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For the Year 1912

VOLUME IV

WATERVILLE
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1914

STATE OF MAINE

THIRD ANNUAL REPORT

State Water Storage Commission

1912

WATERVILLE
SENTINEL PUBLISHING COMPANY
1913

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MAINE STATE WATER STORAGE COMMISSION.

WILLIAM T. HAINES, GOVERNOR,
Chairman.

BLAINE S. VILES, *Land Agent.*

EDWARD P. RICKER, SOUTH POLAND.

JAMES M. MCNULTY, BANGOR.

EDWARD C. JORDAN, PORTLAND.

CYRUS C. BABB, *Chief Engineer.*

AUGUSTA, MAINE, January 15, 1913.

To the State Water Storage Commission, Augusta, Maine.

GENTLEMEN:—In accordance with the provisions of Chapter 170, Public Laws of 1911, I beg to submit the Third Annual Report of this Commission and recommend its publication.

It is not practicable at the present time to report a final plan for the comprehensive development of the storage basins of the State as will tend to develop and conserve the water powers, for the reason that the appropriations have not been sufficient to make the necessary field examinations in the time allowed.

Certain bills introduced into the present Legislature, the Seventy-sixth, provide for the creation of a Public Utilities Commission and the abolishing of the Water Storage Commission, but with the provision that the former Commission shall be vested with all the powers, duties and privileges of the latter, and shall have custody and control of all records, maps and papers pertaining to the office of the Water Storage Commission. This report may be the last one of the present Commission, but under the intent of the new law as proposed, the work could be carried forward by the Public Utilities Commission.

Very respectfully,

CYRUS C. BABB,

Chief Engineer.

REPORT OF THE CHIEF ENGINEER

CYRUS C. BABB.

LEGISLATION.

The Seventy-fifth Legislature referred to the next legislature a bill prepared by the Chief Engineer providing for extensive control by the State of the construction of dams, the taxation of water powers and the regulations of storage reservoirs on the great ponds of the State. During the following two years, the bill was extensively modified and will be introduced into the Seventy-sixth Legislature. It is believed that the adoption of some such bill is necessary in accordance with the provisions of the organic act creating this Commission, whereby the Commission is to report a comprehensive plan for the improvement and development of the water powers and storage basins of the State. *a*

a Later.—The Legal Affairs Committee reported that the bill "ought not to pass" and this report was adopted by the Seventy-sixth Legislature.

FIELD OPERATIONS.

TOPOGRAPHIC SURVEYS.

The Commission has continued the usual coöperation with the U. S. Geological Survey in the prosecution of topographic surveys throughout the State.

The unit of publication is an atlas sheet showing a tract (quadrangle) 15′ in extent each way or about 215 square miles, varying with the latitude. The scale is 1 : 62,500 or about one mile to an inch. Contours, or lines of equal elevation, are shown with a 20-foot interval. These sheets are sold by the U. S. Geological Survey at the rate of ten cents a sheet. When fifty or more are ordered, the rate is $3.00.

Fifty sheets have been issued for the State of Maine, named as follows: Eastport, Petit Manan, Cherryfield, Bar Harbor, Swan Island, Mt. Desert, Ellsworth, Deer Isle, Bluehill, Orland, Orono, Matinicus, Vinalhaven, Castine, Penobscot Bay (scale 1 : 125,000), Bucksport, Bangor, Tenants Harbor, Rockland, Monhegan, Boothbay, Wiscasset, Vassalboro, Waterville, Small Point, Bath, Gardiner, Augusta, Norridgewock, Anson, Bingham, The Forks, Casco Bay, Freeport, Lewiston, Livermore, Buckfield, Biddeford, Portland, Gray, Poland, York, Kennebunk, Buxton, Sebago, Norway, Dover, Berwick, Newfield, Fryeburg, Kezar Falls, North Conway, N. H., and Gorham, N. H.

The Bryant Pond and Skowhegan quadrangles have been completed and preliminary lithographic copies have been issued. During 1912 field work was completed on the Bethel quadrangle. This sheet completes the tier of quadrangles in this section of the State to the western boundary joining the Gorham, N. H. quadrangle. A lithographic copy of the Bethel sheet will probably be issued in April, 1913. Field work on the Skowhegan sheet was begun and completed during 1912 and, as mentioned above, lithographic copies of it have been issued. Primary triangulation has been extended to cover the Burnham, Washington Pond, and Waldoboro sheets with the idea of undertaking the topographic mapping of this section during 1913.

River and Lake Surveys.

Special river and lake surveys of many of the more important rivers and lakes in the State have been made. The resulting river maps, generally on a scale of 1 inch to 2000 feet, show, not only the plan of the rivers with 5-foot contours along the banks, but also the profiles of the rivers. These maps are of great value in studying both developed water powers and undeveloped water power possibilities. From these maps can be obtained a close estimate of the total horsepower that can be developed at the various unutilized falls and rips, when studied in connection with the stream gaging work.

The special lake maps are on varying scales of one inch to 1,200 feet, 2,000 feet, 3,000 feet and 4,000 feet. Some large scale maps, one inch to 200 feet, of the outlets of a number of the lakes are also shown. These maps in general show the high water line, the low water line, and the 5-foot contour lines from 10 to 25 feet above the lake. Soundings are often shown, and occasionally several 5-foot sub-contours. These sub-contour lines are interesting, in that they represent the shore lines that would result if the lakes should be drawn down 5 or 10 feet as the case may be. These lake maps are of special value in computing the capacity of the various lakes in cubic feet when their use as storage reservoirs is contemplated.

Owing to the reductions in the appropriations and allotments the special River and Lake surveys had to be discontinued for the current year. However, the sheets noted in the 2nd Annual Report as unpublished, have been issued and the entire edition is now available for distribution except those sheets where the edition is exhausted. The following is a complete list of these maps as issued and as surveyed to date:

River and Lake Surveys.

Kennebec Basin.

1. Kennebec River, Skowhegan to The Forks, Sheet No. 1.
2. Kennebec River, Skowhegan to The Forks, Sheet No. 2.
3. Kennebec River, Skowhegan to The Forks, Sheet No. 3.
4. Kennebec River, Skowhegan to The Forks, Sheet No. 4.
5. Kennebec River, The Forks to Moosehead Lake.
6. Kennebec River, Profile, Augusta to Moosehead Lake.

7. Brassua Lake and plan of outlet.
*8. Wood Pond and plan of outlet.
*9. Attean Pond.
*10. Long Pond; Holeb Pond; Moose River, Moosehead Lake to Brasssua Lake.
*11. Flagstaff Lake; West Carry Pond; Spring Lake; Spencer Ponds; Middle Roach Pond; Lower Roach Pond.

PENOBSCOT BASIN.

12. Penobscot River, Bangor to North Twin Lake, Sheet No. 1.
13. Penobscot River, Bangor to North Twin Lake, Sheet No. 2.
14. Penobscot River, Bangor to North Twin Lake, Sheet No. 3.
15. Penobscot River, Bangor to North Twin Lake, Sheet No. 4.
16. Penobscot River, Bangor to North Twin Lake, Sheet No. 5.
17. West Branch Penobscot River, Chesuncook Lake to Ambejejus Lake, Sheet 1.
18. West Branch Penobscot River, Chesuncook Lake to Ambejejus Lake, Sheet 2.
19. West Branch Penobscot River, Chesuncook Lake to Ambejejus Lake, Sheet 3.
20. East Branch Penobscot River, First Grand Lake to Medway, Sheet No. 1.
21. East Branch Penobscot River, First Grand Lake to Medway, Sheet No. 2.
22. East Branch Penobscot River, First Grand Lake to Medway, Sheet No. 3.
23. Chamberlain, Telos and Webster Lakes and Round Pond.
24. Baskahegan, First and Second Grand and Allagash Lakes.
25. Mattawamkeag River, mouth to No. Bancroft, Sheet No. 1.
26. Mattawamkeag River, mouth to No. Bancroft, Sheet No. 2.
27. Mattawamkeag River, mouth to No. Bancroft, Sheet No. 3.
28. Schoodic, Seboeis, Endless and Mattawamkeag Lakes and Pleasant Pond.
29. West Branch Penobscot River, Chesuncook Lake to Seeboomook, Sheet No. 1.
30. West Branch Penobscot River, Chesuncook Lake to Seeboomook. Sheet No. 2.

ANDROSCOGGIN BASIN.

31. Androscoggin River, Brunswick to Umbagog Lake—profile only, Sheet 1.
32. Androscoggin River, Brunswick to Umbagog Lake—profile only, Sheet 2.
33. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 3.
34. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 4.
35. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 5.

* Edition exhausted.

36. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 6.
37. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 7.
38. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 8.
39. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 9.
40. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 10.
41. Umbagog, Lower and Upper Richardson Lakes, Sheet No. 1.
42. Mooselucmaguntic Lake
43. Mooselucmaguntic and Richardson Lakes, Outlet plans, Sheet No. 3.

UNION RIVER BASIN.

44. Abraham, Scammons and Molasses Ponds and Webbs Pond Outlet, Sheet 1.
45. Alligator, Rocky and Spectacle Ponds, Sheet 2.
46. Great Pond, Green Lake Outlet and Branch Lake Outlet, Sheet 3.
47. Union River, Ellsworth to Great Pond, Sheet 1.
48. Union River, Ellsworth to Great Pond, Sheet 2.

KENNEBEC BASIN.

49. Dead River, mouth to Chain of Ponds, Sheet No. 1.
50. Dead River, mouth to Chain of Ponds, Sheet No. 2.
51. Dead River, mouth to Chain of Ponds, Sheet No. 3.
52. Dead River, mouth to Chain of Ponds, Sheet No. 4.
53. Dead River, mouth to Chain of Ponds, Sheet No. 5.
54. Dead River, Chain of Ponds and outlet; Jim Pond and outlet, Sheet 6.
55. Dead River, South Branch; Tim Pond and outlet, Sheet 7.
56. Spencer Stream; Little Spencer Stream; King and Bartlett Lake and outlet; Little Bartlett Lake and outlet; Baker Pond and outlet, Sheet 8.
57. Dead River, Long Falls, special map, Sheet 9.
58. Sandy River, mouth to Madrid, Sheet No. 1.
59. Sandy River, mouth to Madrid, Clearwater Pond and outlet, Sheet No. 2.
60. Sandy River, mouth to Madrid, Sheet No. 3.
61. Sandy River, mouth to Madrid, Sheet No. 4.
62. Sandy River, mouth to Madrid, Sheet No. 5.

PISCATAQUIS BASIN.

63. Piscataquis River, mouth to Blanchard, Sheet No. 1.
64. Piscataquis River, mouth to Blanchard, and Schoodic Stream, Sheet No. 2.

65. Piscataquis River, mouth to Blanchard, Sheet No. 3.
66. Piscataquis River, mouth to Blanchard, Sheet No. 4.
67. Piscataquis River, mouth to Blanchard, Sheet No. 5.
68. Sebec River, mouth to Sebec Lake, Sheet No. 6.
69. Sebec Lake and outlet, Sheet No. 7.
70. Pleasant River, mouth to Katahdin Iron Works, Sheet No. 8.
71. Pleasant River, mouth to Katahdin Iron Works, Sheet No. 9.
72. Houston Stream, mouth to Big Houston Pond, Sheet No. 10.
73. Big Houston Pond and outlet; Silver Lake and outlet, Sheet No. 11.

ANDROSCOGGIN BASIN.

74. Rangley Lake, Sheet No. 1.
75. Rangeley Lake outlet.
76. Rangeley River; Kennebago River, Sheet No. 2.
77. Kennebago Lake; Little Kennebago Lake, Sheet No. 3.
78. Rapid River; Pond-in-River.

HYDROGRAPHIC SURVEYS.

Stream gagings, a special branch of such surveys, are only considered in this section. This is one of the most important branches of work in connection with the investigations of water storage and the development of water powers. The run-off of a stream, like the rainfall in its basin, varies from day to day, month to month, and year to year. For the correct determination of the value of any stream for a storage development, a continuous record of its discharge should be available in order to determine the maximum, the minimum, and the dependable run-off from season to season.

During the current year this important branch of the work has been continued, but with a decreased allotment from what it was during the previous two years. The results of the work for 1912 are given in the following pages in their appropriate places under the respective river basins.

The following is a list of the various gaging stations in the State that have been maintained from time to time with the length of record of each.

List of Gaging Stations in Maine.

St. John River near Dickey, (1910-1911).
St. John River at Fort Kent, (1905-1912).
Allagash River near Allagash (1910-1911).
St. Francis River near St. Francis (1910-1911).
Fish River at Wallagrass (1903-1908).
Madawaska River at St. Rose du Dégèlé (1910-1911).
St. John River near Van Buren (1908-1912).
Aroostook River at Fort Fairfield (1903-1910).
St. Croix River at Woodland (1902-1911).
St. Croix River near Baileyville (1910-1912).
Machias River at Whitneyville (1903-1912).
Union River at Amherst (1909-1912).
Green Lake Stream at Lakewood (1909-1912).
Branch Lake Stream near Ellsworth (1909-1912).
West Branch Penobscot River at Millinocket (1901-1912).
Penobscot River at West Enfield (1902-1912).
East Branch Penobscot River at Grindstone (1902-1912).
Mattawamkeag River at Mattawamkeag (1902-1912).
Piscataquis River at Foxcroft (1902-1912).
Cold Stream at Enfield (1904-1906).
Kenduskeag Stream near Bangor (1908-1912).
Phillips Lake and outlets (1904-1908).
Moose River at Rockwood (1902, 1908, 1910-1912).
Moosehead Lake at Greenville (1903-1906, stage only).
Moosehead Lake at East Outlet (1895-1912, stage only).
Kennebec River at The Forks (1901-1912).
Kennebec River at Bingham (1907-1911).
Kennebec River at North Anson (1901-1907).
Kennebec River at Waterville (1893-1912).
Roach River at Roach River (1901-1908).
Dead River at The Forks (1901-1907, 1910-1912).
Carrabassett River at North Anson (1901-1907).
Sandy River at Farmington (1910-1912).
Sandy River at Madison (1904-1908).
Messalonskee Stream at Waterville (1903-1905).
Sebasticook River at Pittsfield (1908-1912).
Cobbosseecontee Stream at Gardiner (1890-1912).
Androscoggin River at Errol, N. H. (1905-1912).
Androscoggin River at Gorham, N. H. (1903) fragmentary.
Androscoggin River at Shelburn, N. H. (1903-1907, 1910).
Androscoggin River at Rumford Falls (1892-1912).
Androscoggin River at Dixfield (1902-1908).
Presumpscot River at outlet Sebago Lake (1887-1912).
Saco River near Center Conway, N. H. (1903-1911).
Saco River at West Buxton (1907-1912).

Geologic Surveys.

Coöperative work has been continued throughout the year between the U. S. Geological Survey and the State Commission in a systematic investigation of the geologic resources of the State. Field work has been confined to the Portland-Casco Bay quadrangle.

Two geologic folios have been issued for the State, the Rockland Folio and the Penobscot Bay Folio. The field work and descriptive text for the Eastport Folio are completed and the maps are now in the hands of the engraver. It is expected that the edition will be ready for distribution in 1913.

The Frenchman Bay quadrangle lies east of the Penobscot Bay folio and will include the Mount Desert, Bar Harbor and Swan Island quadrangles. The field work has been completed by Prof. C. W. Brown of Brown University. During the progress of the work field conferences were had with him by Dr. George Otis Smith and Mr. E. S. Bastin. It is understood that the descriptive text is not yet completed for the folio.

There will be found towards the end of this volume a report on the geology of the Eastport quadrangle by Messrs. Edson S. Bastin and Henry S. Williams and a preliminary report of the geology of the Portland and Casco Bay quadrangles by F. J. Katz. The last report is preliminary and subject to modification if need be, as the result of further field work.

A bibliography of Maine geology has been compiled in the office of the Commission and is published at the end of this report. The greater portion of the information has been obtained from the various reports of the U. S. Geological Survey on the Bibliography of the United States. Reports examined are Bulletins Nos. 127, 188, 189, 301, 372, 409, 444, 495, 524. Additional references were obtained from a card catalog of the Portland Society of Natural History, as kindly loaned by Mr. Arthur H. Norton, Librarian of the Society; and from a card catalog of Bowdoin College as compiled by the late Professor Leslie A. Lee, and the late Professor F. C. Robinson and loaned by Prof. Marshall P. Cram.

During the progress of the coöperative field work, in connection with the study of the geology of the Rockland, Penobscot Bay and Eastport folios, as well as in the field work on

The Granites of Maine and Road Materials of Maine, duplicate sets of specimens were collected by the geologists of the U. S. Geological Survey. The set for the Eastport folio was forwarded directly from Washington to the office of this Commission. It was found through correspondence that the other sets were boxed and in a storeroom of Bowdoin College and on request, were forwarded to Augusta. By authority of the Governor and Council, arrangements were made with the curator of the State Museum for the suitable arrangement of these specimens in cases in the Museum where they are now on exhibition.

PRECIPITATION.

The following table gives the monthly precipitation record for 1912 of the various stations throughout the State. It is a continuation of the tables published in the 1st Annual Report on pages 45-59 and in the 2nd Annual Report on page 30. Opposite page 34 of the latter report is a map of the State showing lines of average annual precipitation.

