

Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- Coloured covers/
Couverture de couleur
- Covers damaged/
Couverture endommagée
- Covers restored and/or laminated/
Couverture restaurée et/ou pelliculée
- Cover title missing/
Le titre de couverture manque
- Coloured maps/
Cartes géographiques en couleur
- Coloured ink (i.e. other than blue or black)/
Encre de couleur (i.e. autre que bleue ou noire)
- Coloured plates and/or illustrations/
Planches et/ou illustrations en couleur
- Bound with other material/
Relié avec d'autres documents
- Tight binding may cause shadows or distortion along interior margin/
La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/
Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

- Coloured pages/
Pages de couleur
- Pages damaged/
Pages endommagées
- Pages restored and/or laminated/
Pages restaurées et/ou pelliculées
- Pages discoloured, stained or foxed/
Pages décolorées, tachetées ou piquées
- Pages detached/
Pages détachées
- Showthrough/
Transparence
- Quality of print varies/
Qualité inégale de l'impression
- Continuous pagination/
Pagination continue
- Includes index(es)/
Comprend un (des) index

Title on header taken from: /
Le titre de l'en-tête provient:

- Title page of issue/
Page de titre de la livraison
- Caption of issue/
Titre de départ de la livraison
- Masthead/
Générique (périodiques) de la livraison

Additional comments: /
Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below /
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X	12X	14X	16X	18X	20X	22X	24X	26X	28X	30X	32X
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

April 1891.

THE
* OTTAWA NATURALIST *

VOLUME V. No. 1.

The
TRANSACTIONS.

Of the
* Ottawa Field Naturalists' Club *

(Organized March, 1879. Incorporated March, 1884.)

CONTENTS.

	PAGE
List of Officers	3.
List of Members	4
Treasurer's Report, 1891	8
Drinking water, with special reference to the Ottawa City supply. By A. McGill	9

OTTAWA, CANADA:
J. D. Taylor, Printer, 48 to 50 Queen St.

Issued April 5th, 1891.

Published Monthly at \$1.00 per annum.

Patron :

HIS EXCELLENCY THE LORD STANLEY OF PRESTON,
GOVERNOR GENERAL OF CANADA.

President : DR. R. W. ELLS.

Vice-Presidents :

1ST, T. J. MACLAUGHLIN, | 2ND, H. M. AMI.

Secretary : W. H. HARRINGTON, P. O. Department.

Treasurer : A. G. KINGSTON, Dept. Public Works.

Librarian : W. A. D. LEES, P. O. Box 4071.

Committee : {MISS E. BOLTON, MISS G. HARMER, MISS M. A. MILLS,
JAMES FLETCHER, WILLIAM SCOTT, R. B. WHYTE.

Standing Committees of Council :

Publishing—JAMES FLETCHER, *Editor*; W. H. HARRINGTON, A. G. KINGSTON, W. A. D. LEES, *Assistant Editors*.

Excursions—T. J. MACLAUGHLIN, H. M. AMI, MISS G. HARMER, MISS M. A. MILLS, R. B. WHYTE.

Soirées—A. G. KINGSTON, MISS E. BOLTON, JAMES FLETCHER, WILLIAM SCOTT.

Readers :

Geology and Mineralogy—H. M. AMI, W. F. FERRIER, C. W. WILLIMOTT.

Botany—JAMES FLETCHER, WM. SCOTT, R. H. COWLEY.

Conchology—F. R. LATCHFORD.

Entomology—T. J. MACLAUGHLIN, W. H. HARRINGTON, J. FLETCHER

Ornithology—A. G. KINGSTON, W. A. D. LEES, PROF. J. MACCOUN.

Zoology—J. BALLANTYNE, H. B. SMALL, W. P. LETT.

The Librarian will furnish the Publications of the Club at the following rates :—

Transactions, - -

Part 1, Not sold singly.

" 2, 25 cts. ; to members, 15 cts.	} \$1.00 for Vol. I.
" 3, 25 " " 15 "	
" 4, 25 " " 15 "	
" 5, 30 " " 20 "	} \$1.00 for Vol. II.
" 6, 40 " " 25 "	
" 7, 30 " " 20 "	

The Ottawa Naturalist, \$1.00 per annum.

Monthly parts, 10 cents ; to members, 5 cents.

Quarterly parts, 25 cents each ; to members, 15 cents.

EXTRAS — BILLINGS, W. R. Palæontology. An elementary lecture.
pp. 11, 5c.

ELLS, R. W. Asbestos ; its history, mode of occurrence and
uses. pp. 24, 10c.

1891

VOL. V.

1892

THE
OTTAWA NATURALIST.

BEING VOL. VII. OF THE

TRANSACTIONS

OF THE

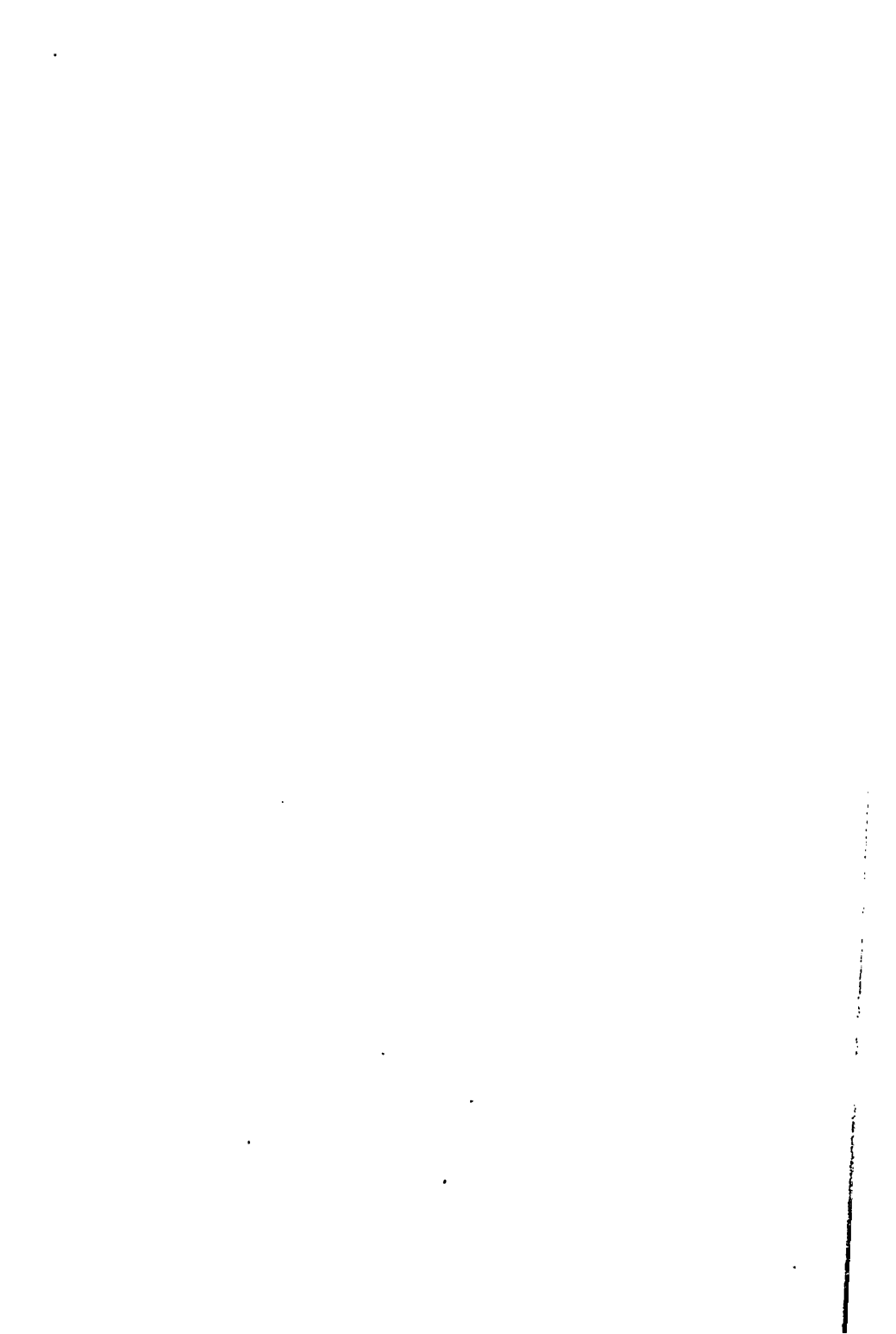
OTTAWA FIELD-NATURALISTS' CLUB.

(Organized March, 1879. Incorporated March, 1884.)

OTTAWA:

J. D. TAYLOR, BOOK AND JOB PRINTER, 48 AND 50 QUEEN STREET.

1891.



