away for fire wood, but at night are set adrift, and lodge all along the wharves and shores: a greater part of these are pine, and sink almost immediately after being put into the water.

This same custom I may say exists all through this Province, but to a great extent on the northern portion.

I would strongly recommend that the Government would take this matter into their careful consideration, and devise some means of preventing the depositing of all mill refuse in our rivers. If not attended to in time, it will destroy our fisheries altogether, as well as interfere seriously with the navigation of our rivers.

I would suggest that the penalty for casing any mill refuse in the streams should be punishable by imprisonment of the owner of the mill, or the person in charge of same, as there is no use in putting on a small fine, as they would sooner run the risk of being fined than imprisoned.

I would be pleased to be of service to you at any time.

Yours very truly,

(Signed,) Wm. Muirhead.