Precipitation at Stations in Maine for 1912.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Soldier Pond	2.50	2.60	1.45	....	1.62	1.00	4.11	1.83	0.52	1.49	1.92	0.28	.....
Van Buren	....	....	....	....	....	....	....	.....	....	....	4.38	2.42	.....
Presque Isle	....	....	....	....	3.55	....	....	.....	1.84	....	2.78	2.02	.....
Houlton	1.60	2.10	3.21	1.95	3.20	3.20	3.45	8.40	1.50	4.36	0.95	2.30	36.22
Eastport	4.37	2.16	3.76	3.06	3.93	1.35	2.25	3.76	1.67	3.05	2.86	5.83	38.05
Ellsworth	1.72	1.50	4.36	2.18	5.28	3.62	3.47	4.32	2.90	5.32	5.22	3.74	43.63
Patten	....	....	1.47	....	....	....	3.02	11.28	4.00	5.60	4.51	1.21	.....
Danforth	3.06	3.21	2.03	2.48	5.26	2.32	3.23	4.24	2.54	4.40	3.26	3.90	39.93
Chesuncook Dam	3.43	3.20	3.51	2.06	5.34	3.20	2.03	6.07	4.64	2.67	4.42	2.36	42.93
Millinocket	2.36	3.69	1.98	2.34	7.12	2.49	2.27	6.94	3.55	6.75	6.34	2.74	48.57
Orono	2.87	2.50	3.93	4.60	8.05	2.32	4.60	4.69	3.11	4.97	2.92	3.27	47.83
Bar Harbor	5.75	4.68	5.95	3.70	8.75	1.18	4.50	3.93	3.88	4.95	5.73	6.47	59.47
Greenville	4.53	2.98	3.04	2.87	6.32	1.91	3.45	5.38	4.89	4.42	4.17	2.14	46.10
Eustis	3.43	1.83	2.57	2.04	5.66	1.12	3.14	6.05	4.22	2.30	3.58	2.58	38.52
The Forks	2.10	2.75	2.75	2.18	5.06	1.02	2.59	3.67	3.20	3.60	2.00	2.65	33.57
Madison	5.27	3.15	4.82	3.45	6.26	1.38	2.83	6.96	3.73	5.90	5.17	3.25	52.17
Farmington	4.24	2.79	3.81	2.91	6.52	1.03	2.03	5.80	3.53	4.61	4.62	2.65	44.54
Fairfield	4.43	2.74	3.88	1.90	5.27	0.47	3.35	5.27	2.00	3.00	2.59	3.69	38.59
Winslow	3.30	2.68	4.46	2.49	5.27	0.51	3.15	4.80	2.19	3.37	3.52	2.46	38.20
Maine Insane Hospital, Augusta	4.79	2.26	5.23	3.15	5.89	1.29	2.38	2.74	3.29	4.13	4.23	3.59	42.97
Gardiner	4.89	2.40	5.41	3.36	6.11	1.03	2.38	2.99	3.42	4.17	4.64	3.65	44.45
Upper Dam	2.10	2.37	2.27	1.92	4.45	1.75	1.99	5.44	3.10	1.64	2.69	2.38	32.10
Middle Dam	1.91	1.69	1.87	1.86	5.56	1.75	2.32	6.57	3.32	1.93	2.28	2.47	33.53
Errol Dam	2.73	2.13	2.98	2.13	4.90	2.46	2.54	5.14	3.91	2.25	3.52	2.78	37.47
Rumford Falls	2.88	2.70	3.19	2.44	5.51	1.10	2.22	4.89	3.88	4.28	3.70	2.54	39.33
Livermore Falls	5.75	2.07	4.30	2.90	5.42	0.47	2.79	4.28	3.41	3.68	4.85	2.79	42.71
Lewiston	4.45	2.83	5.26	2.86	5.00	0.79	3.03	2.96	3.45	3.47	4.24	3.82	42.16
North Bridgton	3.12	2.41	5.13	2.90	5.17	1.20	2.95	3.55	3.82	3.81	3.84	2.62	40.52
Songo	3.31	1.70	5.15	3.17	5.26	0.81	4.19	2.54	3.15	3.14	3.22	3.32	38.96
Portland	4.86	4.44	6.34	3.49	3.81	0.55	2.50	2.26	2.91	2.29	3.58	4.16	41.19
Cornish	3.32	2.17	5.75	2.63	5.30	0.77	4.06	3.54	2.66	3.62	3.82	4.09	41.73
Biddeford	1.80	2.70	6.30	3.50	4.40	0.50	2.50	4.40	4.70	3.30	3.70	4.50	42.30
Aziscohos Dam, N. H.	2.35	1.08	2.42	2.20	6.22	1.49	1.75	6.28	4.26	2.12	2.89	2.26	35.32
Ponticook Dam	3.19	1.95	3.21	2.34	4.88	1.86	2.23	5.41	3.73	1.93	2.68	3.19	36.60
Gorham, N. H.	2.88	2.24	1.92	1.83	4.59	1.67	2.15	4.29	5.67	2.88	2.83	2.49	35.44

Additional Precipitation Stations for 1912.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Ashland	....	2.92	2.70	..	....	....	....	....	....	5.96	3.77	1.19	.....
Howe Brook	5.65	4.81	2.75	2.47	5.40	4.68	4.16	6.69	2.63	3.27	3.96	1.30	47.77
Cambridge	....	....	....	2.40	6.17	1.22	2.52	6.55	3.58	5.32	5.50	3.03	.....
Woodland	2.32	2.28	4.82	3.76	6.43	1.67	2.81	5.20	3.14	7.85	3.70	5.09	49.07

DOMESTIC WATER SUPPLY COMPANIES.

The following list gives the names of water companies in this State, according to the records of this office, serving the towns in question with a domestic supply of water. It is the intention to obtain ultimately information regarding the physical features of the various plants; the nature of the supply, whether gravity, direct pumping or pumping into standpipe; the pressure; the amount of water consumption and the like.

Domestic Water Supply Companies.

Andover
    Andover Water Co.
Ashland
    Ashland Light & Water Co.
Auburn
    Auburn Water Works
Augusta
    Augusta Water District
Bangor
    Bangor Water Board
Bar Harbor
    Bar Harbor Water Co.
Bath
    Maine Water Co.
Belfast
    Belfast Water Co.
    Penobscot Bay Water Co.
Benton
    Kennebec Water District
Berwick
    Berwick Water Co.
Bethel
    Bethel Water Co.
Biddeford
    Biddeford & Saco Water Co.
Bingham
    Bingham Water Co.
Bluehill
    Bluehill Water Co.
Boothbay
    Boothbay Water Co.
Boothbay Harbor
    Boothbay Harbor Water Co.
Brewer
    Bangor Railway & Electric Co.
Bridgton
    Bridgton Water & Electric Co.
Bristol
    Twin Village Water Co.
Brownville
    Brownville-Maine Water Co.
Brownville Junction
    Williamsburg & Brownville Water Co.
Brunswick
    Brunswick & Topsham Water Co.
Buckfield
    Buckfield Water Power & Electric Light Co.
Bucksport
    Bucksport Water Co.

Calais
Maine Water Co.
Camden
Camden & Rockland Water Co.
Cape Elizabeth
Shore Acres Water Co.
Caribou
Caribou Water, Light & Power Co.
Castine
Castine Water Co.
Acadia Aqueduct Co.
Cherryfield
Cherryfield Water Co.
Chesterville
Farmington Falls Water Co.
Clinton
Clinton Water Co.
Columbia Falls
Columbia Falls Water & Electric Light Co.
Corinna
Corinna Water Co.
Cumberland
Foreside Water Co.
Damariscotta
Portland Power & Development Co.
Twin Village Water Co.
Danforth
Danforth Water Co.
Deer Isle
Lily Water Co.
Dexter
Dexter Water Board
Dover
Dover & Foxcroft Water District
East Machias
East Machias Light & Water Co.
Eastport
Eastport Water Co.
Eden
Bar Harbor Water Co.
Ellsworth
Bar Harbor & Union River Power Co.
Falmouth
Foreside Water Co.
Farmington
Farmington Water Plant
Farmington Falls
Farmington Falls Water Co.
Fort Fairfield
Frontier Water Co.
Fort Kent
Fort Kent Water Co.
Foxcroft
Dover & Foxcroft Water District
Frankfort
Hillside Water Co.
Franklin
Franklin Water Co.
Freeport
Freeport Water Works
Bibbers Island Water District
Friendship
Friendship Water Co.
Fryeburg
Fryeburg Water Co.
Gardiner
Gardiner Water District
Gorham
Gorham Water Co.
Greenville
Greenville Water Co.
Guilford
Guilford Water Co.
Hallowell
Hallowell Water Works
Hampden
Hampden Water Co.
Harrison
Harrison Water Co.
Hartland
Hartland Water Co.
Hebron
Hebron Water Co.
Hermon
Hermon Water Co.
Higgins Beach
Scarboro Water Co.
Houlton
Houlton Water Co.

Island Falls
Island Falls Water Co.
Isle au Haut
Isle au Haut Water Co.
Jackman
Jackman Water Co.
Jonesport
Jonesport Light & Water Co.
Kennebunk
Mousam Water Co.
Kezar Falls
Kezar Falls Water Co.
Kingfield
Kingfield Water Co.
Kittery
Kittery Water District
Lewiston
Lewiston Water Works
Liberty
Liberty Water Co.
Lincoln
Lincoln Water Co.
Lisbon
Lisbon Water Co.
Lisbon Falls
Lisbon Falls Water Co.
Livermore Falls
Livermore Falls Water District
Lubec
Lubec Water Works
Machias
Machias Water Co.
Madison
Madison Water Co.
Mechanic Falls
Mechanic Falls Water Co.
Mexico
Rumford & Mexico Water District
Milbridge
Milbridge Water Co.
Millinocket
Millinocket Water Co
Milo
Milo Water Co.
Monson
Monson Water Co.
Mount Desert
N. E. Harbor Water Co.
Seal Harbor Water Co.
Naples
Naples Water Co.
New Portland
North Village Water Co.
New Sharon
Farmington Falls Water Co.
New Sharon Water Co.
Newcastle
Twin Village Water Co.
Newport
Newport Water Co.
Nobleboro
Twin Village Water Co.
Norridgewock
Norridgewock Water Works
North Berwick
North Berwick Water Co.
North Bridgton
North Bridgton Water Co.
North Haven
North Haven Water Works
North Parsonsfield
North Parsonsfield Water Co.
North Yarmouth
North Yarmouth Water Co.
Northeast Harbor
Northeast Harbor Water Co.
Norway
Norway Water Co.
Oakland
Oakland Water Co.
Ogunquit
Ogunquit Water Co
Old Orchard
Biddeford & Saco Water Co.
Old Town
Bangor Railway & Electric Co.
Orono
Orono Water Co.
Patten
Northern Penobscot Water Co.
Patten Water Co.

Phillips
Phillips Water Co.
Pittsfield
Pittsfield Water Works
Portland
Portland Water District
Presque Isle
Presque Isle Water Co.
Pine Point
Prouts Neck Water Co.
Prouts Neck
Prouts Neck Water Co.
Randolph
Gardiner Water District
Rangeley
Rangeley Water Co.
Richmond
Richmond Water Works
Rockland
Camden & Rockland Water Co.
Rockland Water Co.
Rumford
Rumford & Mexico Water District
Sabattus
Sabattus Water Co.
St. George
St. George Water Co.
Sanford
Sanford Water Co.
Sangerville
Sangerville Water Co.
Searsport
Searsport Water Co.
Penobscot Bay Water Co.
Shawmut
Shawmut Water Co.
Skowhegan
Skowhegan Water Co.
Coburn Aqueduct Co.
Somesville
Somesville Water Co.
South Berwick
South Berwick Water Co.
Southwest Harbor
Southwest Harbor Water Co.
Springfield
Springfield Water Co.
Springvale
Springvale Aqueduct Co.
Standish
Standish Water Co.
Stockton Springs
Stockton Springs Water Co.
Penobscot Bay Water Co.
Stonington
Stonington Water Co.
Stratton
Stratton Water Co.
Strong
Strong Water Co.
Sullivan
Sullivan Harbor Water Co.
Swans Island
Swans Island Water Co.
T. A. R. 7, W. E. L. S.
Northern Water Co.
T. 3, R. 5, B. K. P. E. K. R.
Greenville Water Co.
Union
Union Water Co.
Van Buren
Van Buren Water District
Veazie
Bangor Railway & Electric Co.
Vinalhaven
Vinalhaven Water Co.
Waldoboro
Waldoboro Water Co.
Warren
Warren Water Supply Co.
Waterville
Kennebec Water District
Weld
Weld Water Co.
Wells
York Shore Water Co.
Mousam Water Co.

West Farmington
Suburban Water District
West Skowhegan
West Skowhegan Aqueduct Co.
Westfield
Westfield Water Co.
Wilton
Wilton Water Co.
Winn
Winn Water & Power Co.
Winslow
Kennebec Water District
Winter Harbor
Grindstone Neck Water Co.
Winterport
Winterport Water Co.
Winthrop
Hillside Water Co.
Winthrop Cold Spring Water Co.
Winthrop Water & Drainage Co.
Gales System
Wiscasset
Wiscasset Water Co.
Woodland
Woodland Water Co.
Yarmouth
Yarmouth Water Co.
York
York Shore Water Co.
York Harbor
York Shore Water Co.

LAKE STORAGE.

The final plan for the development and regulation of a reservoir system should be based on accurate and detailed topographic maps of the several reservoir sites similar to the maps described on page 5 which this department is issuing from time to time as the surveys are completed. Such maps should show the high and low water lines, a number of contours above high water up to the limits of practical storage and a number of sub-contour lines or down to the limits to which the lakes may be drawn. From such maps, accurate determinations of the storage capacities for varying heights can be determined. It will be many years, however, before such detailed maps of all the lakes and ponds of the State can be prepared.

Meanwhile, this department has undertaken the planimeter measurements of all the lakes and ponds in the State as can be found on the best maps available. For this purpose the following maps are used: the special lake maps as issued by this department; the regular topographic sheets of the U. S. Geological Survey; the township plans in the office of the State Assessors; many private recent reservoir and township maps on file in this office; and in a few cases county atlases where more accurate maps were not available.

The lake and pond areas as thus determined are given in the following pages under appropriate river basins. There is also given in the same tables an estimate for each lake of the amount of present storage both in feet and cubic feet and also of the possible storage in feet and cubic feet. For many of the sites more or less accurate information on this subject is available, that is, the amounts in cubic feet of both present and possible storage. Most of these reliable data are given in the 1st Annual Report under the subject headings of lake storage. For other lakes and ponds, reports were at hand on the storage in feet, such as heights of dams, etc. In a large number of cases, however, no such information was available and an estimate of height was made and the corresponding capacity in cubic feet computed. In the capacity tables in the following pages, wherever the heights appear as 5 feet or 10 feet it is in almost all cases the assumed or estimated height of storage. For instance, under present storage, when it was known that there was a dam at the outlet of a pond and no other information was available, the height was put as 5 feet. The height of possible storage depends on a number of factors; as to whether the drainage area above is sufficient to contribute the amount of water to fill the reservoir to that height; whether the topography at the dam site is such that it will be feasible financially to build the dam; or whether settlements around the shores of the lake will permit raising to the height as contemplated. In the various capacity tables, these detailed studies have not been made on the 5 and 10-foot assumed heights. After scanning the base map of the State, compiled in this office, if it was thought the drainage area was small or if any local conditions were known to exist, as settlements around the lake in question, the smaller height, that is, 5 feet, was adopted. In other cases the 10-foot height was used. It is believed that this 5-foot or 10-foot height of possible storage is a fairly conservative figure to adopt for all the lakes and ponds in the State where exact information as to storage capacities was not available. It was found necessary to make some such kind of an estimate of total storage for various river basins in connection with the mass curve studies of run-off, both leading up to an approximate estimate of the total capabilities for reservoir storage in the entire State.

In the 2nd Annual Report are given lake area and storage capacity tables for the following river basins; St. John River; St. Croix River; Coastal Basin No. 1; Machias River; Coastal Basin No. 2; Union River and Penobscot River. This report contains similar tables for the remaining river basins of the State.

The following tables summarize the storage in each basin of the State.

Summary of Storage in St. John River Basin.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Possible storage capacity, cubic feet.
Upper St. John River	2,670	20.29	132	5,656,529,000
Allagash River	1,240	47.63	26	11,554,203,000
St. Francis River	560	10.45	54	2,913,294,000
Fish River	890	63.05	14	22,887,611,000
Madawaska River	800	45.92	17	12,801,761,000
Upper Aroostook River	656	18.08	36	5,040,415,000
St. Croix Stream	221	1.32	167	367,995,000
Big Machias River	313	4.29	73	1,195,986,000
Presque Isle Stream	165	0.65	254	192,362,000
Little Madawaska Stream	256	2.98	86	830,777,000
Main Aroostook River	679	5.93	115	1,653,190,000
Presque Isle River	77	0.17	453	47,394,000
Meduxnekeag River	497	3.89	128	1,083,637 000
Main St. John River	2,420	1.95	....	543,630,000
Total	11,444	226.60	50.5	66,768,784,000

Summary of Storage in St. Croix River Basin.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
East Branch	644	49.17	13.1	12,556,987,000	16,885,942,000
West branch	674	82.76	8.1	13,044,581,000	21,368,791,000
Main River	155	3.81	40.7	....	531,085,000
Total	1,473	135.74	10.8	25,601,568,000	38,785,818,000

Summary of Storage in Coastal Basin, No. 1.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Cathance River	....	5.79	....	898,242,000	1,555,615,000
Dennys River	....	13.55	....	2,504,879,000	3,617,215,000
Little River	....	3.15	....	351,268,000	439,085,000
Little Falls River	....	0.18	....	....	25,091,000
Orange River	....	2.24	....	....	560,355,000
Pemaquam River	....	2.82	....	243,100,000	716,476,000
Tidewater	....	.44	....	....	61,334,000
Total	....	28.17	....	3,997,489,000	6,975,171,000

Summary of Storage in Machias River Basin.

East Branch	345	28.85	12.0	3,265,676,000	7,265,111,000
West Branch	495	24.45	20.2	3,347,640,000	7,029,540,000
Total	840	53.30	15.8	6,613,316,000	14,294,651,000

Summary of Storage in Coastal Basin, No. 2.

Pleasant River	....	2.42	....	257,876,000	337,330,000
Narraguagus River	....	5.34	....	....	1,009,201,000
Tunk Stream	....	3.84	....	944,242,000	1,056,036,000
Tidewater	....	11.09	....	622,525,000	1,956,512,000
Bagaduce River	....	1.87	....	....	260,663,000
Patten Stream	....	1.71	....	....	238,361,000
Total	....	26.27	....	1,824,643,000	4,858,103,000

Summary of Storage in Union River Basin.

East Branch	123	7.23	17.0	494,290,000	1,546,539,000
West Branch	172	7.55	22.8	....	2,679,779,000
Main River	242	39.52	6.1	1,872,900,000	16,290,261,000
Total	537	54.40	9.9	2,367,190,000	20,516,579,000

Summary of Storage in Penobscot River Basin.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
West Branch	2,100	172.38	12.2	38,695,297,000	68,688,110,000
East Branch	1,130	61.58	18.4	10,292,594,000	36,745,253,000
Mattawamkeag River	1,500	40.76	36.8	3,912,408,000	21,275,466,000
Piscataquis River	1,500	63.37	23.7	9,449,949,000	18,942,115,000
Passadumkeag River	383	31.50	12.2	5,110,389,000	8,061,038,000
Main River	1,957	40.24	48.7	578,477,000	7,240,004,000
Total	8,570	409.83	20.9	68,039,114,000	160,951,986,000

Summary of Storage in Coastal Basin No. 3.