Patron :

HIS EXCELLENCY THE LORD STANLEY OF PRESTON,
GOVERNOR GENERAL OF CANADA.

President : DR. R. W. ELLS.

Vice-Presidents :

1ST, T. J. MACLAUGHLIN, | 2ND, H. M. AMI.

Secretary : W. H. HARRINGTON, P. O. Department.

Treasurer : A. G. KINGSTON, Dept. Public Works.

Librarian : W. A. D. LEES, P. O. Box 4071.

Committee : {MISS E. BOLTON, MISS G. HARMER, MISS M. A. MILLS,
JAMES FLETCHER, WILLIAM SCOTT, R. B. WHYTE.

Standing Committees of Council :

Publishing—JAMES FLETCHER, *Editor*; W. H. HARRINGTON, A. G. KINGSTON, W. A. D. LEES, *Assistant Editors*.

Excursions—T. J. MACLAUGHLIN, H. M. AMI, MISS G. HARMER, MISS M. A. MILLS, R. B. WHYTE.

Soirées—A. G. KINGSTON, MISS E. BOLTON, JAMES FLETCHER, WILLIAM SCOTT.

Readers :

Geology and Mineralogy—H. M. AMI, W. F. FERRIER, C. W. WILLIMOTT.

Botany—JAMES FLETCHER, WM. SCOTT, R. H. COWLEY.

Conchology—F. R. LATCHFORD.

Entomology—T. J. MACLAUGHLIN, W. H. HARRINGTON, J. FLETCHER

Ornithology—A. G. KINGSTON, W. A. D. LEES, PROF. J. MACCOUN.

Zoology—J. BALLANTYNE, H. B. SMALL, W. P. LETT.

The Librarian will furnish the Publications of the Club at the following rates :—

Transactions, - -

Part 1, Not sold singly.

" 2, 25 cts. ; to members, 15 cts.	} \$1.00 for Vol. I. To members, 70 cts.
" 3, 25 " " 15 "	
" 4, 25 " " 15 "	
" 5, 30 " " 20 "	} \$1.00 for Vol. II. To members, 50 cts.
" 6, 40 " " 25 "	
" 7, 30 " " 20 "	

The Ottawa Naturalist, \$1.00 per annum.

Monthly parts, 10 cents ; to members, 5 cents.

Quarterly parts, 25 cents each ; to members, 15 cents.

EXTRAS — BILLINGS, W. R. Palæontology. An elementary lecture.
pp. 11, 5c.

ELLS, R. W. Asbestos ; its history, mode of occurrence and
uses. pp. 24, 10c.

LIST OF MEMBERS.

- | | |
|---|--|
| <p>Alexander, Mrs. J.
 Alexander, Miss Isabel.
 Allan, W. A.
 Ami, H. M., <i>M.A., F.G.S., F.G.S.A.</i>
 Anderson, <i>Lieut.-Col. W. P., C.E.</i>
 <i>M.I.C.E.</i>
 Anderson, Mrs. W. P.
 Angus, Miss I.
 Archibald, Miss E.
 Armstrong, John R.
 Bailey, Prof. I. W., <i>M.A., Ph. D.,</i>
 <i>F.R.S.C., (Fredericton, N.B.)</i>
 Baldwin, Miss E. G.
 Baldwin, Miss H. A.
 Bulland, Rev. J. B., <i>O.M.I., D.D.</i>
 Ballantyne, J.
 Ballantyne, Norman F.
 Ballantyne, Miss I. M.
 Baptie, Geo., <i>M.A., M.D.</i>
 Barlow, A. E., <i>M.A.</i>
 Barlow, Scott.
 Barnston, Duncan (—, Ceylon)
 Bate, C. Percy.
 Bate, H. Gerald.
 Bate, H. N.
 Beddoe, Chas. H.
 Bell, E. B.
 Bell, Robert, <i>B App.Sc.M.D., LL.D.,</i>
 <i>F.R.S.C., F.G.S.A.</i>
 Bennetts, F. K.
 Bethune, Rev. C. J. S., <i>M.A., D.C.L.</i>
 (Port Hope, Ont.)
 Billings, B. P.
 Billings, W. R.
 Blanchet, C. A.
 Blanchet, W. H.
 Boardman, Wm. F.
 Bolton, Rev. C. E. (Paris, Ont.)
 Bolton, Miss Eliza.</p> | <p>Borden, F. W., <i>M.D., M.P., (Can-</i>
 <i>ning, N.S.)</i>
 Boulton, Arthur.
 Boville, T. C., <i>B.A.</i>
 Bowen, Miss Alice. (Quebec.)
 Bowerman, J. T.
 Bristow, A. A.
 Bristow, Mrs. A. A.
 Broadbent, Ralph L.
 Brodie, R. J., <i>B. App. Sc., (Smith's</i>
 <i>Falls, Ont.)</i>
 Brodie, W., <i>L.D.S. (Toronto)</i>
 Brough, James S.
 Brown, R. D.
 Brown, Mrs. E. D.
 Brumell, H. Pareth.
 Burgess, T. J. W., <i>M.D., F.R.S.C.</i>
 (Montreal.)
 Burland, J. H., <i>B. App.Sc. F.C.S.,</i>
 <i>Butterworth, Miss Maria E.</i>
 Campbell, A. M., (Perth, Ont.)
 Campbell, Miss C.
 Campbell, R. H.
 Carstairs, J., <i>B.A. (Iroquois, Ont.)</i>
 Casey, M. W.
 Chamberlin, Mrs. B.
 Chant, C. A., <i>B.A.</i>
 Christie, A. J., <i>Q.C.</i>
 Chubbock, C. E. D.
 Cochrane, A. S., <i>C.E.</i>
 Code, R. G.
 Cornu, Felix, <i>M.D. (Montreal.)</i>
 Coste, E., <i>M.E. (Buffalo, N.Y.)</i>
 Cousens, W. C., <i>M.D.</i>
 Cowley, R. H., <i>B.A.</i>
 Craig, Prof. J. A. (Madison, Wis.)
 Craig, John.
 Craig, Wm. (Russell, Ont.)
 Crawford, Mrs. Mary.</p> |
|---|--|

- Creighton, J. G. A., *B.A., B.C.L.* Harrington, Mrs. W. H.
 Darcy, Miss T. Harrison, Edward.
 Dawson, G.M., *LL.D., D.Sc., Assoc. R.S.M., F.G.S., F.R.S.C.* Hay, George.
 Deeks, W. E., *B.A.*, (Montreal). Hay, W. H.
 Deeprise, *Reg. C. S.* Hayter, F., *B.A.*
 Devlin, R. J. Henderson, Thomas.
 Dimock, W. D., *B.A.* (Turo, N.S.) Herridge, *Rev. W. T., B.A., B.D.*
 Dixon, F. A. Hilborn, W. W. (Leamington, Ont.)
 Dowling, D. B., *B. App. Sc.* Hodgins, John.
 Elkins, A. W., *C.E., F.L.S.*, (Sher- Hope, Jas.
 brooke, Que). Ingall, E. D. *Assoc. R.S.M., M.E.*
 Ells, R. W., *LL.D., F.G.S.A.* Interior, Department of.
 Evans, Jno. D., *C.E.* (Copper Cliff, Jarvis, S.
 Ont.) Jenkins S. J., *B.A.*
 Ewart, D. Johnson, E. V., *C.E.*
 Faribault, E. R., *C.E.* Johnston, Ro't. A. A.
 Ferrier, W. F., *B. App. Sc.* Jones, C. J.
 Fisher, S. A., *B.A., J.P.* (Knowl- Kearns, J. C.
 ton, Que.) Keefer, Thos. C., *C.E.*
 Fleming, Sandford, *C.M.G., C.E., Keeley, D. H.*
F.R.C.I., F.R.S.C. Kingston, A. G.
 Fletcher, Hugh, *B.A.* Laflamme, Revd. J. A. K., *D.D.,*
F.R.S.C., (Quebec).
 Fletcher, Miss C. F. S. Lambart, *Hon. O. H.*
 Fletcher, James, *F.L.S., F.R.S.C.* Lambe, L. M., *F.G.S.A.*
 Fletcher, Mrs. J. Laupey, Wm. G., *M.E.*
 Fortescue, L. Lampman, A., *B.A.*
 Fortescue, Mrs. L. Latchford, F. R., *B.A.*
 Forward, Arthur J. (Iroquois, Ont.) Law, John.
 Fuller, Thos., *R.C.A.* Lawson, A. C., *Ph D., F.G.S.A.*
 Gemmell, R. E. (Berkeley, Cal.)
 Gemmill, J. A. Lawson, *Prof. G., LL.D., Ph. D.*
 Gilmour, T. *F.R.C.I., F.R.S.C.* (Halifax.)
 Giroux, N.J., *C.E., F.G.S.A.* Lee, Miss Katharine.
 Glashan, J. C. Lehmann, A., *B.S.A.*
 Gobeil, A. Lees, W. A. D.
 Gordon, F. A. Lees, Miss V.
 Grant, *Sir J. A., K.C.M.G. M.D.,* Lees, Miss Jessie.
F.R.C.S., Edin., F.R.S.C., F.G.S. LeSueur, W. D., *B.A.*
 Grist, Henry. LeSueur, Mrs. W. D.
 Grist, Miss Mary L. Lett, W. P.
 Hardie, John. Lindsay, A.
 Hardie, Miss Jessie. Living, Miss A. Marion.
 Harmer, Miss G. (Hintonburgh, Loux, Wm. *M.D.*
 Ont.) Lovick, Miss G.
 Harmon, Miss A. Maria. Lowe, John.
 Harrington, W. H. MacCabe, J. A., *LL.D.*