Goose River	18	2.36	7.6	328,966,000	328,966,000
Wescott Stream	23	0.28	82.2	....	39,030,000
Passagassawakeag River	43	1.42	30.3	....	197,936,000
Duck Trap River	35	2.19	16.0	....	305,269,000
Megunticook River	25	2.73	9.2	334,541,000	380,541,000
Goose River	8	0.10	80.0	....	13,939,000
St. George River	225	12.64	17.8	348,229,000	2,178,442,000
Goose River Stream	11	0.13	84.6	....	18,121,000
Medomak River	74	2.14	34.6	....	367,995,000
Muscongus Sound	5	0.37	13.5	....	51,575,000
Pemaquid River	36	4.50	8.0	....	627,264,000
Campbell Brook	2	0.08	25.0	....	11,151,000
Damariscotta River	57	7.52	7.6	1,038,471,000	1,671,310,000
Sheepscot River	228	5.71	40.0	102,593,000	1,179,538,000
Total	790	42.17	18.7	2,152,800,000	7,371,077,000

Summary of Storage in Kennebec River Basin.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Moose River	735	28.07	26.1	1,003,031,000	8,688,081,000
Kokadjo (Roach)	109	7.30	14.9	1,260,000,000	1,541,664,000
Moosehead Lake	396	118.38	3.3	23,735,000,000	30,578,753,000
Between Moosehead Lake and The Forks	330	8.02	41.2	1,229,352,000	3,133,554,000
Total above mouth Dead River	1,570	161.77	9.7	27,227,383,000	43,942,052,000
Dead River, No. Branch	195	4.42	44.2	303,800,000	1,644,809,000
Dead River, So. Branch	168	1.46	115.0	....	203,514,000
Dead River between junction North and South Branches & Long Falls	137	3.11	44.1	830,000,000	2,425,514,000
Dead River between Long Falls & Spencer Stream	46	1.84	25.0	....	108,727,000
Spencer Stream	218	5.87	37.1	870,000,000	3,583,270,000
Dead River below Spencer Stream	114	2.09	54.6	....	291,331,000
Total in Dead River	878	18.79	46.7	2,003,800,000	8,257,165,000
Total above The Forks	2,448	180.56	13.5	29,231,183,000	52,199,217,000
Austin Stream	97	0.94	103.2	....	131,031,000
Main River between The Forks & Solon	195	6.49	30.1	802,882,000	1,504,584,000
Carrabasset River	401	7.09	56.6	412,600,000	1,657,652,000
Sandy River	644	5.75	112.0	439,066,000	1,392,528,000
Wesserunsett Stream	142	3.04	46.7	424,589,000	828,686,000
Main River between Solon & Waterville	343	1.52	225.8	....	291,330,000
Total above Waterville	4,270	205.39	20.8	31,310,320,000	58,005,028,000
Sebasticook River	975	35.95	27.1	5,179,556,000	9,070,772,000
Messalonskee Stream	205	30.79	6.7	4,188,210,000	5,874,541,000
Cobbosseecontee Stream	221	20.54	10.8	2,003,901,000	3,002,227,000
Main River below Waterville	230	6.83	33.7	896,849,000	1,292,723,000
Total for basin	5,900	299.50	19.7	43,578,836,000	77,245,291,000

Summary of Storage in Androscoggin Basin.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Upper Androscoggin River	635	74.78	8.5	19,824,089,000	22,179,541,000
Magalloway River.......	460	14.68	31.4	8,444,940,000	8,834,541,000
Between Errol & Rumford	995	6.62	149.8	192,361,000	1,285,196,000
Between Rumford & Lewiston..................	860	26.53	32.4	1,224,697,000	4,881,684,000
Little Androscoggin River	380	15.15	25.1	1,745,607,000	2,091,856,000
Between Lewiston&Mouth	178	5.12	34.8	762,753,000	794,814,000
	3,510	142.88	24.6	32,194,447,000	40,067,632,000

Summary of Storage in Royal River Basin.

Royal River total........	136	1.52	89.5	114,361,000	172,846,000

Summary of Storage in Presumpscot River Basin.

Crooked River...........	136	4.30	27.6	331,753,000	587,261,000
Songo River............	244	16.30	15.0	3,332,861,000	3,433,225,000
Sebago Lake............	56	52.12	1.1	11,035,301,000	11,181,665,000
Pleasant River..........	48	3.29	14.6	819,625,000	868,412,000
Main River.............	132	1.41	93.7	177,028,000	196,543,000
Total..............	616	77.42	8.0	15,696,568,000	16,267,106,000

Summary of Storage in Saco River Basin.

Main river in New Hampshire.................	439	3.60	122.0	572,064,000	756,061,000
Main river between N. H. line & Ossipee River..	400	16.43	24.3	1,038,747,000	2,310,837,000
Great Ossipee River.....	462	17.40	26.6	1,585,165,000	4,482,288,000
Little Ossipee River.....	172	3.85	44.7	392,806,000	763,313,000
Main river below Great Ossipee River.........	258	1.38	186.8	117,785,000	219,542,000
Total..............	1,730	42.66	40.6	3,706,567,000	8,532,041,000

Summary of Storage Coastal Basin No. 4.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Kennebunk River	50	0.75	66.7	51,296,000	104,544,000
Mousam River	157	3.57	44.0	251,185,000	557,566,000
York River	12	0.21	57.1	....	29,272,000
Coastal	6	0.61	9.8	....	85,029,000
	225	5.14	43.8	302,481,000	776,411,000
Piscataqua River (b)	550	(a)5.65	....	1,442,987,000	1,636,742,000

(a) includes only ponds located wholly or partially in Maine.
(b) Maine 240 square miles; New Hampshire 310 square miles.

Grand Summary of Storage in Maine.

St. John (a)	11,400	226.60	50.5	....	66,768,784,000
St. Croix	1,470	135.74	10.8	25,601,568,000	38,785,818,000
Coastal No. 1	....	28.17	....	3,997,489,000	6,975,171,000
Machias	840	53.30	15.8	6,613,316,000	14,294,651,000
Coastal No. 2	....	26.27	....	1,824,643,000	4,858,103,000
Union	537	54.40	9.9	2,367,190,000	20,516,579,000
Penobscot	8,570	409.83	20.9	68,039,114,000	160,951,986,000
Coastal No. 3	790	42.17	18.7	2,152,800,000	7,371,077,000
Kennebec	5,900	299.50	19.7	43,578,836,000	77,245,291,000
Androscoggin (b)	3,510	142.88	24.6	32,194,447,000	40,067,632,000
Royal	136	1.52	89.5	114,361,000	172,846,000
Presumpscot	616	77.42	8.0	15,696,568,000	16,267,106,000
Saco (c)	1,730	42.66	40.6	3,706,567,000	8,532,041,000
Coastal No. 4	(d)775	(e)10.79	71.8	1,745,468,000	2,413,153,000
Total	....	1,551.25	....	205,990,367,000	465,220,238,000
Total for Maine	33,040	1,484.12	22.3	204,091,850,000	447,034,045,000
(a) in Canada	....	45.92	....	....	12,801,761,000
(b) in New Hampshire	....	3.17	....	....	804,293,000
(c) in New Hampshire	....	18.04	....	1,898,517,000	4,580,139,000
(d) Total drainage area.					
(e) Maine lakes only.					

The following table summarizes the facts regarding the lake systems of Maine. The total area of the State is 33,040 square miles of which 1484 square miles are the lake areas. This shows that there is 1 square mile of lake area for every 22.3 square miles of total area. There are 2183 bodies of water in the State over about 6 acres in extent, not including the numerous ponds of an acre or two in area. This is 1 lake for every 15.1 square miles of land area. The average size of all the lakes is 0.68 square miles or 435 acres.

Lake Systems of Maine.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio drainage area to lake area.	Number of lakes.	Average area of lakes sq. miles.
St. John (a)	11,400	226.60	50.5	360	0.63
St. Croix	1,470	135.74	10.8	72	1.89
Coastal No. 1	....	28.17	....	34	0.83
Machias	840	53.30	15.8	76	0.70
Coastal No. 2	....	26.27	....	81	0.32
Union	537	54.40	9.9	52	1.05
Penobscot	8,570	409.83	20.9	612	0.67
Coastal No. 3	790	42.17	18.7	103	0.41
Kennebec	5,900	299.50	19.7	437	0.68
Androscoggin (b)	3,510	142.88	24.6	198	0.72
Royal	136	1.52	89.5	6	0.25
Presumpscot	616	77.42	8.0	66	1.17
Saco (c)	1,720	42.66	40.6	119	0.36
Coastal No. 4	(d)775	(e)10.79	71.8	24	0.45
Total	....	1,551.25	....	2240	0.69
Total for Maine	33,040	1,484.12	22.3	2183	0.68
(a) In Canada	....	45.92	....	8	....
(b) In New Hampshire	....	3.17	....	13	....
(c) In New Hampshire	....	18.04	....	36	....
(d) Total drainage area.					
(e) Maine lakes only.					

RUN-OFF MAGNITUDE DIAGRAMS.

A method of studying river discharge problems that has recently come into more general use by hydraulic engineers is by the construction of what may be called run-off magnitude diagrams. The daily discharges of a river for a year or a series of years are plotted, not chronologically, but in order of magnitude, beginning with the maximum discharge, then the next lower and so on down to the minimum discharge. Occasionally such studies are made by monthly averages, but the results are from 5 to 15 percent larger than when the basis is the daily discharge. *a.*

The curves of this office are plotted on the basis of unit flow in cubic feet per second per square mile as ordinates, and time as abscissæ, 1 year or 8760 hours. The abscissæ can easily be expressed in percentage of time if so desired. Two curves are given for each stream; first, that of the minimum year for which there is a record, and second, the average for the entire period for which there are complete yearly records.

The average curve for several years is reduced to a one-year record as follows: The daily discharge for *each* year is arranged in order of magnitude, then the maxima are averaged, then the next lower set and so on down to the minima. The resulting curve is a true average curve for the period. Another method is to arrange the daily discharge for the entire period in order of magnitude regardless of years. In such a case the scale would vary for one, two, three years, etc., and it is necessary to know the length of record in using the diagram. The curves of this office are based on the first method.

USE OF DIAGRAMS.

These diagrams are especially useful in computing the amount of auxiliary power, either in storage or in auxiliary steam power, necessary to install to supplement a water power.

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a. Mr. Walter H. Sawyer, Hydraulic Engineer, Union Water Power Co., Lewiston, Maine, is authority for the statement that in the case of the Androscoggin River, computations based on monthly averages are about 16% larger at minimum flow or for about 5 percent of the time, than when the basis of computations is the daily flow; and about 7 1-2 percent larger for medium stages. Curves for weekly averages are about 5% larger at low stages than these computed by the daily discharge.

For an example: 300 K. W. are to be developed on a certain stream where the drainage area is 250 square miles and the available head 20 feet. It is desired to know the auxiliary power in kilowatt hours that will be required during a minimum year.

Select from the run-off magnitude curves, the one best suited to the stream under consideration, after a study of the topography, the amount and effect of storage in the basin above, and the average rainfall as shown on Plate I of the 2nd Annual Report of this Commission. Let us assume that it is decided that the Sebasticook River curve, Plate I, is best adapted to the stream under consideration.

The formula for horsepower with 80% efficiency of wheels is as follows:

$$\text{H. P.} = \frac{\text{second-feet per sq. mile x drainage area x head}}{11}$$

and the similar formula, expressed in kilowatts with 74% efficiency from the generator is

$$\text{K. W.} = \frac{\text{second-feet per sq. mile x drainage area x head}}{16}$$

$$\text{or second-feet per sq. mile} = \frac{16 \text{ K. W.}}{\text{drainage area x head}}$$

For the example:

$$\text{the required sec.-ft. per sq. mile} = \frac{4800}{5000} = 0.96$$

Therefore for the stream in question, to develop continuously 300 K. W., a constant flow of 0.96 sec. ft. per sq. mile is necessary. On the magnitude diagram of run-off of Sebasticook River, it is seen that during the minimum year, water could only be depended upon for 75 days to develop all of the power, and for the balance of the year recourse must be had to auxiliary power. Year in and year out, on the average, the river will furnish sufficient water for 195 days.

Proceed further and determine the amount in K. W. hours of the auxiliary power necessary to maintain the assumed capacity of the plant during the year of lowest run-off. Draw a horizontal line at 0.96 sec. ft. per sq. mile from the right hand edge of the diagram until it intersects the curve of minimum flow.

The area included between this horizontal line and the minimum run-off curve is equivalent to 982,500 K. W. hours as measured by planimeter or determined by counting the small squares, as each smallest square for the example in question is equivalent to 3750 K. W. hours.

The maximum ordinate on the right hand side indicates that it would be necessary to install a steam plant of 285 K. W. capacity. The horizontal line of 0.96 second-feet per square mile intercepts the minimum run-off curve at about 75 days, indicating that for this length of time, power could be obtained wholly from water.

If it should be found through tests or operation that it required 2 lbs. coal to every K. W. hour, then 982 tons of coal would have to be consumed in the year for the plant under consideration.

Applying the same process of reasoning and methods of computations to the curve of average run-off, it is found that the area between the horizontal line of 0.96 sec.-ft. per sq. mile and the average run-off curve is equivalent to 427,500 K. W. hours. With the same fuel consumption, the average amount of coal required per annum would be 428 tons. The plant would operate by water alone about 195 days on the average.

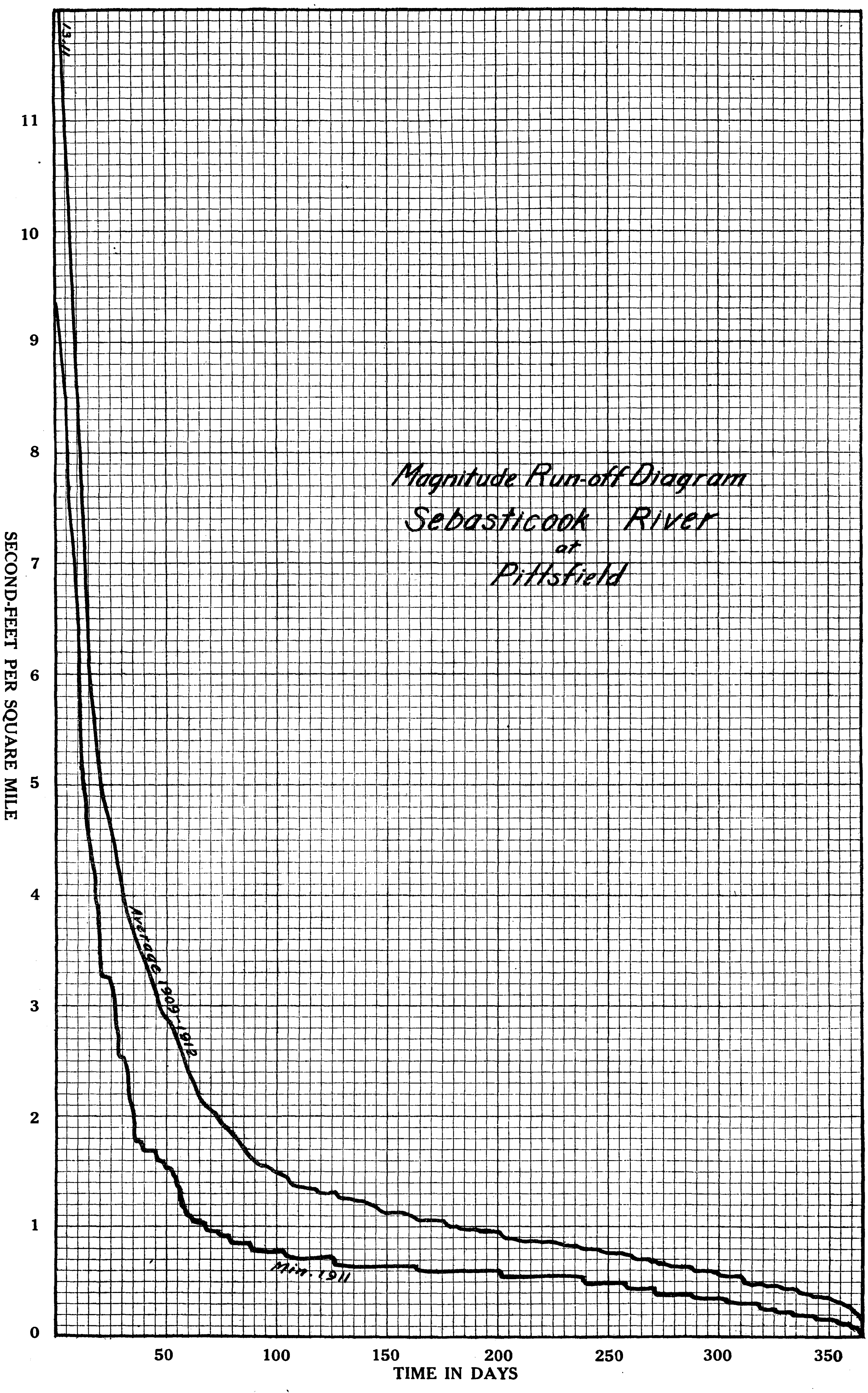
The magnitude curve can also be used in estimating the amount of storage necessary to carry the plant through the dry seasons without recourse to auxiliary power. For the example in question, 1 square inch equals 1,080,000,000 cubic feet. The average deficiency represented by the area below the horizontal line 0.96 sec.-ft. per square mile and the average run-off curve is equivalent to 1,231,200,000 cubic feet, the storage necessary during the average year. Similarly, for the minimum year, a reservoir capacity of 2,829,600,000 cubic feet will be required. After detailed surveys and estimates of cost for the construction of dams, rights of way, interest charges and the like, it may be found the most economical to provide storage for the average year and install an auxiliary steam plant for the minimum year. For the example, in such a year, such an auxiliary would have to develop 555,000 kilowatt hours with a coal consumption of 555 tons.

It was shown above that it would be necessary to install a steam plant of 285 kilowatt capacity to tide over the days of lowest run-off. If storage for the average year is created as noted above, the capacity of the auxiliary steam plant would only have to be 84 kilowatts and with 74% efficiency.

The above examples illustrate the value of stream gagings and also the utility of diagrams of run-off arranged in order of magnitude. It is believed that the more engineers study such diagrams, the more use they will make of them in computations for hydro-electric developments.

Such run-off magnitude diagrams have been prepared for the following rivers and will be found in the appropriate places under the respective drainage basins:

Machias River at Whitneyville, drainage area 465 square miles.
Penobscot River at West Enfield, drainage area 6600 square miles.
Kenduskeag Stream near Bangor, drainage area 191 square miles.
Kennebec River at The Forks, drainage area 1570 square miles.
Sebasticook River at Pittsfield, drainage area 320 square miles.


Magnitude Run-off Diagram
Sebasticook River
at
Pittsfield
SECOND-FEET PER SQUARE MILE
TIME IN DAYS
1911
Average 1909-1912
Min. 1911
0
1
2
3
4
5
6
7
8
9
10
11
50
100
150
200
250
300
350

LOG DRIVING AND LUMBERING.

General Statement.

One of the most important uses of the rivers of Maine, since the early history of the State, has been as highways of transportation for its lumber products. The earlier reservoirs were mainly constructed for the purpose of storing water to be used in the annual drives of logs. Many of the decisions of the courts of Maine have been in relation to controversies between log driving interests. It is only within more recent years that the power interests have contended successfully for the control of the rivers, ponds and reservoirs of the State.

Log-cutting operations are begun much earlier now than formerly. During August of each year many men are in the woods building camps, swamping roads, and getting ready for the winter's cut, which is to be begun in the early fall. After the logs are cut they are "yarded" in convenient places, and when the snow comes they are hauled to the "landing," located on the shore of some tributary of the river down which they are ultimately to find their way. When the ice breaks up in the spring, the logs are rolled into the stream and float down on the high stage. In this way many small streams are driven which are almost dry after the first spring freshets. At the outlet of many of the ponds are dams which hold the spring waters back until the logs are ready, when, by a series of flushes, the logs are floated down the smaller streams to the larger stream below. If the first freshet fails to be of sufficient volume to flush the drive down stream, a part of it is held up and may have to remain over until the following spring. After the drive is out of these small streams it is customary to allow the gates of dams at their headwaters to remain open until the next fall, so that during the summer the flow is natural.

The method used on the small streams is similar to that employed on the main river. On many streams, reservoirs are formed for the purpose of storing water to be used in carrying the main drive through the crooked and rocky sections and to float the logs over the otherwise shallow places.

LUMBERING OPERATIONS.

The annual lumbering operations in the State as reported by the various mills to the U. S. Forest Service, are shown in the following table and includes both soft and hard wood.

Annual Lumbering Operations.

YEAR.	Total feet, B. M.
1880	566,656,000
1890	564,243,000
1900	765,515,000
1905	745,706,000
1906	1,088,747,000
1907	1,103,808,000
1908	929,350,000
1909	1,111,565,000
1910	860,273,000

The average for the six year period from 1905 to 1910 is 973,242,000 ft. B. M. and with an average value of about $16,500,000.

The present total water horsepower developed in the State is about 350,000. At an annual value of $20 per H. P. the total value would be $7,000,000. If the annual value of a developed horsepower is considered as $47.20 the total horsepower developed in the State would be equal to the value of the annual forest cut, namely $16,500,000.

Let us now consider the total value of Maine's two greatest natural resources. The Forest District has an area of about 11 million acres. To this should be added 3 million acres to include the detached forested areas outside of the legal district, giving a total of 14 million acres of forested land for the entire State. This includes both soft and hard woods. The present average value of this timber land is perhaps from $5 to $6 per acre. It ranges from practically nothing for burnt-over land to as high as from $35 to $50 per acre in favorable localities. The total value of the standing timber of the State, including the soft and hard woods, is therefore $75,000,000. The value of timber will undoubtedly increase. It is believed, however, that in this State, the annual cut is greater than the annual natural increase in growth, so that in the final summary, the value of the standing timber may be placed at from $75,000,000 to $100,000,000.

The total potential water power of the State, as estimated by the hydrographers of the United States Geological Survey, is 1½ million horsepower, and ultimately it may reach 2 million. Anywhere from $50 to $300 per horsepower, with an average of about $100 per horsepower, is often expended on the construction of a water power plant. This makes a value of the total horsepower of the State that will probably ultimately be developed as $150,000,000.

The following table shows approximately the log drive of soft woods for the year 1910, by drainage basins, for the entire State.

Logging Crop for 1910.

River Basin.	Feet, Board Measure.
St. John	125,000,000
St. Croix, Machias, etc	90,000,000
Penobscot	200,000,000
Kennebec	125,000,000
Androscoggin	80,000,000
Saco	30,000,000
Miscellaneous	100,000,000
Total	750,000,000

Railroad Freight Rates.

The following table shows the present railroad freight rates on logs and pulpwood between certain points in the State.

3

Freight Rates.

Destination and Commodity.	Rate per cwt. cents.	Distance miles.	Rate per ton-mile cents.
Norcross to Oldtown		69.1	
Logs	6		1.72
Pulpwood, poplar	3		0.86
spruce	3½		1.04
Norcross to Bangor		75.6	
Logs	7½		1.98
Pulpwood, poplar	4½		1.20
spruce	5		1.32
Mattawamkeag to Bangor		57.7	
Logs	3.8		1.32
Pulpwood	3.0		1.04
Indian Pond to Solon		42.0	
Logs	3.8		1.82
Pulpwood	3.0		1.42
Indian Pond to Waterville		81.8	
Logs	4.7		1.16
Pulpwood	3.6		.88
Indian Pond to Hallowell		103.3	
Logs	5.1		.98
Pulpwood	4.0		.78
Average			1.25

St. John River.

As a result of long standing difficulties between the United States and Canada regarding operations on St. John River, an International Commission was appointed to report on the various questions involved. The Commission on the part of the United States was authorized by act of Congress 1908, the authority of the Commission being dated January 12, 1909. The Commission at first was simply authorized to consider the problems connected with logging operations on the St. John River. In February 1910, its authority was very materially increased and it was asked to submit a comprehensive report on the conservation of the water resources of the entire St. John basin, with special reference to log-driving. The report of the Board of Consulting Engineers appointed by this commission contains extensive data on log-driving conditions, but the complete report is not yet available for publication. The following information is that as given to the press.

PRESENT OPERATIONS.

The logs which are cut on the St. John river above the mouth of the Allagash and on all of the tributaries are driven to the main river by individual owners and are there delivered to the driving corporation which takes them to their destination.

The Madawaska Log Driving association drives the logs between Big Rapids above the mouth of the Allagash River and Grand Falls. The contractors for this company employ from 100 to 200 men during the driving season.

At a point just above the "pitch" at Grand Falls the control of the drive is assumed by the St. John Log Driving company which is responsible for the delivery of logs into the Fredericton boom. This company employs about 80 men.

For the ten years, 1902 to 1911, the size of the drive handled by the Madawaska Log Driving association has varied from 80,000,000 feet in the years 1905 and 1908 to 127,000,000 in the year 1907. The latter was the largest drive of the past 21 years handled by this concern. Of the total quantity of lumber driven during the 10 years referred to, 78 per cent has come from the upper St. John and Allagash rivers, and for the past five years 86 per cent has been cut on these waters.

Annual Log Drive, St. John River.

YEAR.	Amount Feet, B. M.	YEAR.	Amount Feet, B. M.
1892	66,053,680	1902	115,530,000
1893	75,706,640	1903	93,705,000
1894	80,292,920	1904	52,737,000
1895	63,308,644	1905	80,225,000
1896	75,691,273	1906	113,592,000
1897	103,245,192	1907	127,136,000
1898	82,852,300	1908	80,889,000
1899	59,841,667	1909	108,574,000
1900	96,868,097	1910	87,503,712
1901	73,432,058	1911	104,097,200

IMPROVEMENTS RECOMMENDED.

In studying the subject of log-driving the engineers find the course of the St. John River to divide itself naturally both by its physical characteristics and by the methods of handling the logs, into three general sections as follows:

First. The upper St. John, which is that portion of the river from the forks of the Northwest and Southwest branches to the mouth of the Allagash River. This portion of the river is driven by individuals, who deliver their logs to the Madawaska Log Driving association at the mouth of the Allagash, or a few miles above at Big Rapids.

It is stated that this part of the river is so difficult that no corporation would care to enter into contract for driving it.

In this section is found the least opportunity for water storage of any portion of the entire St. John system. In fact, but six square miles or only two-tenths per cent of its entire drainage area of 1,850 square miles is occupied by lakes or ponds, as compared with nearly three per cent on the Allagash, four per cent on the Madawaska, and six per cent on the Fish river system.

This leads to a very rapid run-off of the melting snow as the early spring rains at about the time the log drives are started, often resulting in hard driving conditions when the snow-water has drained away, especially on account of the rapid fall and rocky nature of the river bed.

For this reason all advantage possible should be taken of what storage opportunities there are and particular attention should be paid to improving the channel on these upper waters to the end that the logs may be advanced as far as possible on their journey before the flood water is gone.

Second. From the mouth of the Allagash to Grand Falls. There is testimony to the effect that when the rear of the drive reached the mouth of the Allagash they are usually considered safe. With the proper handling of the storage reservoirs which can be developed on the Allagash and St. Francis rivers and attention to getting the logs from those streams into the main river at an early date, comparatively little trouble should be experienced on this section.

Third. From Grand Falls to Fredericton. This section is almost entirely dependent on a sufficient volume of water to float the logs and this can be easily provided by the storage reservoirs that are recommended in the report.

Upper St. John River.

On the upper St. John River, at St. John Pond, and at Baker Lake it is practicable to store 100 per cent more water than at present.

These reservoirs should be fully developed. At English Lake and Daaquam Deadwater dams should be built, which will also store considerable water for flushing the logs from point to point, as is done on smaller streams. The stored water, which can be obtained from these reservoirs, together with such clearing and improvement of the river channels as can be readily done, should ensure for any year the safe driving of logs, cut on these waters down to Seven Islands.

At this point a dam should be erected to carry a "head" of 16 feet of water, submerging the islands, and creating a pond about five miles long. Here the logs would be collected and sluiced intermittently with the quantity of water which would be accumulated during each interval. By this method of operation the logs would be driven over Priestly Rapids to Louis St. John's about nine miles below. In this distance there are about one mile of boulders which should be removed.

Twelve miles below Seven Islands at a point called "Basford Rock," a site has been selected where another driving dam should be built to flow back to Louis St. John's. This dam would be operated in the same manner as that at Seven Islands, to flush the logs to the mouth of the Big Black river.

Future experience may show the desirability of building a roll dam at Priestly Rapids which is a difficult section of the river to drive, and a suitable site is available at that point.

A site for a driving dam exists on the main river at Big Black rapids, about two miles above the mouth of Big Black river. Serious difficulties are now experienced from large jams forming on the gravel bars and reefs of ledge composing these rapids. In the drive of 1910, from 15,000,000 to 20,000,000 feet of logs were caught in the jam which formed here, and which extended up the river for about four miles. This condition no doubt can, and should be, considerably improved by blasting, and the construction of wing-dams to contract the channel, but the chief dependence must probably be placed on maintaining a sufficient depth of water to float the logs freely past this stretch of river by means of driving dams mentioned.

The same may be said of the eight and one-half miles from Half Way Brook to the foot of Big Rapids where about 10,000,000 feet of logs were jammed in the driving season of 1910. There are 15 or 18 points in the 24 miles between Big Black

River Rapids and those known as "Big Rapids," about four miles above the mouth of Little Black River, that give some trouble, and the worst of them could be submerged by the construction of several low roll dams, should future experience prove that the reservoirs recommended, and a reasonable amount of channel clearing are insufficient to easily and safely pass the logs over this section of the river.

At "Sinclair's Bar" just above the mouth of the Little Black River is a wide shallow stretch, about one and one-half miles long, which is said to be impossible to drive over on a low stage of water on account of insufficient depth of water to float the logs. It is suggested that wing dams be built there to restrict the channel. Also about 200 boulders should be removed along here in a distance of about two miles.

On the Big Black River, additional storage is recommended on Depot Lake, and the construction of a dam on the deadwater, about six miles above the mouth. The latter dam would create a comparatively large reservoir, which would be used for maintaining a suitable driving stage in the main river, between the mouth of this tributary and the mouth of the Allagash River. Another large reservoir would be obtained by a dam which should be built on Little Black River at "Johnson Brook" about three miles above the mouth.

It is believed that the several dams which are recommended and the liberal use of dynamite to remove and level the worst of the boulders along the line will make the driving of the logs on the 75 miles of river known as the upper St. John safe and economical.

Allagash and St. Francis Rivers.

On the Allagash River opportunity exists for obtaining a large quantity of storage, sufficient not only for driving logs but for increasing the flow of the river.

This increase would be greatly to the benefit of any water power which may be developed. Dams should be built at the outlet of Eagle, Churchill, Long, Round, Musquacook lakes, of sufficient height for log-driving purposes. These could be raised in the future to the highest limits when demanded by the water power conditions. There is a suitable site for a driving dam on the main Allagash stream at "Five Finger brook," if such a dam is found to be necessary, and a dam should be constructed at Allagash Falls, similar to the one on the St. John river at Seven Islands. This work with comparatively little blasting of boulders and points of ledge will make fine driving conditions for the whole length of this stream.

On the main river from the mouth of the Allagash to St. Francis, very little can be done except to blast boulders which now cause jams at low stages of water. About 300 of these should be removed in this 12 miles. The Allagash River and Little Black River reservoirs should be used for maintaining a sufficient driving stage in this section of the main river.

On the St. Francis there should be erected a dam at the foot of Boundary Lake, and another at the foot of Glazier Lake, flowing Cross and Beau lakes. These would be used primarily for storage and for maintaining a driving stage on the main river, as they would not be drawn on very heavily for driving out of this stream.

St. Francis to Grand Falls.

Six miles below the St. Francis, at Little River flat much trouble has been experienced from logs going ashore at high water, and involving considerable expense to return them to the channel. This can be remedied without great expense by the construction of a wing dam 300 feet long. Three miles below this is Hafford's Bar and Rocks, where much trouble is caused by logs groundng on the gravel bar and rocks. It is called the worst place between St. Francis and Fort Kent but it seems that the proper attention to the placing of booms should correct almost all of this difficulty.

At "Chapel rocks" is another place where at high water many logs are thrown ashore behind an island on the Canadian side. This can be corrected by a short and inexpensive wing dam. At McCulloms Rock and Canadian Island, Fish River rapids, Baker Brook Island, and Pine Island ledges, similar difficulty is experienced on falling water, but it is believed that all these can be corrected by a suitable arrangement of piers and booms.

About the only place that gives much trouble between Fort Kent and Edmundston is Michaud's Flat and Ledges, about 13 miles below Fort Kent. The flat being on the outside of the bend of the river it is hard to protect by a boom and it is doubtful if logs can be prevented from going ashore there at high water. But at Michaud's Ledges about a mile below a judicious amount of blasting would prevent logs from collecting. Aside from these points no difficulty is experienced through to Grand Falls as is evidenced by the fact that one driving crew attends to this 43 miles of river.

AMOUNT OF WATER REQUIRED.

It is not a large quantity of water that is best for driving logs but as steady and uniform flow as possible. Absolute uniformity of flow cannot be attained on the St. John river as there are opportunities for storing water only a limited proportion of the spring freshet. By the construction of the reservoir dams recommended the freshets will be materially reduced in height and on some of the branches will be nearly eliminated, thus reducing the expense and delay now experienced by returning to the water logs that have stranded at the height of the flood.

The engineers believe that it will be desirable for the best and most economical handling of the water if one corporation could be made responsible for driving the logs through the whole length of the river as far up as Seven Islands at least. It has been stated that no corporation or individual would care to contract for driving the logs in the upper St. John under the present conditions. Those conditions would be so relieved by these improvements that a practical river man would not hesitate to assume the responsibility of handling the logs in the upper section of the river.

As a result of the investigation the engineers have decided that there will be necessary for log-driving purposes a flow of 4,500 second feet at Fort Kent during the month of June and of 8,000 second feet at Grand Falls during the month of July. It is believed that it will rarely or never be necessary to use stored water for log-driving during the month of June. During the past 11 years it would have been necessary for eight out of the 11 to release stored water in July.

The maximum amount required was in the year 1903 and amounted to 4,000 second feet for the month, which corresponded to a quantity of storage of 10,500 million cubic feet. This is about 15 per cent of the quantity of water that can be stored on the tributaries of the St. John if the storage above Chamberlain lake is included. If it is not included, the maximum requirements for log-driving would be about 18 per cent of the total storage.

Considering only the amount of storage that can be obtained by limiting it to present high water marks in the various lakes, the maximum requirement for log-driving would be about 32 per cent, including Chamberlain Lake, and 40 per cent without Chamberlain Lake.

The average quantity of water required for log driving as shown by estimates covering the last 11 years, is about 5,000 million cubic feet or seven per cent of the total possible storage (including Chamberlain Lake) and about 15 per cent of the storage available to present high water levels.

It is thus seen that in the ordinary year the amount of stored water required for log-driving will be small in amount. In a dry year about one-third of the storage to present high water levels would be required for log-driving or about one-sixth of the total possible storage.

St. Croix River.

The following information is all that is available at the present time for this basin.

Log Drive, St. Croix River.

Year.	West River.			East River.		
	Total drive Feet, B. M.	Total cost.	Cost per M feet.	Total drive Feet B. M.	Total cost.	Cost per M feet.
1908......	12,000,000	....	....	21,000,000	....	....
1909......	17,200,000	....	....	26,100,000	....	....
1910......	15,000,000	....	....	26,400,000	....	....
1911......	21,100,000	....	....	25,200,000	....	....
1912......	15,200,000	....	....	19,000,000	....	....
Total..	80,500,000	....	....	117,700,000	....	....

Total drive main river, 198,200,000 feet, B. M.

Average cost of towing and driving $0.52 per M feet.

Average length of drive, 80 miles.

Cost of driving per mile-thousand $0.0065.

Cost of driving per ton-mile 0.0037.

MACHIAS RIVER.

The figures below on the cost of log-driving on this stream are within the corporation limits but do not include the cost of driving such logs as are landed on small tributary streams from the points where landed into the driving limits of the corporation or main stream. The total distance of the corporation limit from Fifth Lake to Machias is about 60 miles but a large proportion of the drive for the past ten years has come from branch streams that enter lower down. A fair average of the river driving would be about 30 miles. For the past ten years there has been an annual drive of 2 or 3 million of logs from Old Stream on which there is a tax of only 5 cents per thousand. This stream enters Machias River about 12 miles above the mouth.

Log Drive, Machias River.