- MacCraken, John I.
 MacDougall, P. A., *M.D.*
 MacFarlane, T., *M.E., F.R.S.C.*
 MacLaughlin, T. J.
 McConnell, R. G., *B.A., F.G.S.A.*
 McGill, A., *B.Sc.*
 McElhinney, M. P.
 McEvoy, Jas., *B. App. Sc.*
 McInnes, Wm., *B.A., F.G.S.A.*
 McLaughlin, S.
 McLean, J. D.
 McMinn, W. J. R., *B.A.*
 McNab, Chas.
 McNaughton, H. F.
 Macoun, Prof. John, *M.A., F.L.S., F.R.S.C.*
 Maroun, J. M.
 Matheson, D.
 Matheson, W. M.
 Mearns, Capt. E. A. (Fort Snelling, Minn.)
 Mencilly, W. J.
 Mills, Miss Margaret A.
 Moore, H. B.
 Nelson, F., *B.A.*
 Nicholls, William
 Nicholls, Rupert W.
 O'Brien, S. E.
 Oxley, J. M., *B.A., B.C.L.*
 Panet, Maurice.
 Paquet, F. X.
 Parliament, Library of.
 Parris, Miss Oriana.
 Perley, Major Henry F., *C.E.*
 Peters, H. J. (Regina, N.W.T.)
 Phillips, J. A.
 Plunkett, J. M.
 Poirier, Hon. P. S. (Shediac, N.B.)
 Pratt, H. O. E.
 Reed, E. Baynes (Esquimalt, B.C.)
 Ripley, C. J.
 Robert, J. A., *B. App. Sc.*, (Montreal).
 Robertson, N.
 Robins, R. N., (Sherbrooke, Que).
 Rondeau, Rev. S., *B.A.*
 Ross, Niles G.
 Ross, W. A., *J.C.C.*
 Rothwell, Miss Lina.
 Ryckman, Rev. E. B., *D.D.*
 Saint-Cyr, D. N., (Quebec).
 Saucier, F. X. R.
 Saunders, Fredk.
 Saunders, Prof. W., *F.L.S., F.R.S.C., F.C.S.*
 Saunders, W. E., (London, Ont).
 Scott, Colin A., *B.A.*
 Scott, D. C.
 Scott, Fred.
 Scott, W.
 Scott, W., *B.A.*
 Scott, W. L., *B.A.*
 Selwyn, A. R. C., *C.M.G., LL.D., F.R.S., F.R.S.C., F.G.S., F.G.S.A.*
 Senate, The
 Senecal, C. O., *C.E.*
 Shenick, Miss A., *B.Sc.*
 Shutt, F. T., *M.A., F.I.C., F.C.S.*
 Simpson, Willibert.
 Small, H. B.
 Small, H. Beaumont, *M.D.*
 Smith, D. E. (Churchville, Ont.)
 Smith, Miss Eloise.
 Smith, Miss Ethel M.
 Smith, W. H., *C.E.*
 Smithson, Miss B. H.
 Sowter, T. W. E.
 Steacy, Miss Isabel.
 Steckel, R., *C.E.*
 Stewart, John.
 Summerby, Wm. J., *M.A.* (Russell, Ont.)
 Surtees, Robert, *C.E.*
 Sutherland, Miss C. F. S.
 Sutherland, J. C., (Richmond, Que).
 Sweetland, John, *M.D.*
 Symes, Miss E.
 Symes, P. B., *A.K.C.*
 Tanner, R. J.
 Taylor, Rev. G. W. (Victoria, B.C.)
 Thayne, E. Stewart.
 Thompson, T. W.
 Thorburn, John, *M.A., LL.D.*
 Topley, W. J.

Topley, Mrs. W. J.	White, W. R. (Pembroke, Ont.)
Treadwell, C. W., <i>B.A., B.C.L.</i>	Whiteaves, J. F. <i>F.G.S., F.R.S.C.</i>
Tyrrell, J. B., <i>B.A., F.G.S., F.G.S.A.</i>	Whyte, Miss Isabella.
Varley, W. B., (Toronto.)	Whyte, J. G.
Verner, J. W. D.	Whyte, Miss Ethel.
Waghorne, <i>Rev. A. C.,</i> (Harbour Grace, Nfld.)	Whyte, Miss Marion.
Wait, F. G., <i>B.A.</i>	Whyte, R. B.
Warwick, F. W., <i>B. Sc.</i> (Bucking- ham, Que.)	Whyte, Mrs. R. B.
Watters, Mrs. A.	Willimott, Chas. W.
Watters, Henry.	Willing, T. N., (Calgary, N.W.T.)
Watts, J. W. H., <i>R.C.A.</i>	Wills, J. Lainson, <i>M.E., F.C.S.</i>
Weldon, Prof. R. C., <i>M.P.</i> , (Halifax)	Wilson, C. W., <i>M.D.</i> (Bucking- ham, Que.)
Weston, T. C.	Wood, Josiah, <i>M. P.</i> , (Sackville, N.B.)
Wheeler, A. O., <i>D.T.S.</i> (New West- minster, B.C.)	Wright, W. R.
White, Geo. R.	Young, <i>Rev. C. J., M.A.</i> (Lans- downe, Ont.)
White, <i>Lieut.-Col.</i> Wm.	

CORRESPONDING MEMBERS.

- EDWARDS, HENRY, 185 East 116th Street, New York, U.S.
- HILL, ALBERT J., *M.A., C.E.*, New Westminster, B.C.
- MERRIA, DR. C. HART, Department of Agriculture, Washington, U.S.
- ORMEROD, MISS E. A., *F.R. Met. Soc.*, Torrington House, Holywell Hill, St. Alban, England.
- PROVANCHER, ABBÉ, Cap Rouge, Que.
- SMITH, PROF. JOHN B., Rutgers' College, New Brunswick, N.J.

TREASURER'S REPORT—1891.

GENTLEMEN,—I have much pleasure in reporting that the finances of the Club are in a very satisfactory condition. A far larger amount has been collected during the past year for subscriptions than has ever before been the case. An amount of \$25.00 not yet paid out, has been put aside by the Council to finish the publication of the *Flora Ottawaensis*. I beg again to draw the attention of the members to the names of the firms which assist the Club by advertising in the OTTAWA NATURALIST. It is not too much to say that these firms are equal to, or the best, in their several lines, and I trust that the members will endeavour to show them that it is a paying investment to assist the Club. In conclusion I would draw attention to the fact that nearly \$6.00 has been unnecessarily expended in postage by the Treasurer in writing for subscriptions. The fees are payable in advance on the third Tuesday in March. If this were attended to by all the members, not only would it save much trouble and expense; but they would get much better value for their money. During the past year owing to the fact that subscriptions were paid in more promptly, no less than 38 pages were added to the OTTAWA NATURALIST. Had everyone paid up this number might have been doubled and the *Flora Ottawaensis* would have been finished. As it is impossible for me, owing to my official duties, to again accept the post of Treasurer I lay this matter before the meeting and beg that you will assist my successor to this extent.

TREASURER'S BALANCE SHEET—1890-91.

RECEIPTS.		EXPENDITURE.	
1890.		1891.	
March 18, Balance.....	\$ 30 52	March 17, Ottawa Naturalist,	
1891.		Vol. iv..	\$254 49
March 17, Subscriptions		Postage ..	11 26
1890-91..	\$212 00		\$265 75
Arrears.....	48 00	Extras. Flora	
	260 00	Ottawaensis	26 00
Advertisements.....	37 00	" Authors'	16 12
Authors' extras.....	9 75		42 12
Transaction sold.....	15 39	General printing....	2 95
Excursion receipts... ..	159 55	General postage....	8 77
		Stationery.....	1 11
		Gratuities.....	6 00
		Library—	
		Shelves.....	6 00
		Binding....	10 00
			16 00
		Excursion expenses .	157 39
		Balance	15 12
			\$515 21
	\$515 21		\$515 21

Ottawa, March 17, 1891.