YEAR.	Total drive Feet, B. M.	Total cost.	Cost per M feet.
1908	17,305,566	$7,058 34	$0.41
1909	19,395,464	6,975 76	36
1910	15,600,074	6,382 59	41
1911	13,839,644	7,005 28	51
1912	15,040,776	5,743 22	38
Average			$0.41

Average length of drive 30 miles.

Cost of driving per mile-thousand $0.014.

Cost of driving per ton-mile $0.008.

UNION RIVER.

According to a report from Whitcomb, Haynes & Co. the average log drive on Union River for the past 5 to 10 years will amount to about 8 million feet B. M. The average cost of this drive will be not far from $1.25 per M feet.

PENOBSCOT RIVER.

PRESENT CONDITIONS.

The data for log-driving in this basin are taken from U. S. Geological Survey Water Supply Paper No. 279 *a* with such

a Water Supply Paper No. 279. Water Resources of the Penobscot River Basin, Maine by H. K. Barrows and C. C. Babb, page 211.

additional material as was available for this report.

There are five principal "drives" in the Penobscot basin, namely, the West Branch, East Branch, Mattawamkeag, Piscataquis, and Passadumkeag. Some of these drives are united at certain points, others are independent from the starting point to the Penobscot Boom, near Greenbush, where all drives are held up to be sorted.

Previous to the 1903 drive, the Penobscot Log Driving Co. drove from the head of West Branch to Penobscot boom. Beginning with the drive of 1903, the West Branch Drive & Reservoir Dam Co., affiliated with the Great Northern Paper Co., took control, their lower limit being Shad Pond, where the Penobscot Log Driving Co. assumed control, driving to the Penobscot boom. By far the larger part of the West Branch drive is for the Great Northern Paper Co. and consequently does not go below Millinocket.

The West Branch drive leaves Chesuncook Lake sometime in June, arriving in Shad Pond on or about July 5 and at Penobscot boom about the 1st of September.

The East Branch Drive Co. drives the East Branch from Grand Lake. Ordinarily West Branch logs are held in Shad Pond until the East Branch drive passes into the main river, so that the two drives will not become mixed. At Lincoln the East Branch logs are sorted, and here the West Branch drive usually overtakes that from the East Branch so that both drives go into the Penobscot boom together, arriving there about the 1st of September. The logs are sold in the Penobscot boom, whence they are driven to their destination.

As a rule the drives of the Mattawamkeag, Piscataquis, and Passadumkeag branches arrive in Penobscot boom sometime in June.

WATER USED IN DRIVING.

It is evident that the water is required for driving at just the time that it should be stored to meet the needs of power plants, and that more or less water is required for the drives during the greater part of the summer.

The following quantities of water are required to drive from Chesuncook Lake to the Penobscot boom:

From Chesuncook to Ambejejus, about 4,000 second-feet.

North Twin to Quakish, probably less than 3,000 second-feet. There is really no excess used in this distance, however, as day pitch of about 3,500 second-feet is used which is held at Quakish Lake and used through the wheels at Millinocket, about 2,500 second-feet being required here day and night.

From Quakish Lake to Shad Pond, about 3,500 second-feet.

It was customary for the Penobscot Log Driving Co. to require 4,000 second-feet from the time their drive left Shad Pond until it arrived below Medway, where the quantity was reduced to about 3,500 second-feet, water being taken from Millinocket Lake and an additional amount being furnished by the East Branch. It is probable that at the present time 3,000 second-feet, used in heads, together with the water supplied by East Branch and lower tributaries, will drive this part of the river.

The amount of water necessary to drive the East Branch is not definitely known, but it is probably between 2,000 and 3,000 second-feet. At the end of the average year the Chamberlain-Telos and Grand-Second Grand lakes storage reservoirs are drawn down to a very low stage, many years flowing with all gates up at the end of the driving season.

QUANTITIES OF LOGS DRIVEN AND COST OF DRIVING.

The following tables show the amount and cost of the principal drives for a series of years. Figures are given for the West Branch drive from 1898 to 1902, inclusive, covering the entire distance from the head of Chesuncook Lake to Penobscot boom. Since 1902 the drive above Shad Pond has been handled by a different company, and figures for this portion of the drive are not available after that date. It will be noticed that with the year 1903 there was an apparent falling off in the amount driven down West Branch. This is explained by the fact that beginning with 1903 the logs of the Great Northern Paper Co. have not entered Shad Pond.

The table relating to the West Branch from Shad Pond to Penobscot boom gives directly the tax per thousand or the charge per thousand made by the driving company against the owners of the logs. The tax per thousand is derived for the remaining tributaries from averages of the cost over the partial distances for which information is available.

Amount and cost of log-driving on Penobscot River and tributaries.

WEST BRANCH OF PENOBSCOT RIVER FROM HEAD OF CHESUNCOOK LAKE TO PENOBSCOT BOOM.

YEAR.	Amount driven Feet B. M.	Cost.	Tax per thousand.
1898	22,406,330	$21,431 99	....
1899	47,970,890	50,623 39	....
1900	48,439,010	48,603 32	....
1901	82,451,920	63,387 98	....
1902	78,499,380	63,796 44	....

WEST BRANCH OF PENOBSCOT RIVER FROM SHAD POND TO PENOBSCOT BOOM.

1903	27,026,000	$25,674 70	$0.95
1904	37,281,740	23,487 50	63
1905	37,207,320	25,128 70	68
1906	41,970,715	29,379 50	70
1907	18,201,930	12,741 40	70
1908	22,625,590	13,122 86	58
1909	33,812,930	19,379 51	58
1910	41,041,800	25,445 91	62

WEST BRANCH OF PENOBSCOT RIVER FROM SHAD POND TO DOLBY.

1908	4,621,860	$462 19	$0.10
1909	30,000,000	3,600 00	12
1910	7,849,180	941 90	12

EAST BRANCH OF PENOBSCOT RIVER FROM GRAND LAKE TO PENOBSCOT BOOM.

1898	23,208,290	$9,496 88	....
1899	37,796,810	21,246 45	....
1900	37,010,810	18,789 34	....
1901	40,952,230	25,570 82	....
1902	40,461,920	30,199 07	....
1903	42,444,200	31,996 36	....
1904	72,908,580	61,161 11	....
1905	44,859,460	45,918 04	....
1906	61,299,690	40,179 02	....
1907	46,149,700	54,244 36	....

MATTAWAMKEAG RIVER FROM GELLERSON BOOM TO PENOBSCOT BOOM.

1903	14,095,490	$7,690 55	....
1904	36,606,720	23,447 85	....
1905	15,729,320	10,403 54	....
1906	11,056,820	8,513 75	....
1907	10,807,570	7,500 93	....
1908	13,046,730	4,273 77	....
1909	10,230,110	3,829 05	....
1910	10,616,970	5,722 23	....
1911	11,429,820	4,302 00	....

Amount and cost of log-driving on Penobscot River and tributaries—Continued.

PASSADUMKEAG RIVER FROM NICATOUS LAKE TO PENOBSCOT BOOM.

Year.	Amount driven Feet B. M.	Cost.	Tax per thousand.
1903..........	17,374,470	$10,399 17	....
1904..........	20,534,459	15,643 93	....
1905..........	7,696,755	4,614 23	....
1906..........	14,254,370	6,654 75	....
1907..........	13,186,760	6,056 88	....

EAST BRANCH, TAX FOR PARTIAL DISTANCES, FROM GRAND LAKE DAM TO PENOBSCOT BOOM.

Year.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1898....................	12,671,930	$0 50	
1899....................	10,764,510	64	First drive.
	10,237,060	83	Second drive.
1900....................	3,844,911	71	First drive
	9,251,530	78	Second drive
1901....................	8,505,860	79	First drive
	9,262,850	81	Second drive
1902....................	3,306,150	91	First drive
	14,830,810	91	Second drive
1903....................	6,657,930	79	First drive
	22,845,900	83¾	Second drive
	3,265,600	83¾	Rafted out in spring of 1904
1904....................	12,196,930	92½	First drive
	30,928,510	92½	Second drive
	12,707,800	92½	Rafted out in spring of 1905
1905*....................	9,608,520	1 38	
1906....................	24,528,840	90	
	8,000,000	90	Rafted out in spring of 1907
1907....................	10,633,555	1 24	Second drive
	13,381,420	1 37½	Third drive
Average............	....	.897	

FROM GRAND LAKE DAM TO LINCOLN.

1905....................	10,495,060	$1.18	
1906....................	13,076,320	70	
1907....................	1,613,560	1 06	Second drive
	3,348,760	1 19½	Third drive
Average............	....	1.034	

FROM HASKELL ROCK TO PENOBSCOT BOOM.

1899....................	1,071,400	$0.54	
1901....................	1,631,800	71	
1905....................	1,088,960	1 21	
Average............	....	$0.82	

*Previous to 1905 the logs were driven from the various points up the river to Lincoln for the same price that they were driven from the corresponding points to the Penobscot boom.

Amount and cost of log-driving on Penobscot River and tributaries—Continued.

FROM HULLING MACHINE TO PENOBSCOT BOOM.

Year.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1899	426,280	$0.44	
1900	1,073,890	51	
1901	116,480	63	
1902	1,692,250	73	
Average	....	$0.578	

FROM SEBOEIS AND WASSATAQUOIK STREAMS TO LINCOLN.

Year.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1905	6,249,830	$0.78	
1906	1,514,000	50	
1907	1,850,250	70	
Average	....	$0.66	

FROM SEBOEIS AND WASSATAQUOIK STREAMS TO PENOBSCOT BOOM.

Year.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1898	10,536,360	$0.30	
1899	8,402,150	33½	First drive
	6,082,140	33	Second drive
1900	19,621,090	36½	
1901	12,845,680	49	First drive
	5,485,480	51	Second drive
1902	16,947,270	61	Two drives
1903	2,035,560	49	First drive
	5,150,810	53¾	Second drive
	300,000	53¾	Rafted out spring 1904
1904	11,478,080	62½	First drive
	2,968,000	62½	Second drive
1905	4,686,350	98	
1906	14,180,530	70	
1907	3,998,235	88	
Average	....	$0.555	

FROM WHETSTONE FALLS TO PENOBSCOT BOOM.

Year.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1902	1,148,490	$0.61	Second drive
1905	6,362,420	77	First drive
1907	2,197,520	1.65	
Average	....	$1.01	

FROM SOLDIER BROOK TO PENOBSCOT BOOM.

Year.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1902	2,536,950	$0.56	
1904	2,629,180	56½	
1905	3,104,810	74	
Average	....	$0.622	

Amount and cost of log-driving on Penobscot River and tributaries—Continued.

FROM MUD BROOK TO PENOBSCOT BOOM.

YEAR.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1900	3,219,390	$0.35½	
1903	2,188,350	43	
1907	858,470	78	
Average	....	$0.522	

FROM GRINDSTONE TO PENOBSCOT BOOM.

YEAR.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1899	813,270	$0.33	
1901	3,104,080	33	
1905	3,263,510	73	
1907	3,496,190	1 15	
Average	....	$0.636	

FROM MEDWAY TO PENOBSCOT BOOM.

YEAR.	Amount driven Feet B. M.	Tax per thousand.	Remarks.
1907	4,771,740	$0.80	

MATTAWAMKEAG RIVER, TAX FOR PARTIAL DISTANCES.

YEAR.	From—	To Lincoln.	To Montague.	To Penobscot boom.
1903	Gellerson boom	$0.58	$0.58	$0.58
1904	" "	70¾	70¾	70¾
	" "	60¾	60¾	60¾
1905	" "	....	68	68
	" "	....	68	68
1906	" "	77	77	77
1907	" "	75	75	75
Average	....	68	69	69
1903	Wytopitlock	$0.53	$0.53	$0.53
1904	"	....	....	65¾
1904	"	....	....	55¾
1905	"	....	....	63
Average	....	$0.53	$0.53	$0.59
1904	Baskahegan	....	....	$0.59¾
	"	....	....	69¾
Average	....	....	....	$0.65
1903	Molunkus	....	....	$0.51
1904	"	....	....	63¾
1905	"	....	....	61
Average	....	....	....	$0.59
1904	Mattakeunk	....	....	$0.63¾
1905	"	....	....	61
Average	....	....	....	$0.62

Amount and cost of log-driving on Penobscot River and tributaries—Concluded.

PASSADUMKEAG RIVER, TAX FOR PARTIAL DISTANCES.

YEAR.	TO PENOBSCOT BOOM FROM—				
	Nicatous.	Pistol.	Madagascal.	Grand Falls.	Saponic.
1903	$0.80½	$0.32½	$0.32½		
1903		48½	48½		
1903		60½	60½		
1904	1 00	77	52		$0.52
1904	1 00	77	62		
1904			62		
1905	74¾	45	31½		
1906	56		32	$0.47	
1906			28		
1907	83	37	25		
1907	50				
Average	$0.78	$0.54	$0.42	$0.47	$0.52
1908	$0.46	$0.33	$0.31	*$0.46	
1909, first drive.	66¾ 51¾				
1900, second drive	61 2-5 46 2-5				
1910, mouth of Nicatous Stream	58				
1910, Nicatous Lake	75				

* Foot of Grand Falls.

The following table, giving the cost of driving per mile thousand and per ton-mile, is compiled from the above data; it is assumed that 1,000 feet board measure weigh 3,500 pounds:

Cost of log-driving on Penobscot River and tributaries.

WEST BRANCH OF PENOBSCOT RIVER FROM HEAD OF CHESUNCOOK LAKE TO PENOBSCOT BOOM, 1898-1902.

Location of Drive.	Distance in miles.	Average tax per thousand.	Cost of Driving.	
			Per mile-thousand.	Per ton-mile.
Head of Chesuncook Lake				
to boom of Great Northern Paper Co.	53	$0 79	$0.0149	$0.0085
to Lincoln	94	1 24	.0132	.0075
to Montague	106	1 29	.0122	.0070
to Penobscot boom	120	1 17	.0098	.0056
Foot of Chesuncook Lake				
to boom of Great Northern Paper Co.	37	63	.0170	.0097
to Lincoln	78	1 04	.0134	.0077
to Montague	90	1 09	.0121	.0069
to Penobscot boom	104	98	.0094	.0054
Sourdnahunk Stream				
to North Twin Dam	25	53½	.0214	.0122
to Lincoln	67	1 06	.0158	.0090
to Montague	78	1 06	.0136	.0078
to Penobscot boom	92	1 01	.0110	.0063
Ambejejus Lake				
to boom of Great Northern Paper Co.	10	47	.0470	.0268
to Montague	63	82½	.0131	.0075
to Penobscot boom	77	68	.0088	.0050
Pemadumcook Lake				
to Lincoln	54	65½	.0121	.0069
to Montague	65	65½	.0101	.0058
to Penobscot boom	78	60	.0077	.0044
North Twin Dam				
to Lincoln	42	56	.0133	.0076
to Penobscot boom	66	52	.0079	.0045
Shad Pond				
to Lincoln	34	31½	.0093	.0053
to Montague	46	48½	.0105	.0060
to Penobscot boom	59	40	.0068	.0039
Average	....	....	$0.0135	$0.0077

WEST BRANCH OF PENOBSCOT RIVER FROM SHAD POND TO PENOBSCOT BOOM, 1903-1907.

Shad Pond				
to Lincoln	34	$0 77	$0.0226	$0.0129
to Penobscot boom	59	77	.0131	.0075
Average	....	....	$0.0178	$0.0102

Cost of log-driving on Penobscot River and tributaries—Continued.

HEAD OF CHESUNCOOK LAKE TO SHAD POND, 1903-1912. *a*

Location of Drive.	Distance in miles.	Average tax per thousand.	Cost of Driving.	
			Per mile-thousand.	Per ton-mile.
Head of Chesuncook Lake to Shad Pond	60	$0 70	$0.0117	$0.0067
Foot of Chesuncook Lake to Shad Pond	44	53	.0120	.0069
Sourdnahunk Stream to Shad Pond	32	50	.0156	.0089
Head of Ambejejus Lake to Shad Pond	19	30	.0158	.0090
Foot of Pemadumcook Lake to Shad Pond	12	16½	.0135	.0077
North Twin Dam to Shad Pond	7	11	.0157	.0090
Average			$0.0140	$0.0080

a. Tax fixed by State legislature.

EAST BRANCH OF PENOBSCOT RIVER FROM GRAND LAKE DAM TO PENOBSCOT BOOM, 1898-1907.

Location of Drive.	Distance in miles.	Average tax per thousand.	Per mile-thousand.	Per ton-mile.
Grand Lake Dam to Penobscot boom	89	$0 90	$0.0101	$0.0058
Grand Lake Dam to Lincoln	63	1 03	.0164	.0094
Haskell Rock to Penobscot boom	84	82	.0098	.0056
Hulling Machine to Penobscot boom	82	58	.0071	.0041
Seboeis River to Lincoln	47	66	.0140	.0080
Seboeis River to Penobscot boom	72	56	.0078	.0045
Whetstone Falls to Penobscot boom	67	1 01	.0151	.0086
Soldier Brook to Penobscot boom	62	62	.0100	.0057
Mud Brook to Penobscot boom	61	52	.0085	.0049
Grindstone Falls to Penobscot boom	59	64	.0108	.0062
Medway to Penobscot boom	51	80	.0157	.0090
Average			$0.0125	$0.0071

Cost of log-driving on Penobscot River and tributaries—Continued.

MATTAWAMKEAG RIVER FROM GELLERSON BOOM TO PENOBSCOT BOOM, 1903-1907.

Location of Drive.	Distance in miles.	Average tax per thousand.	Cost of Driving.	
			Per mile-thousand.	Per ton-mile.
Gellerson Boom				
to Lincoln	52	$0 68	$0.0131	$0.0075
to Montague	63	69	.0110	.0063
to Penobscot boom	77	69	.0090	.0051
Baskahegan Stream				
to Penobscot boom	67	65	.0097	.0051
Wytopitlock Stream				
to Lincoln	34	53	.0156	.0089
to Montague	46	53	.0115	.0066
to Penobscot boom	59	59	.0100	.0057
Molunkus Stream				
to Penobscot boom	48	59	.0120	.0069
Mattakeunk Stream				
to Penobscot boom	43	62	.0144	.0082
Average			$0.0118	$0.0067

PASSADUMKEAG RIVER FROM NICATOUS LAKE TO PENOBSCOT BOOM, 1903-1907.

Location of Drive.	Distance in miles.	Average tax per thousand.	Per mile-thousand.	Per ton-mile.
Saponic Lake				
to Penobscot boom	20	$0 52	$0.0260	$0.0149
Madagascal Stream				
to Penobscot boom	24	42	.0175	.0100
Grand Falls				
to Penobscot boom	26	47	.0177	.0101
Pistol Lake				
to Penobscot boom	30	54	.0180	.0103
Nicatous Lake				
to Penobscot boom	34	78	.0229	.0131
Average			$0.0204	$0.0117

It will be observed from the above table that the value for the average tax per mile varies greatly with the difference in length of distance driven and the difficulties encountered, but apparently the average cost of driving per ton-mile is 0.85 cent; the highest is 2.68 cents and the lowest 0.4. cent.

IMPROVEMENTS IN LOG-DRIVING FACILITIES.

Many things may be done to improve the facilities for driving logs and thereby effect economy in cost of driving and in the amount of water required to float the logs. Dams may be built for the storage of water to be used during the driving season, or for the purpose of creating backwater, thus making smooth an otherwise rough stretch of the river. The whole pond storage may be let out at one time, so as to furnish a "flush" which will float the logs over the shallow and rough places. Rocks and ledges may be blasted out of the channel. Abutments and wings may be built at some of the abrupt turns in the river. Piers and booms may be constructed. A considerable outlay is needed to maintain the booms and existing dams in proper repair. Although much money has been spent on improvements, there is a pressing need for additional expenditure, for with the increased storage for power development should come also improved facilities for log-driving, so that the water shall not be wasted when the logs are driven.

It will be noted that wherever a dam has been built for power development the conditions have, in general, been improved for log-driving. Notable among these improvements are the dams at East Millinocket and Dolby, on the main river a short distance above the mouth of East Branch, which have flooded a considerable stretch of rough water and thereby greatly improved conditions for log-driving. The following table indicates some of the expenses occasioned by improvements during recent years:

Expenses for Improvements on West Branch of Penobscot River from Chesuncook Lake to Medway for the Years 1893-1902. a

Year.	Repairs on main dams.	Repairs on steamers.	Repairs on dams and piers.	Blasting on river.
1893	$1,525 54	$13,322 48	$158 44	–
1894	678 11	–	–	–
1895	1,235 78	350 17	–	–
1896	1,224 30	367 89	–	–
1897	2,263 74	–	–	–
1898	3,779 95	–	141 37	–
1899	10,527 78	728 55	–	$25 00
1900	6,744 62	–	1,049 82	–
1901	5,975 16	–	–	–
1902	4,862 11	9,928 20	1,282 35	–
	$38,817 09	$24,747 29	$2,631 98	$25 00
Average annual expense for 10 years	$3,881 71	$2,474 73	$263 20	$2 50

a. These expenses include in some years the building and care of dams.

Expenses for Improvements on the Main River from Medway to the Penobscot Boom by the Penobscot River Dam & Improvement Co., 1898-1907. a

1898	$1,721 00	1905	$2,373 00
1899	2,535 00	1906	1,700 00
1900	2,946 00	1907	2,900 00
1901	2,450 00		
1902	3,000 00		$23,325 00
1903	1,900 00		
1904	1,800 00	Average yearly expense	$2,332 50

Expenses for Improvements on East Branch of Penobscot River from Grand Lake Dam to Medway, 1898-1906. b

1898	$774 00	1903	$786 00
1899	1,939 25	1904	1,758 00
1900	875 00	1905	1,962 12
1901	610 00	1906	500 00
1902	375 00		

a. These expenses include blasting out rocks and ledges in the river, repairs to dams, hanging and taking care of the booms, and manning them, and executive expense.
b. Some of the amounts here shown include the building of several piers, but for the most part they are for blasting out ledges and rocks in the river.

Kennebec River.

PRESENT CONDITIONS.

There is increasing harmony between the log-driving and the water power interests on this river, largely through the efforts of the Kennebec Water Power Co., a mutual organization of the water power users on the river. The Kennebec Log Driving Association has controlled the drives on the main Kennebec River since about 1830. The two other most important similar organizations in this basin are the Moose River Driving Co. and the Dead River Driving Co. From the reports of these three companies a large part of the following data are compiled.

In the last few years driving has become much easier on the Kennebec and it is less expensive and fewer men are employed. During 1910 a crew of 500 men brought down the spring's drive of 125,000,000 feet, where a few years ago that quantity of logs would have required 800 men. Booms have now been hung at different places on the river to prevent jams. Ledges have been blasted and many of the places where log jams formed that have cost a great deal of money to remove have been cleared and booms fixed so that this trouble is now avoided.

TIME OF DRIVING.

The smaller tributary streams are driven just as soon as the ice goes out of them in the spring—usually about the latter part of April. The Moose River drive usually reaches Moosehead Lake in the latter part of May, and at about the same time the Dead River drive enters the Kennebec. Moosehead Lake is clear of ice, usually, at least, by May 10 and from that time until perhaps about August 1, depending on the season, water is let out of Indian Pond (which is used as a regulating basin) for varying periods each day. The times when the rear of the drive has left Moosehead Lake and reached Riverside boom (about 5 miles above Augusta) for the 13 years 1900 to 1912 are given below:

Dates on which rear of drive left Moosehead Lake and reached Riverside Boom.

Year.	Left Moosehead Lake.	Reached Riverside Boom.	Year.	Left Moosehead Lake.	Reached Riverside Boom.
1900	June 23	Aug. 27	1907	July 5	Sept. 4
1901	July 3	Aug. 9	1908	June 23	Aug. 31
1902	June 15	Aug. 15	1909	July 9	Aug. 23
1903	July 5	Sept. 9	1910	July 7	Aug. 18
1904	July 2	Sept. 8	1911	July 21	Oct. 2
1905	July 24	Aug. 27	1912	July 3	Aug. 30
1906	June 28	Sept. 15			

WATER USED IN DRIVING.

The period during which water is let out of Indian Pond dam lasts usually from May 1 to August 15, although the most water is used during June and July. No record is kept of the flow of this dam or of the length of time the water runs out, although a man is stationed there to control the flow according to the needs of the drive. An inspection of gage readings at The Forks gaging station shows that the duration of the season during which water is let out for log-driving is approximately as follows:

Length of period during which water is released for log-driving.

1902	May 10 to August 6.
1903	April 26 to August 23.
1904	May 14 to August 16.
1905	May 1 to September 3.
1906	May 1 to August 10.
1907	
1908	
1909	May 6 to August 17.
1910	May 1 to August 4.
1911	May 17 to September 14.
1912	May 1 to August 13.

The subjoined table shows the amounts of water that were used in the drives from May to August of each year from 1907 to 1912 according to the records at The Forks gaging station.

For the past three years, special studies of records at this station have been made. During the drive the gates at Indian Pond dam, about 18 miles above The Forks, are raised and lowered daily creating the daily "head" or "hoist." This head lasts, on the average, from 6 to 10 hours and the gates are then closed. For the years 1910, 1911 and 1912 the quantities on the lines marked "average" are the average daily discharges for each month in question. On the lines marked "maximum" the quantities are the average of the maximum discharge of each day or the quantity used at the peak of the hoist. This amounts to about 7200 second feet on the average.

1911 was an unusually low year on the rivers of Maine and the quantities used probably represent the minimum quantity on which drives can economically be handled on the Kennebec. The average for the log-driving season is about 2600 second-feet, and this quantity has been used in later computations on the regulation of Moosehead and other lakes as storage basins.

Discharge in second-feet of the Kennebec River at The Forks during the log-driving season.

Year.	May.	June.	July.	August.	Average.
1907	8,440	5,070	3,920	3,670	5,280
1908	10,500	6,860	2,960	2,830	5,790
1909	8,020	3,950	3,230	2,560	4,440
1910 average	5,980	4,760	3,210	2,440	4,100
1910 maximum	7,760	7,020	7,100	*a*6,570	7,060
1911 average	2,600	3,030	2,330	2,290	2,560
1911 maximum	6,880	7,620	7,640	7,370	7,380
1912 average	8,520	4,970	2,760	2,130	4,600
1912 maximum		*b*7,970	*c*7,230	*d*6,540	7,250

a Aug. 1 to 5, inclusive.
b June 10 to 30, inclusive.
c July 1 and 9–31, inclusive.
d Aug. 1 to 13, inclusive

QUANTITIES OF LOGS DRIVEN AND COST OF DRIVING.

The following table shows the amount and cost of the four principal drives for the thirteen years 1900-1912.

(1) On Kennebec River from The Forks to Riverside boom (about 5 miles above Augusta), 91 miles.

(2) On Kennebec River from Moosehead Lake Outlet to The Forks, 24 miles.

(3) On Dead River from North Branch to The Forks, 43 miles.

(4) On Moose River from Attean to the mouth of the river where it empties into Moosehead Lake, the average length of drive being 17 miles.

It must be kept in mind that these figures cover, in addition to the cost of driving itself, the other charges arising in carrying on this work, such as cost of dams, improvement of channel, booms, etc., as well as executive charges. As many important improvements have been made during these 13 years, such other expenses have been heavy, and the unit costs of driving are therefore higher than if a longer series of years were considered.

Amount and cost of log-driving on Kennebec River and tributaries, 1900-1912.

KENNEBEC RIVER FROM THE FORKS TO RIVERSIDE BOOM.

YEAR.	Total cut, Feet B. M.	Amount taxed, Feet B. M.	Total cost.	Tax per M.
1900	147,424,579	136,418,020	$54,567 20	$0 40
1901	136,063,291	125,744,768	50,297 90	40
1902	133,772,610	122,655,300	55,194 85	45
1903	146,413,732	135,098,090	67,549 07	50
1904	163,894,303	150,476,608	51,162 05	34
1905	132,025,401	121,274,346	43,658 76	36
1906	148,726,278	136,319,939	54,527 99	40
1907	128,955,309	120,893,739	53,193 26	44
1908	128,472,904	116,756,507	56,043 12	48
1909	107,985,561	95,058,953	61,788 31	65
1910	117,007,177	109,092,197	60,000 70	55
1911	115,626,169	98,075,269	63,748 93	65
1912	95,665,550	102,436,674	53,267 05	52
Average				$0 47

Amount and cost of log-driving on Kennebec River and tributaries—Continued.

KENNEBEC RIVER FROM MOOSEHEAD LAKE OUTLET TO THE FORKS.

Year.	Total cut, Feet B. M.	Amount taxed, Feet B. M.	Total cost.	Tax per M.
1900	83,297,162	83,297,162	$4,997 83	$0 06
1901	91,765,535	78,953,778	11,843 07	15
1902	86,391,882	74,707,784	11,206 15	15
1903	95,763,334	83,078,837	12,461 82	15
1904	112,702,582	99,907,353	9,990 76	10
1905	97,655,501	82,844,976	9,112 96	11
1906	97,574,422	79,931,493	9,591 78	12
1907	90,427,107	78,213,336	8,603 46	11
1908	86,173,447	78,119,614	8,593 19	11
1909	68,669,637	61,217,699	9,182 67	15
1910	86,759,916	79,306,884	14,275 24	18
1911	80,445,028	75,676,095	13,621 70	18
1912	83,646,556	80,506,178	8,855 69	11
Average	....	....	....	$0 13

DEAD RIVER.

Year.	Total cut, Feet B. M.	Amount taxed, Feet B. M.	Total cost.	Tax per M.
1900	47,208,011	40,790,202	$14,276 57	$0 35
1901	39,730,456	32,862,021	11,501 71	35
1902	44,215,878	34,705,943	13,882 39	40
1903	45,081,154	33,705,719	13,482 28	40
1904	38,023,533	31,314,718	10,960 17	35
1905	25,294,441	22,070,364	9,931 68	45
1906	38,443,264	29,992,506	16,495 89	55
1907	29,666,938	23,081,152	13,848 70	60
1908	30,763,688	24,622,636	13,542 45	55
1909	29,995,575	24,803,131	15,493 77	62
1910	24,561,773	17,832,281	11,818 24	66
1911	23,488,095	15,746,994	11,022 88	70
1912	13,507,014	15,493,299	9,295 99	60
Average	....	....	....	$0 51

MOOSE RIVER.

Year.	Total cut, Feet B. M.	Amount taxed, Feet B. M.	Total cost.	Tax per M.
1900	....	30,495,221	$10,379 70	$0 34
1901	....	30,699,729	13,151 59	43
1902	....	35,403,382	13,366 61	38
1903	....	41,636,226	18,884 88	45
1904	....	45,386,208	17,619 09	39
1905	....	41,936,725	18,212 36	43
1906	....	40,242,377	15,927 99	40
1907	40,341,513	39,848,743	17,285 95	43
1908	38,464,723	37,957,493	13,126 67	35
1909	42,277,458	37,277,458	13,623 48	37
1910	58,010,898	59,860,898	25,981 66	43
1911	51,986,860	49,430,450	26,914 45	54
1912	51,339,565	58,045,975	31,654 44	55
Average	....	....	....	$0 42

From the above table we can obtain the cost of driving per mile-thousand considering the amounts taxed and the distances; and approximately the cost per ton-mile, considering 1,000 feet B. M. to weigh 3,500 pounds. For Moose River the distance given is computed and is an average one from Moosehead Lake, the various amounts and distances driven being taken into consideration.

Cost of driving on Kennebec River and tributaries, 1900-1912.

Drive.	Distance miles.	Average tax per M.	Cost of Driving. Per mile—thousand.	Per ton-mile.
Kennebec River from The Forks to Riverside boom	91	$0 47	$0.0052	$0.0030
Kennebec River from Moosehead Lake to The Forks	24	13	.0054	.0031
Dead River	43	51	.0119	.0068
Moose River	17	42	.0247	.0141
Moosehead Lake (Moose River to lake outlet, logs towed by boat)	9	15	.0167	.0095

According to the above table, the cost of log-driving per ton-mile on the Kennebec varies from three-tenths to 1 1-2 cents, depending on the distance driven and the difficulties encountered. On the Penobscot (see page 52) the average cost of driving per ton-mile was shown to be 0.85 cents, the highest being 2.68 cents and the lowest 0.4 cents. On the main stretches of these two rivers, the cost per ton-mile is 0.3 cents and 0.4 cents respectively or an average of 0.35 cents. On page 34 it was shown that the cost by rail transportation was 1 1-4 cents per ton-mile.

Androscoggin River.

Log-driving on this stream is handled by the American Realty Co. and Berlin Mills Co. Figures on the total amount of the drive for a period of years and cost of same are available from the former company and are shown below. The second table, covering logs handled on Mooselucmaguntic Lake, shows the amount taken across this lake and taken out of the water at Bemis and loaded on to the cars.

Log-driving, Androscoggin River.

Year.	From—	Total drive, Feet, B. M.	Cost per M.	Distance miles.	Cost per mile-thousand.
1908	Berlin to Rumford.........	51,324,414	$0.148	53.0	$0.0028
1908	Umbagog Lake to Rumford.	17,369,232	.942	84.0	.0112
1909	Umbagog Lake to Rumford.	58,535,190	.423	84.0	.0050
1910	Umbagog Lake to Rumford.	52,366,588	.355	84.0	.0042
1911	Umbagog Lake to Rumford.	37,872,242	.525	84.0	.0062
1912	Ponticook Dam to Rumford	37,872,117	.230	66.2	.0035
1908	Rumford to Livermore.....	28,895,550	.071	27.4	.0026
1909	Rumford to Livermore.....	14,981,364	.205	27.4	.0075
1910	Rumford to Livermore.....	7,889,082	.087	27.4	.0032
1911	Rumford to Livermore.....	10,289,345	.271	27.4	.0099
1912	Rumford to Livermore.....	8,872,882	.062	27.4	.0023
	Average cost per mile-thousand..........	....	....	....	$0.0053
	Average cost per ton-mile..............	....	....	....	.0030

Logs handled on Mooselucmaguntic Lake.

1908	Rangeley drive............	7,646,601	$0.983	16	$0.061
1908	Cupsuptic drive...........	14,868,910	1.276	16	.080
1909	Bemis drive...............	7,322,755	.326	16	.020
1910	Bemis drive...............	13,539,965	.351	16	.022
1911	Bemis drive...............	54,357	.35	16	.022
1912	Bemis drive...............	6,626	.35	16	.022
	Average cost per mile-thousand..........	....	....	....	$0.038
	Average cost per ton-mile..............	....	....	....	.022

The average amount of water required for log-driving on the upper Androscoggin River is 2300 second-feet for two months of the year.

Summary of Log-driving.

The following table shows the average cost of driving logs on a number of rivers of Maine. Based on the figures in the foregoing tables and on the assumption that 1000 feet B. M. of logs weigh 3500 pounds, the average is seen to be $0.0082 per ton-mile. The average freight rate as indicated on page 34 is 50% higher.

Average cost of log-driving on Maine rivers.

River.	Distance miles.	Cost per mile-thousand.	Cost per ton-mile.
St. Croix River	80	$0.0065	$0.0037
Machias River	30	.0140	.0080
Penobscot River, West Branch and tributaries. to Penobscot Boom	10 to 120	.0150	.0086
Penobscot river, East Branch, Grand Lake.... to Penobscot Boom	47 to 89	.0125	.0071
Mattawamkeag River, Gellerson Boom to Penobscot Boom	34 to 77	.0118	.0067
Passadumkeag River, Nicatous Lake to Penobscot Boom	20 to 34	.0204	.0117
Kennebec River, The Forks to Riverside Boom	91	.0052	.0030
Moosehead Lake to The Forks	24	.0054	.0031
Moose River, Attean to mouth	17	.0247	.0141
Dead River, North Branch to mouth	43	.0119	.0068
Moosehead Lake, Moose River to East Outlet (towing by boat)	9	.0167	.0095
Androscoggin River, Umbagog Lake to Livermore	27 to 84	.0053	.0030
towing on Mooselucmaguntic Lake	16	.0380	.0217
Average	....	$0.0144	$0.0082
Average railroad rates	....	.0219	.0125

The next table shows the cost of driving on the lower stretches of the various rivers and for long distances. It is not nearly so difficult driving on the lower portions of the Maine rivers and as a consequence, the cost is less. The average is seen to be $0.0034 per ton-mile, or about one-fourth the average railroad rate. In the 1912 drive from Rumford to Livermore on the Androscoggin River the cost was only $0.0013 per ton-mile, a remarkably low figure.

Cost of log-driving for long distances.