JAMES FLETCHER,
Treasurer.

DRINKING WATER.

WITH SPECIAL REFERENCE TO THE OTTAWA CITY SUPPLY.

A Lecture by A. McGill, B.A., B.Sc., Assistant Analyst to the
Inland Revenue Department.

A very little thought given to the subject will convince us of the hopelessness of seeking for absolutely pure water as a natural product. The great solvent power of water, together with the universal presence of substances, gaseous liquid or solid, which it can take into solution, are conditions which amply suffice to explain the contamination of all natural sources of supply. The whole of the fresh water on the face of the earth has fallen as rain on field, forest, city, street, swamp, or other more or less similar gathering-ground, except such insignificant fraction as falls directly into river or lake. The soluble impurities present in such gathering grounds are conveyed to the storage centres in river, lake or well, and it is fortunate for us that nature has provided, in the course of natural filtration to which such supplies are necessarily subjected, a means of reducing in a great degree the pollution due to organic matter, as will be hereafter explained more fully. The mineral content remains to give so-called "hardness," or other specific character to the supply of each locality. Even before the rain has reached the surface of the earth, however, it is far from pure, since there are always present in the atmosphere particles of organic and inorganic dust, ill-smelling and often poisonous gases, the products of decay, microscopic germs, and other impurities which are washed out of the air by the rain, and make it,—specially the first portion of each shower,—decidedly polluted and unfit, without filtration, to be used as a food supply. The conditions which influence the solubility of solids in water are essentially three, namely, the specific nature of the substance, the temperature of the water, and the presence of other bodies in solution. Even among quite soluble substances very marked and interesting specific differences may be observed. In the six flasks before you I have suspended, in muslin bags, equal quantities (1 ounce) of six different salts, themselves having important relations in the subsequent treatment of this subject, all of them decidedly soluble, and powdered to an approxi-

mately equal degree of fineness. I will now add to each flask one pint of pure water at the ordinary temperature and set them aside for about half an hour. The salts I have selected are 1st, Nitrate of Ammonia, a proximate form taken by much of the decaying animal matter on the earth's surface. This salt will be found to dissolve with extreme readiness,—2nd, Common Salt, or Chloride of Sodium, which exists in vast stratified deposits on every continent and is brought to the surface by natural agencies, such as mineral springs, or artificially by pumped wells (as in the St. Clair Flats, at Goderich, Scaforth, etc.), or by mining as at Cracow and elsewhere. This salt forms the most universal condiment and anti-putrescent agent in the preservation of human food, and as a consequence is present in all sewage, forming a most important clue to the identification of sewage and the tracing of its course where it enters rivers or lakes. Although quite soluble, this salt dissolves only to about one-sixth the amount of the last named. 3rd. Epsom Salts, or Sulphate of Magnesia, and 4th. Glauber's Salt, or Sulphate of Soda, two substances which are very extensively found in mineral waters, and, in fact, give their cathartic properties to most medicinal springs and wells. Epsom Salts dissolves to about the same extent as common salt, while Glauber's Salt has only half this degree of solubility. 5th. Washing Soda, or Carbonate of Soda, and 6th. Bi-carbonate of soda, or Baking Soda, which occur—especially the latter—in many effervescing mineral waters, as in the Vichy and Apollinaris waters, although they are of very much greater importance as manufactured salts. Washing Soda is practically of equal solubility with Glauber's Salt, while bi-carbonate of soda is much less soluble. The solubility of these six salts is seen to be inversely in the order in which I have named them.

As illustrations of naturally occurring salts which are difficult of solution, and yet dissolve to an appreciable extent in natural waters, I can select no better examples than gypsum and chalk, the sulphate and carbonate of lime. Five hundred parts of water are required to dissolve one part of gypsum at the ordinary temperature, so that if a gallon of water fully saturated with gypsum were evaporated to dryness the residual gypsum would weigh only 140 grains, or less than one-third of an ounce. Yet this salt occurring in natural hard waters in very much less amount than is needed to saturate them, is a most

troublesome and harmful impurity when steam boilers are supplied with it. Chalk is as nearly insoluble in pure water as most substances with which we are acquainted, one million parts of water dissolving only eighteen parts of chalk. That is, were a gallon of water fully saturated with chalk to be evaporated to dryness the residue would weigh only about $1\frac{1}{4}$ grains. We shall see, however, that under conditions quite commonly found in nature the solubility of chalk may be increased to 880 parts per million, *i. e.*, a residue of 62 grains would be obtained from a gallon of water saturated under these circumstances. The condition referred to is the presence of free carbonic acid in the water. Before illustrating this, let me indicate the laws which govern the solution of gases in water. These are, briefly, (1st), the specific nature of the gas; (2nd), the temperature; (3rd), the pressure. The two gases, of which our atmosphere is essentially composed, are soluble in water only to a very slight extent. At the ordinary temperature and pressure of the air 100 gallons of water dissolve about 3 gallons of oxygen, and nitrogen is only about half as soluble as oxygen. A fourth law of gaseous solubility applies when a mixture of gases is exposed to a solvent, as in the case of air and water. Each gas is dissolved just in such proportion as it would be were the other gas not present (the pressure, of course, being correspondingly reduced). A consequence of this is that while oxygen and nitrogen are present in air in the ratio of 1 to 4 they are dissolved in water in the ratio of 1 to 2. Thus the atmospheric gases present in water form a mixture very much richer in oxygen than is the air, and the important consequences that follow from this are not far to seek. It is from this dissolved oxygen that fish and all water-breathers obtain the supply to arterialize their blood, and, what bears more directly upon our subject to-night, it is by means of this dissolved oxygen that the various processes by which the harmful and even poisonous organic impurities of natural water are changed to innocent substances, are carried on. So emphatically is the presence of oxygen in solution an essential condition of purity in a surface water, that many chemists always estimate the dissolved oxygen in water analysis. In illustration of this point I may quote the following figures from a report upon the river Seine, above, at, and below Paris:—

Corbeil (20 miles above Paris).....	Dissolved Oxygen =	9.32	CC	per litre.
Epinay (below all the sewers).....	“ “ =	1.05	“ “	
Pont de Poissy (49 miles below Paris)..	“ “ =	6.12	“ “	
Pont de Meulan (58 miles below Paris).	“ “ =	8.17	“ “	
Mantes (68 miles below Paris).....	“ “ =	8.96	“ “	
Vernon (94 miles below Paris)	“ “ =	10.40	“ “	

These numbers are very easy to explain when we consider that the decaying organic matter brought into the river by the sewage of Paris consumes the dissolved oxygen, and is by this consumption of oxygen, converted into other and comparatively harmless compounds, so that, at a point 90 miles below the city and 70 miles below the sewer mouths, the river regains its normal condition as far as this factor is concerned.

Carbon di-oxide, or carbonic acid gas is much more soluble than oxygen. Roughly we may say that water dissolves its own volume of this gas. The only other gas which I shall mention is ammonia, and the extreme solubility of this gas in water is well illustrated in the experiment before you, in which the first portions of water entering the large flask filled with ammonia gas dissolve the whole of the gas thereby creating a vacuum into which a fountain plays—the red liquid (a slightly acid solution of litmus in water) being constantly changed into blue in the fountain jet, and thus bearing witness to the alkaline character of the ammonia.

The solubility of gases in water becomes less as the temperature rises. It is for this reason that water that has been boiled and allowed to cool makes so flat and insipid a beverage. The atmospheric gases, and particularly carbonic acid gas, have been expelled at the boiling temperature, and the water requires artificial aëration before it can become again a sparkling and palatable drink. Under increased pressure a very much larger amount of gas can be held in solution. Effervescing drinks like soda-water, ale and champagne are kept in strong bottles with corks wired down. When the bottle is opened, and ordinary atmospheric pressure applied to the surface of the liquid, the excess of gas which could only be kept in solution by abnormal pressure escapes, and gives the sparkling effervescence characteristic of these beverages.

Unlike gases, a rise in temperature is usually attended with a

marked increase in solubility in the case of solid bodies. The following diagram (see Roscoe and Schorlemmer's *Treatise on Chemistry*, vol. ii., p. 45) will serve to illustrate graphically this point. You will observe that while the rate of increase in solubility for increased temperature varies with the specific nature of the salt, it is pretty generally true that the solubility increases as the temperature rises. In the case of sulphate of soda we have a peculiarity in that the maximum of solubility is found at about 90° Fah. In common salt we find another interesting peculiarity in that for temperatures between the freezing point and boiling point of water the solubility is practically constant at about four pounds of salt per gallon of water. In the case of sulphate of lime we find the very slight solubility of this salt in cold water is even lowered as the temperature reaches the boiling point, although the decrease in solubility is too small to be well marked. However, did this diagram indicate temperatures as high as those found in steam boilers, where water boils under artificial pressure, we should find that at 270° Fah., a temperature which corresponds to the boiling point of water under a pressure of two and a half atmospheres, or about 40 pounds per square inch—a very ordinary boiler pressure—the solubility of gypsum is reduced to one-twentieth part of its solubility at 212° Fah.; and as a consequence of this nineteen-twentieths of the sulphate of lime in solution in a feed-water is deposited as a coherent and very hard crust on the inner surface of the boiler.