River.	Distance miles.	Cost per mile-thousand.	Cost per ton-mile.
St. Croix River	80	$0.0065	$0.0037
Penobscot River, Head Chesuncook Lake to Penobscot Boom	120	.0098	.0056
North Twin Dam to Penobscot Boom	66	.0079	.0045
Shad Pond to Penobscot Boom	59	.0068	.0039
East Branch, Hulling Machine to Penobscot Boom	82	.0071	.0041
Kennebec River, The Forks to Riverside Boom	91	.0052	.0030
Androscoggin River, Umbagog Lake to Rumford	84	.0042	.0024
Ponticook Dam to Rumford	66	.0035	.0020
Rumford to Livermore (1912)	27	.0023	.0013
Androscoggin average	27 to 84	.0053	.0030
Average	....	$0.0059	$0.0034
Average railroad rates	....	.0219	.0125

LEGAL ASPECTS OF WATER-POWER DEVELOPMENT.

INTRODUCTION.

The Chief Engineer approaches this subject with considerable hesitancy, as he makes no pretensions to a training in law. He was impelled to look into the law of waters by the numerous requests that were received in the office of the Commission regarding the legal features of water-power development in the State of Maine. Furthermore, certain questions occurred to him in his consideration of a policy to be adopted by the State for the development of its water powers, or, as the Water Storage law requires, "to report a comprehensive and practical plan for the improvement and creation of such water-storage basins and reservoirs as will tend to develop and conserve the water powers of the State."

Extracts from a number of decisions have been noted that have been of great interest to the writer as bearing directly on the subject-matter, and it is believed will be of general interest to engineers, especially to those practicing in New England.

A large number of court decisions have been read, but the citations given below are intended to represent general principles and not special or unusual cases. Full references are given, so that the facts on which the decisions were based can be looked up, and the subject pursued further if desired, as each case generally has references to other similar ones.

COURT DECISIONS.

Water-power and water-storage developments in Maine have been based mainly in so far as legal features are concerned, on the Colonial Ordinances of 1641-47; the so-called Mill Act; the common law of waters; to a lesser degree, the act relating to the improvement of marshes, meadows, and swamps; the several acts relating to the procedure for the organization of corporations; and the various decisions of the law courts of the State of Maine bearing on these acts.

COLONIAL ORDINANCES, 1641-47.

This act, first adopted by the General Court of the Colony in 1641 and amended in 1647, reads as follows:

Liberties Common.

2. Every inhabitant who is an householder shall have free fishing and fowling in any great ponds, bayes, Coves, and Rivers so far as the Sea ebbs and flows, within the precincts of the towne where they dwell, unless the freemen of the same Towne or the General Court have otherwise appropriated them. Provided that no Towne shall appropriate to any particular person or persons, any great Pond containing more than ten acres of land, and that no man shall come on another man's propriety without their leave otherwise than as hereafter expressed. The which clearly to determine, It is Declared, That in all Creeks, Coves and other places, about and upon Salt-water, where the Sea ebbs and flows, the proprietor of the land adjoining, shall have propriety of the low-watermark where the Sea does not ebb above a hundred rods, and not more wheresoever it ebbs further. Provided that such proprietor shall not by this liberty, have power to stop or hinder the passage of boates or other vessels, in or through any Sea, Creek, or Coves, to other men's houses or lands. And for great Ponds lying in common, though within the bounds of some Towne, it shall be free for any man to fish and fowle there and may pass and repass on foot through any man's propriety for that end, so they trespass not on any man's Corn or Meadow.

A case recently decided by the Supreme Judicial Court of Maine covers in an interesting and thorough, although concise manner, the early history of the various acts of the colonial courts and legislatures upon which the law of Maine is based. (See Conant *v.* Jordan, 107 Me. 227.)

Decisions of Law.

Many decisions have been rendered by the courts on these Colonial Ordinances, among which may be noted the following:

"Although fishing and fowling are the only rights named in the ordinance, it has always been considered that its object was to set apart and devote the great ponds to public use, and that . . . these public reservations, at first set apart with reference to certain special uses only, become capable of many others which are within the designs and intent of the original appropriation. The devotion to public use is sufficiently broad to include them all, as they rise." (West Roxbury *v.* Stoddard, 7 Allen, 158. Watuppa Reservoir Co. *v.* Fall River, 147 Mass. 548,557.)

It is a rule of law peculiar to Maine and Massachusetts under the Colonial Ordinance of 1641-47 that all great ponds —that is, ponds containing more than ten acres—are owned by the State.

While private property cannot be taken for public use without compensation, the waters of great ponds and lakes are not private property.

Under the ordinance, the State owns the ponds as public property held in trust for public uses. It has not only the *jus privatum,* the ownership of the soil, but also the *jus publicum* and the right to control and regulate the public uses to which the ponds shall be applied.

The authority of the State to control waters of great ponds and determine the uses to which they may be applied is a governmental power, and the governmental powers of the State are never lost by mere non-use. (Auburn *v.* Union Power Co., 90 Me. 577.)

The ordinance has been held to be broad enough to justify the State in granting authority to a certain commission to forbid the public navigating the waters of a great pond set aside as a reservoir for water supply. Defendant denied the right of the commissioners to keep him off.

Held: "There is no doubt that the control of the great ponds in the public interest is in the legislature that represents the public. It may regulate and change these public rights or take them away altogether to serve some paramount public interest. . . . The legislature having seen fit to devote the waters of the lake to a public use for the benefit of the inhabitants of the metropolitan water district, it was in its power to deprive the general public of the right to go upon it with boats or otherwise, on the ground that a safe and advantageous use of the water for drinking, and for other domestic purposes would be best promoted by terminating this former right and putting the property in the control of the water board." (Sprague *v.* Minon, 195 Mass. 581, 583.)

The waters of great ponds being, by virtue of the ordinance, public waters, may be devoted to any legitimate public use. In the case of Watuppa Reservoir Co. *v.* Fall River, 147 Mass. 548, the city of Fall River was authorized by the legislature to draw daily one million five hundred thousand gallons of water from the North Watuppa Pond (a great pond) and to "apply the water taken under this act to all domestic uses, the extinguishment of fires, and to the public use of the city." The plaintiffs were the owners of manufacturing establishments on the only outlet of the pond and were owners also of the bed and land on either side of the stream, they were incorporated for the purpose of constructing a reservoir in the pond, and had at great expense acquired flowage rights all around the pond, built a dam, raised the water of the pond, and were maintaining their reservoir. The draw-off by the city caused actual injury to plaintiffs, who contended that the statute authorizing such withdrawal of water without compensation to plaintiffs was unconstitutional.

Held: "These are all public purposes. The legislature acting on the conviction that an abundant supply of pure water to the people is of paramount importance, has deemed it to be a wise policy to appropriate the waters of this pond to those public uses without making compensation to those who, owning land on the natural stream flowing from it, have been accustomed to use the water for power as it flows through the stream. Such owners have no vested rights in the waters of the pond, and a majority of the court is of the opinion that the Commonwealth may thus appropriate the waters by its direct action, or may authorize a city or town to do so, without being legally liable to pay any damages to the littoral owners on the pond or on the stream.

"In view of the rights and powers of the state in and over the great ponds, it seems clear that the rights of proprietors owning land either on the pond or on any stream flowing from it cannot be decided by the rules of common law applicable to ordinary streams. They must be determined with reference to the ordinance (1641-7) and the rule of property established by it, and we are of opinion that they must be regarded as subordinate and subject to the paramount rights of the public declared by the ordinance. All who take and hold property liable to be affected by this rule of property take and hold under and in subordination to it. Each grant carries with it an implied reservation of these paramount rights, unless the terms of the grant exclude such reservation so that the grant from the state of land upon a stream flowing from a great pond did not convey an unqualified fee with the right to enjoy the usual and natural flow of the stream, but a qualified right, subject to the superior right of the state to use the pond and its waters for other public uses, if the exigencies of the public for whom it holds the pond in trust demand it." (Watuppa Reservoir Co. *v.* Fall River, 147 Mass. 548.)

"They [the colonists] reserved to the Colony the property in the ponds themselves, the better to regulate these and other kindred public rights for common good." "The ordinance secures to the Commonwealth, in great ponds, the same kind of ownership in the water that an individual purchaser of the entire area of a small pond would get by a perfect deed, or by an original grant from the government without restrictions." (Minority opinion, Watuppa Reservoir Co. *v.* Fall River, 147 Mass., 548.)

In the case of the state of Maine, it is to be noticed that the exceptions in the Colonial Ordinance, namely, of ponds "otherwise appropriated" by the freemen of a town, or by the General Court, have never applied here and are not required. We know of no grants by towns, nor by any general court. Here there were no apparent limitations. Here, we feel bound to say, the doctrine of the English common law of private ownership in great ponds was never recognized nor adopted, and fowling on and fishing in them was free from the beginning. (Conant *v.* Jordan, 107 Me. 240.)

The state can at its discretion authorize the diversion of the waters of great ponds for public purposes without providing compensation to riparian owners upon the ponds or their outlets. (American Woolen Co. *v.* Kennebec Water District, 102 Me. 153.)

It is too late in the history of the question in this state to contend that the state has not the constitutional power to grant superior, or even exclusive privileges, in the use of its public rivers to persons or corporations. The state represents all rights and privileges in our fresh-water rivers and streams, and may dispose of same as it seems fit. (Mullen *v.* Penobscot Log Driving Co., 90 Me. 555.)

The extra stores of water collected by the mill owner for his use are his own. They could be taken by the state for the public for a compensation. (Pearson *v.* Rolfe, 76 Me. 389.)

The water of the great natural ponds or lakes cannot be lawfully drawn down below their natural low water line, without legislative authority; nor under the mill act.

A bill in equity may be maintained by the owner of land bounded on a great pond to restrain by injunction mill-owners on the outlet from drawing off the water in such pond below its natural low-water mark by excavating the channel or deepening the outlet. (Fernald *v.* Knox Woolen Co., 82 Me. 48.)

Lands bounded upon rivers above the ebb and flow of the tide generally extend to the middle of the stream, but lands bounded on fresh-water lakes and ponds extend only to low-water mark. (Stevens *v.* King, 76 Me. 198.)

It seems that land bounded on a natural lake or pond extends only to the water's edge; otherwise if the pond is artificial. (Robinson *v.* White, 42 Me. 209.)

In the conveyance of land bounded on a fresh water pond, which has been permanently enlarged by means of a dam at its mouth, the title extends to the low-water mark of the pond, in its enlarged state. (Wood *v.* Kelley, 30 Me. 47.)

The rule of common law, that riparian proprietors own to the thread of fresh water rivers, has been adopted in this state. (Brown *v.* Chadbourne, 31 Me. 9.)

A conveyance of land, bounding it on a fresh water stream, extends to the centre or thread of the main channel of the stream.

The purchaser of upland, adjoining navigable tide waters, takes the shore to low water mark, where the ebb of the sea does not extend more than one hundred rods. (Pike *v.* Munroe, 36 Me. 309.)

The right in common of all the citizens to the use of its navigable waters has been established by judicial decisions; and that right is not limited in this State to water, in which the tide ebbs and flows, but it is admitted in lakes and fresh water rivers, which are navigable. (Moore *v.* Veazie, 32 Me. 356.)

The beds of creeks less than 100 rods in width, where the tide ebbs and flows, become the property of the owners of the land through which they pass except such proprietors are not allowed to stop or hinder the passage of boats, or other vessels, in or through any creeks or coves to other men's houses or lands. (Low *v.* Knowlton, 26 Me. 128.)

Below the line of low water, the State owns the beds of navigable rivers and great ponds, and holds them in trust for the public in accordance with the Colonial Ordinance of 1647. (Haynes & Dewitt Ice Co., 86 Me. 319.)

A navigable stream is subject to public use as a highway for the purpose of commerce and travel.

All streams of sufficient capacity in their natural condition to float boats, rafts, or logs, are deemed public highways and as such are subject to the use of the public.

Held: That the Presque Isle Stream above the bridge at Presque Isle village, for a distance of 30 miles is a navigable stream in fact, etc., applies to passage of stream by boat or canoe. (Smart *v.* Aroostook Lumber Co., 103 Me. 37.)

THE MILL ACT.

This act (Rev. Stat., Chap. 94) had its origin in Massachusetts in the early part of the last century and has been continued with slight modifications both in that State and in Maine to the present time. The principles have been handed down in these two States alone although some features of them have been adopted by neighboring States. The object of the statute, in the preamble to this law at its origin, was as follows:

"Whereas, it has been found, by experience, that when some persons in this province have been at great cost and expenses for building of mills serviceable for the public good and benefit of the town, or considerable neighborhood in or near to which they have been erected, that in raising a suitable head of water for that service, it hath sometimes so happened that some small quantity of lands or meadows have been thereby flowed and damnified, not belonging to the owner or owners of such mill or mills, whereby several controversies and law suits have arisen, for the prevention whereof for the future. Be it therefore enacted," etc. (Ancient Charters, p. 404.)

In 1795, February 27, the Legislature of Massachusetts passed an additional or amendatory Act, the preamble and first section of which are as follows:—

"Whereas, the erection and support of mills to accommodate the inhabitants of the several parts of the State ought not to be discouraged by many doubts and disputes; and some special provisions are found necessary relative to the flowing of adjacent lands, and mills held by several proprietors. Therefore, be it enacted," etc.

"That when any person hath already erected, or shall erect any water mill on his own land or on the land of any other person, by his consent legally obtained, and to the working of such mills it shall be found necessary to raise a suitable head of water; and in so doing any lands shall be flowed not belonging to the owner of such mill, it shall be lawful for the owner or occupant of such mill to continue the same head of water on the terms hereinafter mentioned."

This provision was incorporated into our statutes in 1821.

The intent and main features of the Mill Act in question are contained in the first four sections and are as follows:

Erection of Mills and Dams, and Rights of Flowage.

Sec. 1. Any man may on his own land, erect and maintain a water mill and dams to raise water for working it, upon and across any stream, not navigable; or, for the purpose of propelling mills or machinery, may cut a canal and erect walls and embankments upon his own land, not exceeding one mile in length, and thereby divert from its natural channel the water of any stream not navigable, upon the terms and conditions, and subject to the regulations hereinafter expressed.

Sec. 2. No such dam shall be erected or canal constructed on the same stream; nor to the injury of any mill site, on which a mill or mill dam has been lawfully erected and used, unless the right to maintain a mill thereon has been lost or defeated.

Sec. 3. The height to which the water may be raised, and the length of time during which it may be kept up in each year, and the quantity of water that may be diverted by such canal, may be restricted and regulated by the verdict of a jury, or report of commissioners, as is hereinafter provided.

Sec. 4. Any person, whose lands are damaged by being flowed by a mill-dam, or by the diversion of the water by such canal, may obtain compensation for the injury, by complaint to the supreme judicial court in the county where any part of the lands are; but no compensation shall be awarded for damages sustained more than three years before the institution of the complaint.

Decisions of Law.

Numerous decisions of the courts on the Mill Act have been rendered from time to time among which are the following:

Private property shall not be taken for public uses without just compensation; nor unless the public exigencies require. (Const. Art. 1, par. 21.)

The Mill Act, as it has existed in this State, pushes the power of eminent domain to the very verge of Constitutional inhibition. If it were a new question, it might well be doubted whether it would not be deemed to be in conflict with that provision of the Constitution cited above. (Jordan *v.* Woodward, 40 Me. 317, 323.)

Even the reasons for the policy which occasioned such legislation, have ceased to be potential, and although from the long and uninterrupted exercise of the rights of mill-owners, under this act, it must be considered constitutional, yet, no extension of their rights over private property can be allowed by implication. (Jordan *v.* Woodward, 40 Me. 317.)

The Constitution of this State, Art. 1, sect. 21, in the Declaration of Rights, provides "that private property shall not be taken for public uses, without just compensation, nor unless the public exigencies require it." And it is held to be necessarily implied that private property cannot be taken for private uses, without the consent of the owner, with or without, compensation.

Private property may be taken by the sovereign power of the Government in the exercise of the right of eminent domain for purposes of public utility.

Interests in water, as well as in land, may be taken by virtue of this power, and both are equally the subjects of compensation. (Hamor *v.* Bar Harbor Water Co., 78 Me. 127.)

Whether a public exigency exists for the granting of the exercises of the right of eminent domain, is for the legislature to determine. Whether the use for which it is granted is a public one, the court must decide. (Brown *v.* Gerald, 100 Me. 351, 352.)

Whether there is such an exigency,—whether it is wise and expedient or necessary, that the right of eminent domain should be exercised, in case the use is public,—is solely for the determination of the legislature. The legislature however cannot make a private use public by calling it so. Whether the use for which it is granted is a public one must in the end be determined by the court. (*Supra,* p. 360.)

These cases relate to railroads, water companies, boom companies, canals, and the improvement of public streams. As to such cases there is now no doubt. Their uses are rightly deemed public. The public, or such part of the public as has occasion to, may directly enjoy them. Such uses are of great public benefit. (*Supra,* p. 361.)

We think it should be conceded that the taking of land for the purpose of supplying the public, or so much of the public as wishes it with electric lighting, is for a public use. . . . The charter unquestionably gives the company the right of eminent domain for the purpose of supplying a current for electric lighting. (*Supra,* p. 356.)

Saw mills and grist mills, carding mills and fulling mills, cotton gins and other mills, which are regulated by law, and obliged to serve the public, are undoubtedly a public use. But, as respects all other kinds of mills, although they may be a public benefit, they are not a public use within the meaning of the constitution. (State *v.* Edwards, 86 Me. 102.)

Manufacturing, generating, selling, distributing, and supplying electricity for power, for manufacturing or mechanical purposes, is *not* a public use for which private property may be taken against the will of the owner.

A corporation empowered by its charter to generate and transmit electric power, for lease or sale, and having granted to it the right of eminent domain, does not by accepting the provisions of its charter become a quasi-public corporation, and does not thereby become invested with the right to exercise the eminent domain for the purpose of supplying electric power for manufacturing purposes. (Brown *v.* Gerald, 100 Me. 352.)

The legislature has the constitutional power to authorize the erection of dams upon non-tidal public streams to facilitate the driving of logs, without providing compensation for mere consequential injuries where no private property is appropriated.

Where such a dam, erected in accordance with legislative authority, causes an increased flow of water at times in the channel below, thereby widening and deepening the channel and wearing away more or less the soil of a lower riparian owner, it is not such a taking of private property as entitles the owner to compensation. It is a case of *damnum absque injuria.* (Brooks *v.* Cedar Brook & C. Imp. Co., 82 Me. 17.)

By our Mill Act, Rev. Stats., Chap. 94, any person may build upon his own land across a non-navigable stream a water-mill and dams to raise a head of water for working it, and may thereby flow back the water of the stream upon the lands above as high and as far as he deems necessary for the profitable working of his mill, subject only to the conditions and restrictions named in the act itself. The land owners must submit to the flowage, and content themselves with the pecuniary compensation to be obtained through proceedings provided by the statute. Such mill owner can also in the same way increase the height of his dam and the extent of the flowage from time to time as the exigencies of his business may seem to him to require, he making increased compensation for the increased flowage.