The remaining condition which affects the solubility of solids in water is the presence of other substances in solution. There is probably no exception to the statement that the solubility of a solid is influenced more or less by the presence of other dissolved bodies. All the phenomena of precipitation depend upon this principle. I shall have occasion to illustrate this in the course of the evening, but I may now ask you to observe how promptly chlorides are thrown out of solution by salts of silver, salts of iron by ammonia or other alkali, lead salts by carbonates or sulphates, all of which reactions are of great value to water consumers, whether the water be used for household or manufacturing purposes. I can only make detailed reference to two cases of great importance in this connection. The first is the solubility of lead in water, and is of great importance from the extensive use of lead

pipes for conveying water in dwellings. The conditions under which lead is dissolved by water are very complicated, and by no means perfectly understood, but the following broad generalizations are justified by facts. Where water contains nitrates in any considerable amount, and in general where water is essentially soft in character—such as rain-water—the danger of lead being dissolved from the pipe is very great, and poisoning has frequently occurred from this source, as little as one-tenth of a grain per gallon being a poisonous quantity when the water is continually used, since lead is a cumulative poison. Water containing less than one-fourth of this amount has been known to cause serious and dangerous illness. In presence of carbonates, sulphates or phosphates, a thin coating of the carbonate, sulphate or phosphate of lead is formed on, and adheres to, the inner surface of the pipe. Since these salts are practically insoluble they protect the lead pipe from contact with the water and render its use quite safe. Fortunately most natural waters contain a sufficient amount of dissolved carbonic acid or carbonates to prevent danger from the use of lead pipes in their conveyance. It is, however, advisable always to allow water to run freely for a short time where it has been stored in lead service pipes over night, or for any considerable time, especially at a temperature such as is usual in dwellings.

The second illustration of increased solubility due to the presence of a substance in solution is the case of chalk in water containing free carbonic acid. The large glass vessel before you contains water partially saturated with slaked lime. On passing carbonic acid gas from the generator into this water the first effect is the conversion of some of this lime into carbonate of lime or chalk; and the great insolubility of this compound causes its separation with formation of a dense white precipitate which gradually settles down to the bottom of the vessel if allowed to stand at rest. On continuing, now, to pass the carbonic acid gas, after all the lime has been converted into carbonate, we observe this curious effect. The liquid gradually loses its turbidity, and in a few minutes is as clear and transparent as at the first. The excess of carbonic acid gas has caused the precipitated chalk to pass into solution. We have now what is known as *hard* water, and its effect with soap will be apparent from the following

experiment. In the first of these two cylinders I put a pint of ordinary soft water; in the second cylinder I put the same quantity of the hard water which we have now prepared. To each cylinder I now add the same volume of a solution of soap and shake vigorously half a minute. A bulky and persistent lather, nearly filling the cylinder, is formed by the soft water, while the hard water shews merely a thin pellicle of scum, the product of the destruction of the soap added. You will observe that it is necessary to add nine or ten times as much soap to the hard water in order to get a lather comparable with that obtained in the first cylinder. It is evident that hard water causes a waste of soap, and the amount of waste is strictly proportional to the amount of lime in the water, since a perfectly definite decomposition takes place between the soap and the lime salt present. Were the lime present as sulphate the destruction of soap would still occur, with this difference, that in that case no simple and inexpensive mode of softening the water could be applied, and the water would be what is usually called *permanently* hard. The only practicable remedy in such a case is the use of washing soda, for although such remedies as soluble barium salts are very effective in throwing the sulphates out of solution, yet the poisonous character of barium salts, to say nothing of their cost, makes them unavailable in ordinary circumstances. In the case of water which possesses only temporary hardness, *i. e.*, hardness due to carbonate of lime, not only may we use washing soda to cure the evil, but two other processes deserve mention. By boiling the water we drive out of solution the carbonic acid gas, in virtue of which the carbonate of lime is held in solution. On now allowing it to settle, the almost insoluble chalk is deposited, and the soft water may be drawn off. The second and very ingenious plan of softening such water is due to the late Prof. Clarke of Aberdeen, and is usually known as Clarke's process. It consists in adding slaked lime to the water in proper amount to form chalk with the free carbonic acid, which is therefore withdrawn from solution and precipitated along with the now insoluble lime salt originally present in the water. Many large towns and cities in England and elsewhere now soften their whole supply in this way. The water of the Ottawa River is remarkably soft since the gathering ground is essentially free from limestone rocks. The Upper Ottawa region is

characterized by its granites and allied siliceous rocks, with a soil which has resulted from their weathering and destruction by glacial and other agencies. The peaty character of large areas of this gathering ground is evidenced in the brownish colour of the water of the river ; a colour which is due not to the presence of dissolved salts, but to the products of decay of vegetable matter. The results of many analyses of the Ottawa River shew it to contain less than *one* part of solid matter for *ten thousand* parts of water, or less than seven grains per gallon in solution. At certain periods of the year it, however, contains solid matter suspended in the water, causing a turbidity which you must often have remarked. This is particularly characteristic of the river in spring, when the swelling of the smaller streams which feed it and the fine particles of clay and sand washed down from fields and roads, sufficiently account for its muddy appearance, while its current is rapid enough to prevent the settling of this mud to the bottom. In respect to suspended solid matter, however, the Ottawa River compares very favourably with many others—I might say with any other river of its size. The sources of the Ottawa are situated for the most part in a rocky region where there is comparatively little soil to be washed into its waters by spring freshets. It is quite otherwise with such rivers as the Red River at Winnipeg, which gets its name from the highly coloured ferruginous clay, which it carries in suspension ; or with the Missouri and Mississippi, whose waters, joining at St. Louis, sometimes contain the enormous amount of 1,225 grains of solid matter (or nearly three ounces) per gallon. Yet it is from this water that St. Louis takes its supply ; and it will not surprise you to learn that four settling basins of large size have to be provided, so that while one is being drawn from another is being filled, and the other two are settling for use in their turn. Either by subsidence, as at St. Louis, or by simply constructed filter beds, such suspended matter may be got rid of. Of the principles involved in the construction of filter beds, I shall speak later.

From what has been said it will appear that absolutely pure water is not to be sought for in nature. In order to prepare it we must resort to the process of distillation ; and one method of carrying out this process is illustrated by the apparatus before you. The water

which is boiling in the flask upon the left contains sand and clay in suspension, sulphate and carbonate of lime in solution, as well as salts of ammonia and common salt. We shall look in vain in this distillate (the condensed steam) for any traces of these, and although we may find traces of carbonic acid and ammonia, since these readily volatile substances may come over with the first portions of the water vapour, yet if we reject the first portion of distilled water, we shall find the remainder to be absolutely pure, since the salts mentioned above are not converted into vapour at the temperature at which water boils, and they therefore remain behind in the flask. Even the ammonia might have been prevented from coming over had we taken proper precautions in treating the water before applying heat. It will, however, be evident that distillation is too expensive a method to be practically available on the large scale for water purification: and it is only in such cases as on shipboard that water for drinking purposes is obtained in this way. A process quite analogous to this is, nevertheless, carried on by natural agencies on the large scale. The formation of clouds, and the precipitation of their watery burden, as rain, snow, etc., is but a vast distilling of the surface waters of the earth; and were it not for the impurities washed out of the air by it, rain water would be quite as pure as the distilled water flowing from this condenser. Indeed, were proper pains taken to reject from cisterns the first portions of each shower, as containing the bulk of the impurities of the air, and the dust and dirt from the roofs on which it falls, rain water might be collected and stored so as to form a perfectly wholesome and even palatable drinking water, since it is well aerated, and the insipidity due to absence of dissolved solids is less and less noticed as people become habituated to its use. I have figured in this diagram two original devices, by means of either of which a definite portion of each rain-fall may be automatically prevented from entering the cistern, and only the later portions of the shower allowed to flow into it; and I think that every cistern should be provided with a contrivance fitted to effect this separation of the earlier from the later portion of each rain-fall.

For purposes of brevity I shall omit any mention of sea water, or lake water; and devote the remainder of the evening to some remarks upon river and well waters; and in order to make it possible to define

the character of a sample from the results of its analysis, I propose to indicate here the essential features of the operations collectively known as *Water Analysis*.—

Naturally the first tests made are those which require only the direct use of the senses : taste, smell and sight.

1. *Taste*.—It is only in rare instances that this character is sufficiently definite to be of any value. When the taste of a sample is so markedly unusual as to attract attention, as, for instance, to its saltiness or its sulphur flavour, or its sharpness or pungency, as is the case of some mineral springs, it may be safely asserted that such a water, however useful medicinally, is unsuited to ordinary household purposes.

2. *Smell*.—It is rare that a natural water exhibits any smell at the ordinary temperature. Certain spring waters contain sulphurous gases in solution and these have a more or less nauseating smell, at times intense enough to remind one of rotten eggs. Many samples, however, which are quite odourless when cold, become distinctively *bad smelling* when heated. A pint or so of the water may be placed in a glass stoppered bottle and the whole heated to about 100° F., when, if the stopper be withdrawn and the bottle immediately applied to the nose, peaty waters will often betray themselves by a characteristic smell, and water from surface wells to which sewage has access will frequently be found to have quite a stinking odour.

3. *Colour*.—It is perfectly wonderful how many different tints of colour are exhibited by natural water from different sources; indeed it would scarcely be overstating the case to say that no two water samples have the same tint. True it may not always be possible, even with the refinements of science, to distinguish with absolute exactitude the nice differences that occur, yet, when we employ a colour comparer of the model exhibited, and look through a column of water 24 inches deep, it becomes possible to distinguish very slight differences indeed. The first of these tubes contains distilled water, and seems quite colourless; the second contains ordinary Ottawa river water and looks quite brown by comparison. In the third tube I have a sample of Ottawa water which has been treated with 10 grains of common alum to the gallon, and you will note that although not as colourless as distilled water, it

has been very greatly improved in this respect. The brownish tint of the Ottawa river water, in common with many other Canadian rivers, as the Richelieu, the Yamaska, etc., is due chiefly to dissolved vegetable matter of peaty origin. Alumina has the property of precipitating such colouring matter, hence the improvement on adding alum. In reference to this feature, namely, colour in water, I may say that while it is desirable on æsthetic grounds that a drinking water should be as colourless as possible, we know of no positive reason for condemning a highly coloured water as unwholesome. I shall show later that the presence of much organic matter, even though only of vegetable origin, and innocent enough in its character, is cause for anxiety and possible danger, and of course so far as colour helps us to ascertain the presence of such matter it becomes a valuable factor in the analysis; still we must remember that it is only as potentially, not as actually dangerous, that we object to the use of peaty waters, and we cannot therefore condemn them on the ground of high colour alone. The observation and recording of colour in water is of greatest consequence when the *same water* supply is studied from day to day. Then indeed, a change in tint corresponds always to a change in character; and the cause of this change must be looked for, if necessary, by a complete analysis of the water. For purposes of registering the observed depth of colour nothing better is known to me than the scale devised by I ovibond, in which a set of glass slips of fixed and comparable colour values is employed. I am able to shew you the standard glasses, but a full illustration of the mode of using them would require more time than we have to spare. The depth of colour is expressed in terms of this scale in Bulletins 15 and 18 of the Inland Revenue Department.

4. *Turbidity and Clearness* are due to matter in suspension or its absence, and vary according to conditions which have already been explained.

5. *Oxygen in Solution* becomes a valuable factor in the analysis of the water of the same stream at different points of its course, as I have already illustrated in the case of the Seine at and below Paris. The estimation is, however, of no value when a single sample is concerned, since the amount which may be present in a perfectly pure water varies

with so many conditions. Water from deep artesian wells is sometimes nearly free from dissolved oxygen, and is yet of the purest possible description.

6. *The Dissolved Solids* are estimated by evaporating a known volume of the water to dryness in a platinum dish and weighing the residue. The drying of the residue is effected at 100° C. ($=212^{\circ}$ F.), a temperature high enough to drive off all except chemically combined water. This residue is then ignited in the dish, and the resulting ash is weighed; the loss of weight is usually stated in a separate column in reporting the analysis, although a much less value is attached to this number than was the case some years ago. The loss was then supposed to be essentially due to organic matter which had been burnt away, and was hence thought to be a measure of the impurity of the water analyzed. Now, we know that far more importance must be attached to the kind of organic matter present than to the total amount of it, and since the loss on ignition gives no information on this point its indications are of correspondingly small moment. Besides this, the loss is partly due to escape of carbonic acid gas from carbonates, and to loss of water which has been combined in such a way that it was not driven off by heating to 100° C.

I may here mention that it is possible to burn away the organic matter from the residue in such a way as to collect the products of combustion, and from them to calculate the amounts of carbon and nitrogen which the residue contained. Since nitrogen is, as a rule, present to a larger amount in organic matter having an animal origin than in that having a vegetable origin, it is possible from the relative amounts of nitrogen and carbon to get an idea of the proportion of animal impurities existing in the sample analyzed. This process is a very tedious and troublesome one, and requires the utmost care in its execution that results of any value may be obtained. It was employed by Dr. Frankland in the analysis of the waters of Great Britain (1868—1876), and he concludes that surface water or river water containing 2 parts of organic carbon, or 0.3 parts of organic nitrogen per million, should be rejected where possible. I have not employed the process in the analyses of Canadian river and well waters which I have made within

recent years, nor am I aware that it is in use by any Canadian analyst at present. Prof. Marsan, in December, 1888, found 9 parts organic carbon and 0.47 parts nitrogen per million in the Ottawa city supply, and did not consider these numbers to condemn the water for domestic use.

The ignited residue contains the inorganic salts, sand, etc., which were present in the water. Unless these are in excessive amount their discrimination is not necessary, since in ordinary water samples they consist of lime, magnesium, or soda salts, quite harmless in character, unless, as I have already explained, the water is wanted for boiler supply. Many analyses of the Ottawa river water shew the ignited residue to vary from 20 to about 80 parts per million, according to the season of the year, and the part of the river from which the sample is collected. Other rivers show a much higher inorganic content, as, for instance, the Grand River, at Brantford (Nov., 1889), 348 parts per million, and the Assiniboine, near Winnipeg (May, 1888), which gave 1088 parts per million.

In this residue, however, we always look for phosphoric acid, since phosphates are highly characteristic of sewage, and their presence in the minutest traces is a very suspicious indication.

7. *Nitrogen* existing as ammonia in water is present in consequence of the fact that whenever organic matter containing nitrogen undergoes decay a considerable proportion of this nitrogen takes the form of ammonia, and the exceeding solubility of this gas in water causes it to be at once dissolved. You are, many of you at least, acquainted with the fact that the atmosphere of a stable, unless kept very thoroughly cleaned, has a decided smell of spirits of hartshorn. This odour is due to the decomposing nitrogenous matters present, and the formation of ammonia as one of the products of decay. The universal occurrence of organic decay makes it practically impossible that a natural water should be absolutely free from ammonia. When, as in some tables of analysis, you find nitrogen as ammonia stated to be absent, you must understand this to mean that the amount present is too small to make its quantitative estimation possible. Yet it is wonderful with what certainty we can measure minute traces of ammonia. When you find tables in which the nitrogen existing as ammonia is stated to three places of decimals,

the results being given in parts per million, this means that we aim at estimating one part of nitrogen in one billion parts of water, or less than one-ten-thousandth of a grain per gallon. In order to give you some idea of how this is done I place in one of these tubes a column of 24 inches of water quite free from ammonia, and in another I place an equal quantity of water to which I have added ammonia in the proportion of one part nitrogen to one million parts of water. The two samples as reflected to you from the mirrors are of course quite indistinguishable from each other. To each I now add a small quantity of a prepared test liquid called Nessler's solution, and you will observe in the course of a minute or two that while the contents of the first tube are unchanged in colour, a faint brownish yellow colour gradually develops itself in the second tube. Of course it is possible in the laboratory to apply this test in such a way as to obtain still greater sensitiveness, but the illustration will serve to give you confidence in numerical statements of the results of analysis even when fractional parts of a million are expressed.

8. While the simpler organic bodies containing nitrogen yield this nitrogen as ammonia during decomposition, many of the more complex substances which enter into the composition of animal structure, such as albumen, fibrin, etc., form other proximate products of decay, these possessing the common property of being converted into ammonia when boiled with a strongly alkaline solution of permanganate of potash. The ammonia obtained by treating a sample in this way, after the ammonia already present in it has been taken off, is called "Albuminoid" ammonia, as suggested by Wanklyn, the author of the process, and is properly considered as a most important factor in the analysis. Indeed, if it were ever allowable to adjudge a sample of water for drinking purposes upon the indications of a single factor in the analysis I would select this estimation as the critical one. The author of the process, who in conjunction with other analysts, worked upon a very large number of samples of all degrees of badness, concludes from his experience that "0.10 per million begins to be a very suspicious sign, and 0.15 per million ought to condemn a water absolutely." This standard would go hard with Ottawa river water, which in 1888 gave from 0.12 to 0.27 in different samples; in March and April of last year gave 0.1

and 0.16; and in August last gave 0.125 albuminoid nitrogen per million. We must not forget that these are English standards and on that account are questionably applicable to American rivers, which flow for very great distances over forest and marshy regions where contamination by sewage—in the ordinary acceptance of this term—cannot occur. We must, I think, concur in the wisdom of Prof. Mallet's decision that "local standards of purity should be adopted, based on sufficiently thorough examination of the water-supply in its usual condition. Unfortunately no systematic and continuous examination of our city supply has yet been undertaken, and it is impossible for me to state, except in a very imperfect way, what the normal composition of the Ottawa water is. It must, of course, be expected to vary for different months; but we should have a series of analyses made at weekly intervals for a number of years; and from the averages so obtained it would be a simple matter to determine the mean character of the water for any period. When we consider that water is a universal food substance that it enters into the preparation of every article of food; that from the nature of its production and storage, it is peculiarly liable to contamination in various ways, and that the most fatal diseases have been fully proven to have become epidemic, through its agency, we shall, I think, agree that a constant and careful examination of the supply of a city like ours is but a reasonable and necessary precaution.

9. When organic matter containing nitrogen has been exposed for a sufficiently long time to the ameliorating influences that are always at work in nature, the nitrogen takes the form of nitric acid, and when this is once formed and enters into combination with bases as nitrates, the condition of the nitrogen is fairly stable, and the nitrates so formed may exist as such for an indefinite length of time. Complex organic substances like albumen are thus changed into simple inorganic substances, perfectly harmless, and only interesting to the analyst as serving to measure the previous sewage contamination of the supply. For where much sewage has found entrance to a well-water, for example, although little or none may be now present as sewage, the tell-tale nitrates serve to prove past contamination. I need scarcely say that such wells as those quoted below are undoubtedly infected by sewage:—

	NITROGEN PER MILLION PARTS, AS .		
	Ammonia, Free, &c.	Albuminoid Ammonia.	Nitrates and Nitrites.
Inland Revenue Department, bulletin 5, page 8, No. 16.....	0.033	0.305	11.967
Inland Revenue Department, bulletin 5, page 8, No. 17.....	0.090	0.165	15.909
Inland Revenue Department, bulletin 13, page 6, No. 6761.....	0.000	0.148	27.357
Inland Revenue Department, bulletin 13, page 15, No. 43.....	trace.	0.050	39.000

In order to guard against miscomprehension I must mention here that nitrates although fairly stable compounds, are not absolutely such; but may, under certain conditions, be again resolved into ammonia or nitrogen.

10. I have already referred to the universal employment of common salt as a condiment and preservative; a fact which accounts for its presence in sewage, and makes a search for it in water analysis a very important step in the examination. The readiness with which minute traces of kitchen salt can be recognized will be evident to you from this experiment. When nitrate of silver solution is added to this solution of chromate of potash, a few drops of this weak solution is sufficient to produce a decidedly reddish tint, due to the bright red chromate of silver formed in the re-action, the particles being suspended through the water in the tube. I will now repeat the experiment, taking the precaution to add a very small amount of common salt to the chromate solution, before adding the silver, drop by drop, for a very long time without producing any red colour in the liquid: in fact, no chromate of silver will be permanently formed until enough silver has been added to decompose the common salt present. On this principle is based a method by which we can detect less than 1 part of salt in 1 million parts of water. Wherever sewage is present chlorides will be found. In the four wells whose nitrates indicated past sewage contamination, the chlorine in chlorides was found to be 148, 134, 65 and 143 parts per million respectively. A large number of good wells whose analyses

are to be found in the bulletins of the Inland Revenue Department will be seen to contain chlorine in varying amounts from 1 to 10, or more parts per million. We must not, however, forget that in many parts of Canada salt is found in the soil, and in various deep-seated springs, and it is therefore absolutely essential that the location and surroundings of the well should be known to the analyst before he pronounces an opinion on the results of chlorine estimation. Many wells in Winnipeg and other parts of Manitoba contain from 200 to 300 parts c. chlorine per million, and are yet free from sewage pollution.

11. The only other feature in water analysis to which I need refer is the estimation of dissolved organic matter essentially non-nitrogenous in character, in other words, of vegetable origin. Such organic matter is with difficulty destroyed by oxidation and requires the employment of the most powerful oxidizing agencies we know to effect its decomposition. For the purpose we always use permanganic acid, a sample of which I show you in solution. Observe its beautiful deep purple colour and see how the addition of a very small quantity of water, impure from decomposing organic matter in solution, serves at once, or at least in a very short interval of time to cause the purple to become less and less intense, and shortly to disappear altogether. Now, by using a solution containing a known amount of permanganic acid, and adding it in excess to a measured quantity of the water to be examined, we can easily, at the end of, say four hours, estimate the excess of permanganic acid by chemical means, which need not be here explained, and thus obtain by difference the quantity used up in oxidizing the organic matter present in the sample of water. Since permanganic acid gives up a definite amount of its oxygen to this purpose, it is convenient to state the results of the examination as so many parts by weight of oxygen to the million parts by volume of water. The observation is usually made for two periods, viz., intervals of 15 minutes and 4 hours; the more easily oxidized organic matter being attacked in the shorter interval, and this part always includes any animal or more objectionable matter present. The following numbers quoted from Bull. v of the Inland Revenue Department will serve to give an idea of the indications afforded by this test:—

	OXYGEN CONSUMED PER 1,000,000 PARTS WATER.	
	15 Minutes.	4 Hours.
Lake Ontario, at Hamilton.....	0.120	0.440
River St. Lawrence, at Brockville.....	0.276	0.612
River Richelieu, at St. John's, Que.	0.740	1.668
Bay of Quinte, at Belleville.....	1.420	3.040
River St. Maurice, at Three Rivers, Que.	2.612	4.456
Ottawa River, February, 1888.....	2.868	5.760
Moncton Supply, New Brunswick.....	5.436	10.444

The place occupied by Ottawa river water in this list is certainly one of *bad eminence*. As this water has been examined at irregular intervals since 1888, I may add the following results:—

Ottawa River, April, 1890.....	3.060	4.886
“ “ August, 1890.....	3.747	6.387

It will be seen from these numbers that while the amount of oxidizable organic matter in the river varies from month to month as might be expected, and according to a law which we have not the necessary data to discover, the amount is at all times very large, and it behoves us to examine the conditions under which a water containing so large a quantity of dissolved organic matter is safe as an article of food. That the organic matter is not *per se* of an injurious nature is sufficiently evident from the fact that we and our fathers do use it and have used it with impunity. Let me ask your attention for a few moments to another matter. There is a large class of diseases generally spoken of as *zymotic* which have this property in common. Whenever a single case of such a disease occurs in a locality we may be pretty sure that immediately in its vicinity, and gradually further and further from that point as a centre, we shall find the disease spreading until it

becomes an epidemic. That is to say, such is the normal tendency of this class of diseases, and I may instance cholera, typhoid fever, diphtheria, influenza and la grippe as examples. There can be little doubt that the plagues and pestilences, such as the Black Death which visited England in the 14th century after having spread all over Europe and caused the death of twenty five millions of people, were other instances of zymotic diseases; and the fact that such plagues and pestilences are of so much less frequent occurrence now-a-days, and so much less malignant when they occur in the more civilized parts of the world than elsewhere, gives us the first important clue to their comprehension, and we may hope to their extermination. For it has been and is just in proportion to the cleanly habits of a people that these diseases lose their fatal character. This suggests a close connection between *filth and disease*, and the more carefully that we look into the matter, following this clue, the more fully are we convinced that such is the case; that cleanliness of person and surroundings is the first law of health. Still, this does not fully explain the phenomenon of zymotic disease, since the advent of a specific case of disease is necessary that the evil effects of uncleanly habits may be fully emphasized. This would seem to imply the existence of a specific disease virus or poison for each of these epidemics, the spread of which poison was favoured by the prevalence of uncleanly habits. Reasoning on this line led Pasteur, Koch, Cohn and others to the discovery of what will hereafter be regarded as the most important generalization of medical science in our century, namely, that which points to the existence of a special microbe, bacillus or living germ for each of the so-called zymotic diseases. The next step was to attempt the isolation of this germ, and with certain diseases this has been done. In the case of *Anthrax*, Koch has cultivated the bacillus and studied it throughout its complete development. The chart before you will serve to give an idea of the appearance of this enemy of mankind, as magnified about 15,000 times linear. In the next diagram I shew you both *in situ*, and isolated the *bacillus tuberculosis* from photographs by Koch. It is the study of this bacillus which has made Koch's name so widely known within the last year; but my purpose in emphasizing the matter is to draw your attention to the explanation which this theory of zymotic diseases offers of their sudden spread. The specific

bacilli are found in the waste matter from the bodies of patients, and may, and must, if the greatest care be not taken to make the thing impossible, find their way into the atmosphere, and into open water courses, into wells by surface or sewer drainage if such drainage finds access to them. And while the taking of these disease germs into the lungs in respiration is unquestionably the most effective way of spreading the disease yet experience has proved beyond a doubt that taking them into the system in our drinking water or our food is only second in danger. I might quote many historical instances in proof of this if time permitted, You will find such in the Sixth Report of the Royal Commissioners (1868) on preventing the pollution of rivers. The importance of immediate attention to the destruction of the dejecta of patients suffering from any of these zymotic diseases will be evident; but how are we to protect ourselves when by chance such infection pollutes our streams and wells? There is but one safe rule, and it is this: Use no water for domestic purposes which at any time contains sewage; because although normal sewage may not contain actually poisonous substances, and may, when sufficiently diluted, be drunk with impunity, as proved by Dr. Emmerlich and others: yet we can never know when diseased sewage containing morbid germs may enter such a water course, and the only safe way is to have nothing to do with it. As I have said this is really the only safe rule, but what shall we do when we cannot help ourselves. To take our own case; there is apparently no other source from which we can obtain a supply than the Ottawa river, and this receives the sewage of places like Aylmer, Quyon and others; together with the drainage of fertilized fields all along its course, and the fertilisers used are, as we know, not unlikely to contain disease germs. Fortunately nature furnishes, in dissolved oxygen and through other conditions, the means of self purification for such contaminated waters. Only give time enough and the most dangerous sewage contamination will be converted into harmless matter by natural agencies. Still, it is reasonable to suppose that water containing much organic matter in solution is more likely to furnish a suitable and congenial *nidus*, or nourishing ground for bacteria than water that is more nearly free from organic matter. This is the disadvantage at which we are placed; and I have no hesitation in saying that not only on æsthetic, but

also on hygienic grounds some method should be provided for precipitating, or otherwise separating from our river water the large amount of organic matter it contains before supplying it to the citizens for household use.

Returning now to the consideration of well water, it will appear that the chief differences in character to be expected between deep well waters on the one hand, and shallow well, or surface waters on the other hand are such as may result from the influence of filtration through deep layers of soil. The most effective way of presenting these differences will be by asking your attention to the following table in which a few shallow wells, and a few deep wells are contrasted as regards the results of their chemical analysis:—

	No.	Total Solids.			Nitrogen.			Chlorine in chlorides.	Phosphates.	Oxygen Consumed.	
		Dry at 100° C.	Ignited.	Loss.	Alb.	Free.	Nitrates			15 min.	4 hours.
Shallow Wells .	1	128	84	44	0.066	0.016	0.133	3.0	none	0.168	0.440
	2	424	312	112	0.016	0.090	0.109	66.0	"	0.194	0.232
	3	148	99	49	0.250	0.020	0.450	9.6	tr.	1.830	3.645
	4	424	320	104	0.181	0.946	1.154	4.0	none	2.412	5.042
Deep Wells. . . .	5	1312	1136	176	0.080	0.140	0.260	330.0	"	0.076	0.244
	6	552	404	148	0.060	0.090	0.010	10.0	"	0.160	1.600
	7	993	692	301	0.640	0.200	37.000	108.0	heavy traces	3.390	8.670
	8	1112	640	472	0.218	11.190	5.910	260.0	traces	0.552	1.55

No. 1 —A well in the suburbs of Hamilton, Ont.

No. 2—A well at Ashburnham, Ont.

No. 3 —A well in a bog at Joe's Point, St. Andrews, N.B.

No. 4—A well at Brandon, N.W.T.

No. 5 A public well in Winnipeg, Man.

No. 6—An artesian well at Goderich, Ont.

No. 7—A well at Three Rivers, Que.

No. 8—A well in a large tenement house, Sherbrooke, Que.

Numbers 1 and 2 in the above table give a very fair idea when contrasted with numbers 5 and 6, of the differences which exist between shallow and deep wells. The solids in the latter are much higher, and although chlorides are present even in large amount, they need not indicate sewage contamination, since their presence may be due to chlorides in the soil or in rock strata through which the water has passed. Albuminoid nitrogen should be low in these deep waters; that it happens to be still lower in amount in the shallow wells quoted indicates their freedom from sewage. Number 3 shews sewage contamination not only in its albuminoid nitrogen but in its traces of phosphates, and this is corroborated by its chlorine, for while 66 parts chlorine does not indicate anything wrong in No. 2, one-seventh part as much chlorine is a bad indication in No. 3, since its sewage origin is borne out by other features of the analysis. The free ammonia in No. 4 serves to indicate sewage, and the nitrates here shew past sewage contamination. Numbers 7 and 8, although deep wells, shew in many items of the analysis that sewage has found entrance to them, and they cannot be safe or desirable sources of domestic supply.

I had intended interpreting for you the results of analysis of Ottawa river water for some years past, so far as I have been able to collect statistics; but this would require at least another half hour, and it is now past ten o'clock. I must therefore defer this portion of the subject until some future opportunity. There remains also the important question of how, by artificial means, the quality of a natural water supply may be improved. This is in itself a subject large enough to occupy a whole evening in its treatment, and must therefore be left to be dealt with in the future.



SUMMARY

— OF —

Canadian Mining Regulations.

NOTICE.

THE following is a summary of the Regulations with respect to the manner of recording claims for *Mineral Lands*, other than *Coal Lands*, and the conditions governing the purchase of the same.

Any person may explore vacant Dominion Lands not appropriated or reserved by Government for other purposes, and may search therein, either by surface or subterranean prospecting, for mineral deposits, with a view to obtaining a mining location for the same, but no mining location shall be granted until actual discovery has been made of the vein, lode or deposit of mineral or metal within the limits of the location of claim.

A location for mining, except for *Iron* or *Petroleum*, shall not be more than 1500 feet in length, nor more than 600 feet in breadth. A location for mining *Iron* or *Petroleum* shall not exceed 160 acres in area.

On discovering a mineral deposit any person may obtain a mining location, upon marking out his location on the ground, in accordance with the regulations in that behalf, and filing with the Agent of Dominion Lands for the district, within sixty days from discovery, an affidavit in form prescribed by Mining Regulations, and paying at the same time an office fee of five dollars, which will entitle the person so recording his claim to enter into possession of the location applied for.

At any time before the expiration of five years from the date of recording his claim, the claimant may, upon filing proof with the Local Agent that he has expended \$500.00 in actual mining operations on the claim, by paying to the Local Agent therefor \$5 per acre cash and a further sum of \$50. to cover the cost of survey, obtain a patent for said claim as provided in the said Mining Regulations.

Copies of the Regulations may be obtained upon application to the Department of the Interior.

A. M. BURGESS,

Deputy of the Minister of the Interior.

DEPARTMENT OF THE INTERIOR,
Ottawa, Canada, December 19th, 1887. }

HENRY WATTERS,

Chemist and Druggist,

Corner of Sparks and Bank Streets,

OTTAWA.

ROBERTSON BROS.,
Booksellers and Stationers,

69 Rideau Street.

Natural History Works supplied to
order.

C. P. WILLIMOTT & CO.

333 Wellington St., Ottawa.

Mineralogists & Lapidaries

Every variety of stone cut and polished.
Large stock of cut stones to select from.
Rock sections for microscope carefully prepared.
Collections of named characteristic
Canadian minerals from \$1 upwards. Give
us a call if you want something new. Send
for catalogue.

J. D. TAYLOR,
Book and Job Printer,

48 & 50 Queen St.

OTTAWA.

J. G. BUTTERWORTH & CO.,

ALL-RAIL COAL,

86 Sparks Street.

WM. HOWE,

Importer of Artists Materials and Artistic
Interior Decorations. Manufacturer
of White Lead, Paints & Colors.

Howe's Block, - - OTTAWA.

M. M. PYKE,
MEN'S OUTFITTER,

69 SPARKS ST.,
OTTAWA, - - - ONTARIO.

BOARDING and DAY SCHOOL

-FOR-

YOUNGLADIES.

(Established 1862.)

49 DALY AVENUE.

MISS A. M. HARMON, - - PRINCIPAL

A. J. STEPHENS,
FINE SHOES,

33 SPARKS ST.

Boots and Shoes Made to Measure.

J. & R. CRAIG, Tailors, 105 Sparks St., Ottawa.