But there is one important and absolute exception to the above-named statutory right to retard the natural flow of a stream: "No such dam shall be erected (or canal constructed) to the injury of any mill (or canal) lawfully existing on the same stream." (Section 2 of Mill Act, Rev. Stats., Chap. 94.) It follows, as a corollary, that when a second mill has been built above the flowage of the first and older mill and dam, such flowage cannot be increased by raising the dam or by other appliances so as to lessen the original efficiency of the mill above. Whatever the greater age of his mill, the right of a mill owner to increase his head of water ceases when the flowage begins to injure the operation of a mill, however new, if already lawfully erected before the injurious flowage began. So long, however, as the additional flowage does not reach up so far as to injuriously affect some mill by that time lawfully erected, the right to increase the flowage is unlimited except as limited by the statute itself. This increase can be effected by raising the height of the solid dam, by the use of flashboards, or by other appliances. The owners of *unoccupied* water powers, or mill sites, must submit to have them flowed out and made useless, and must content themselves with the statutory compensation. (National Fibre Board Co. *v.* L. & A. Electric Co., 95 Me. 321.)

The plaintiff whose land has been overflowed by a *reservoir dam* erected by the defendants upon their own land, but for the use of a mill not owned by them nor standing upon their land, may maintain an action on the case for the damages caused by such dam. The process by complaint, under Rev. Stats. 94 (Mill Act), cannot be sustained upon these facts. (Crockett *v.* Millett, 65 Me. 191.)

As between proprietors of dams on the same stream, he has the better right who was first in point of time.

Unless the plaintiff abandoned his site, the temporary destruction of his dam would not enable the defendant to acquire, as against the plaintiff, the right of a prior occupant. (Lincoln *v.* Chadbourne, 56 Me. 197.)

Mill owners have a right to maintain their dam as it was at the time of the deeds to them; and if, through want of repair for a series of years subsequent to that, it lets the water escape, the owners have the right to repair and tighten it, although the water is thereby raised higher and retained longer than it was while the dam was in a dilapidated condition. (Butler *v.* Huse, 63 Me. 447.)

The United States Supreme Court has passed upon the Mill Act and has upheld its constitutionality. Mr. Justice Holmes delivered the opinion of the court.

This is a bill in equity to restrain the defendants in error from flooding the plaintiff's land by means of a dam erected under the Massachusetts Mill Act The injunction is asked on alternative grounds —either that the Mill Act does not authorize the dam, or that, if it does, then it is contrary to the Fourteenth Amendment of the Constitution of the United States.

The dam in question is built across the Chicopee River, a non-navigable stream, at Red Bridge. It was begun, in pursuance of a long previous determination, on August 3, 1899, and was completed within a reasonable time. The plaintiff owned a mill and dam, more than two miles above, and land below its dam on the two sides of the water-course, down to within about two miles from the principal defendant's dam. On April 4, 1900, the plaintiff determined to build a dam near its lower boundary, and began the work of construction on August 11 of the same year. This dam was completed before, although it was begun after, the defendants', and will be rendered nearly or wholly useless by the back flow from the defendants' structure. The plaintiff's original dam and mill will not be interfered with. The Supreme Judicial Court decided that under the statute then in force, Pub. Stats., c. 190, par. 2, the principal defendant, herein called the defendant, acquired the prior right, and that the statute was constitutional.

The only question which it is necessary for us to consider is whether the act as construed violates the Fourteenth Amendment. General objections to Mill Acts as taking property for private use or on other grounds have been disposed of by Head *v.* Amoskeag Manufacturing Co., 113 U. S. 9. See further Clark *v.* Nash, 198, U. S. 361; Strickley *v.* Highland Boy Gold Mining Co., 200 U. S. 527. Such acts have been in force in Massachusetts ever since an act of 1714, c. 15, 1 Prov. Laws, 729. The practice sanctioned by them would seem from the recitals of that act to have been still older. It may have begun with grist mills and may have had its justification in the public needs which exempted from military watchings and warnings one miller to each grist mill; act of 1693, c. 3, par. 13; 1 Prov. Laws, 130; and in the public duties which were expressed in the act of 1728, c. 6, par. 3; 2 Prov. Laws, 497. But at all events, the liability of streams to this kind of appropriation and use has become so familiar a conception in New England, where water power plays as large a part as mines in Utah, that it would not be very extravagant to say that it enters as an incident into the nature of property in streams as there understood.

However, the liability of upper land to be flowed is not a liability to be flowed without payment. The principal objection made to the law is that it makes no adequate provision for payment, if it is construed as it has been construed by the state court. There has been no substantial change in the form of this provision for the better part of a century. It reads: "A person whose land is overflowed or otherwise injured by such dam, may obtain compensation therefor upon his complaint before the superior court for the county where the land or any part thereof lies; but no compensation shall be awarded for damages sustained more than three years before the institution of the complaint." Pub. Stats., c. 190, par. 4. The jury is to take into consideration damage to other land as well as the damage to the land overflowed. Section 14. It is to assess the damages sustained within three years, par. 16, and to determine what sum, to be paid annually, would be reasonable compensation for the damages that may be occasioned thereafter, and also a sum in gross for all damages from the use of the dam in the manner fixed by it, par. 18 the jury having power to regulate the height of the dam. Section 17. The complainant is given an election to take the gross sum, in which case the owner of the dam loses all benefit of the act after three months until he pays. Section 19, 20. Otherwise the complainant has an action for the annual compensation and a lien on the dam and lands used with it. Section 21 et seq. And, finally, if dissatisfied with the amount of the annual compensation, he may bring a new complaint. Section 30.

In considering whether these provisions are sufficient it is important to know exactly what the upper owner loses by the dam. The state court lays it down that there is no taking under the right of eminent domain. 186 Mass., 95. We assume this to mean what often has been said with regard to the Mill acts, that under them no easement or title of any kind is gained in or over the upper land, and that the water could be diked out, Storm *v.* Manchaug Co., 13 Allen, 10, 13; Lowell *v.* Boston, 111 Mass., 454, 466; although the language has not been uniform and it seems to have been held otherwise when the damages are paid in gross. Isele *v.* Arlington Five Cents Savings Bank, 135 Mass., 142. Taking the law to be as stated by the court, it would follow that only the damage physically suffered is to be paid for. When a title is taken, for instance, to the waters of a stream, it is held that the whole value of the title must be paid, although a considerable use may be left in fact to the party aggrieved. Howe *v.* Weymouth, 148 Mass., 605; Imbescheid *v.* Old Colony Railroad Co., 171 Mass., 209. Flowage under the Mill Acts seems to be regarded as presenting the converse case. As no title is gained to have the water on the upper land, the dam owner pays only for the harm actually done from time to time.

In determining whether a statute of a State is constitutional, this court cannot wholly neglect the long-settled law and common understanding of that State, and will not, under the Fourteenth Amendment, upset what has long been established and accepted. Even the incidents of ownership may be cut down by the peculiar laws and usages of a State. (Otis Co. *v.* Ludlow Co., 201, U. S., p. 140, 150-153.)

NATURAL FLOW.

Thurber v. Martin, 2 Gray, 394 was an action of tort for obstructing the natural flow of the water, and diverting it from the plaintiff's mill. In delivering the opinion of the Court, Chief Justice Shaw thus stated the law of the case:— "Every man has the right to the reasonable use and enjoyment of a current of running water as it flows through or along his own land for mill purposes, having a due regard to the like reasonable use of the stream by all the proprietors above and below him. In determining what is such reasonable use, a just regard must be had to the force and magnitude of the current, its height and velocity, the state of improvement in the country in regard to mills and machinery, and the use of water as a propelling power, the general usage of the country in similar cases, and all other circumstances bearing upon the question of fitness and propriety in the use of the water in the particular case." (Davis *v.* Winslow, 51 Me. 264, 292.)

Every proprietor of land on the banks of a river or stream has naturally an equal right to the use of the water; and this right to use, implies a right to control, detain and even diminish the volume of the water, but only to a reasonable extent.

What is a reasonable detention depends upon the size of the stream, as well as upon the uses to which it is subservient, as the detention must necessarily be sufficient to accumulate the head of water requisite for practical use.

The right of detention is not limited to time necessary for repairs or to extraordinary occasions, but applies to the ordinary use of such streams provided it be not an unreasonable use or detention. (*Supra,* p. 602.)

Thus he may apply it to domestic purposes or purposes of irrigation, but not to such an extent as unreasonably to diminish its quantity. (*Supra,* p. 604.)

In Pitts & als. *v.* The Lancaster Mills, 13 Met. 157, the defendants, owners of a mill and dam above an ancient mill-dam of the plaintiffs, rebuilt and raised that dam above its former height, whereby the water was wholly cut off from the plaintiff's mill for a period of six days, greatly to his detriment. The case was submitted to the court upon an agreed statement of facts, and a nonsuit was ordered, the court assigning as a reason therefor, that "this was not an unreasonable use of the watercourse by the defendants, and that any loss which the plaintiffs temporarily sustained by it, was *damnum absque injuria*." "What is a reasonable use," the Court say, "must depend upon circumstances, such as the width and depth of the bed, the volume of water, the fall, previous usage, and the state of improvements in manufactures and the mechanic arts." (Davis *v.* Winslow, 51 Me. 264, 293.)

A mill owner has no right to unnecessarily and unreasonably detain water from those who have a right to use it subsequent to his own; and he will be liable in damages for doing so.

What is a reasonable use and what an unreasonable detention, are questions of fact for the jury. (Phillips *v.* Sherman, 64 Me. 171.)

The new dam raised the outlet some 3 feet, and held the water at that level, but did not divert it. No more water was thereby taken from the stream than the capacity of the 24 inch pipe would divert. That quantity might be taken, even if no water should be left to flow in the natural channel. The natural flow was substantially the same with the new dam as with the old or without any dam. (Hamor *v.* Bar Harbor Water Co. 92 Me. 364, 377.)

In the case of Mullen *v.* Penobscot Log Driving Co., 90 Me. 555, the defendant was a company chartered by the legislature for driving all logs of all owners in the West Branch waters, and the company was given the exclusive control and management of the waters of the river, so far as necessary to enable it to successfully execute the obligations resting upon it, an obligation in some respects partaking of the character of a public trust.

Held: The plaintiff was not entitled even to the natural flow or to draw from the reserves of water in order to create what would at the time and place be equivalent to the natural flow, so long as the company needed or would be likely to need the same water for driving its own logs to market. The defendant's right was the superior right. The plaintiff's right was secondary and conditional. Such is the inevitable effect of the grants to the company by the legislature. The stores of water are accumulated by using the natural flow until the necessary head is obtained. It was not that the defendant company would not let the water down when it needed its use itself but the plaintiff desired the use and advantages of it in advance of the use of it by the company.

The State represents all rights and privileges in our fresh-water rivers and streams, and may dispose of same as it seems fit. (*Supra*, p. 567.)

FLOATABLE STREAMS.

A stream, which, in its natural condition, is capable of being commonly and generally useful for floating boats, rafts or logs, for any useful purpose of agriculture or trade, though it be private property, and though it be not strictly navigable, is subject to the public use, as a passageway.

Though the adaptation of the stream to such use may not be continuous at all seasons, and in all its conditions, yet the public right attaches, and may be exercised whenever opportunities occur.

When a stream is inherently, and in its nature, capable of being used for the purpose of commerce, for the floating of vessels, boats, rafts, or logs, the public easement exists.

In such a stream, the right in the public exists, notwithstanding it may be necessary for persons floating logs thereon, to use its banks. (Brown *v.* Chadbourne, 31 Me. 9.)

In order to make a stream floatable it is not necessary that it should be so at all seasons of the year. It is sufficient if it have that character at different periods with reasonable certainty and for such a length of time as to make it profitable for that purpose.

The question is whether the stream is floatable without the dam. If it is not, the plaintiff could not avail himself of the fact that it is made so by the defendant's dam. If the stream was originally private property, exclusively so, any improvements made upon it by the owner would give the public no rights on it. But if on the other hand the stream is by nature floatable, those who have occasion to use it as such may do so and may also have the benefit of such improvements as may be put upon it having reasonable regard to the rights of the owner. (Holden *v.* Robinson Co., 65 Me. 216, 217.)

The judge instructed the jury that if the river in its natural state was capable of being useful for floating boats, logs, etc., for purposes of trade or agriculture, the plaintiff was entitled to recover, however long the dam of the defendant might have stood; and notwithstanding his use of the river had been open, notorious, and adverse, and although no logs had ever been floated over the falls where the dam now is. (Knox *v.* Chaloner, 42 Me. 150.)

Whether a stream is capable of being used as a passageway for the purposes of commerce is a question of fact for the jury. (Treat *v.* Lord, 42 Me. 552.)

The presiding judge instructed the jury that if Cold Stream was such a stream as the public would have an easement in for the driving of logs, on account of its inherent capacity for being so used . . . that the right of way was in the waters, and the plaintiff in such case would have no authority to prevent its exercises; that he could by law erect and continue his dams and mills, but was bound to provide a way of passage for the defendants' logs; that some streams are entirely private property, and some are subject to the public use and enjoyment; that the test has been sometimes held to consist in the fact whether they are susceptible or not of use as a common passageway for the public. And, by request of plaintiffs' counsel the judge instructed the jury "that if the stream was incapable in its natural state of being used to propel logs without the erection of dams or other structures on plaintiffs' land, there could be no public servitude."

The judge also instructed the jury that the law, as established in this state, and which they would take for their guide, was, that "the true test to be applied in such cases is whether or not a stream is inherently and in its nature capable of being used for the purposes of commerce, for the floating of vessels, boats, rafts, or logs—when a stream possesses such a character, then the easement exists, leaving to the owners all other modes of use not inconsistent with it;" that a stream might possess such a character, even though, when the forest was first opened on its shores, it were so obstructed by fallen trees, brush and driftwood, that neither vessels, boats, rafts, or logs could be floated, through its course, upon its surface, until such obstructions had been removed; that, perhaps, many such streams, when the forests about them were first opened, would need such clearing out before they could be profitably used; and that it was a question for the jury to determine, from the evidence in the case, whether or not the stream was inherently and in its nature capable of being used for the purposes of commerce, for the floating of vessels, boats, rafts, or logs. (*Supra,* p. 556.)

The controversy in the case of Pearson *v.* Rolfe, 76 Me. 380, arose from a conflict between log-owners and mill-owners as to their respective rights in the use of the water at certain falls in the Penobscot River in the town of Old Town. Pearson represents mill-owners, Rolfe represents log-owners. Pearson has mill structures upon his privilege, with such appendages as dams, sluices, and booms. Rolfe had a quantity of logs in the river which he was unable to drive over the dam at Pearson's mills, *unless Pearson would shut down his mill-gates,* thereby suspending his own business of manufacturing, until water enough should accumulate in his mill-pond to float the logs over. This Pearson refused to do, basing his refusal upon the allegation that the driftway in the dam, without shutting down his working gates, afforded all the facility for floating logs by his mills that existed in the river at that place in its natural state,—as much as there would be, provided his mills and all of his structures were entirely out of the way. Rolfe contends that the facts were otherwise, but further contends that Pearson, even if he represents the facts truly, having it within his power to furnish more water than the natural facility and flow, was under an obligation from his situation to do so.

The counsel for Rolfe contended that the doctrine of *reasonable use* applied; and that, if the river in its natural condition would not furnish a sufficient flow, Rolfe was entitled to the use of the river in its changed condition for his purposes. We think this position cannot be maintained. Our idea is that the doctrine of reasonable use does not apply when the river is *not* naturally floatable; but does apply when it *is* naturally floatable or log-navigable, when both parties can use the natural flow and desire to use it at the same time. We are well satisfied that, whenever logs cannot be driven over a particular portion of a fresh water river such as the Penobscot, above the flow and ebb of the tide, while in its natural condition, such portion of the river is not at such time navigable or floatable, and that the use of the water at such time, and place, belongs exclusively to the riparian proprietor, so far as he needs the same for his own purposes.

The Penobscot River at the place in question, as before intimated, was floatable only,—floatable, because capable of valuable use in bearing the products of the forests to markets or mills. A floatable stream is the least important of the classes of streams called navigable. Rolfe had the right to use the river so far as it was a floatable river, in such parts or places and at such times as it was floatable. He had the right to avail himself of its navigable capacity for floating logs. But only so far as it was navigable or floatable in its *natural condition.* It is the natural condition of a stream which determines its character for public use, and it must be its navigable properties in a natural condition unaided by artificial means or devices. It is well settled in this state and elsewhere, that, if a stream is not susceptible of valuable use to the public for floatable purposes, without erections for raising a head, it cannot legally be deemed a public stream, even though it might be easily converted into a floatable stream by artificial contrivances. Wadsworth *v.* Smith, 11 Me. 278; Brown *v.* Chadbourne, 31 Me. 9; Treat *v.* Lord, 42 Me. 552; Nuis. (2d ed.) 463, and cases.

The log driver takes the waters as they run, and the bed over which they flow as nature provides. Nor has any person the right, unless upon his own land, or under legislative grant, to remove natural obstructions from the bed of a river in order to improve its navigation. This is clear from the same authorities.

On the other hand, what rights have the adjudged cases accorded to the riparian proprietor in merely floatable and non-tidal streams? It is settled in this state that he owns the bed of the river to the middle of the stream. He owns all the rocks and natural barriers in it. He owns all but the public right of passage. The right of passage does not include any right to meddle with the rocks or soil in the bed of the river. If rocks are taken, the owner may sue in trespass for the act, or may replevy them from the wrongdoer. (Pearson *v.* Rolfe, 76 Me. 383-386.)

Let it be borne in mind that the complaint against Pearson is not that he kept back the natural flow, but that he refused to keep it back,—that he would not shut down his gates and suspend his business in order to keep it back. The demand was that he should suspend his own sawing and shut down his mill-gates until the accumulation of water in the mill pond might be enough to create a navigable flow through the public passage. (*Supra*, p. 387.)

Held: A mill-owner upon a floatable river is not under legal obligation to provide a public way, for the passage of logs over his dam, better than would be afforded by the natural condition of the river unobstructed by his mills. The right of passage is to the natural flow of the river or its equivalent.

Held: A mill-owner is not under legal obligation to furnish any public passage for logs over his dam or through his mills at a time when the river at such place in its natural condition, does not contain water enough to be floatable if unobstructed by mills, although the river is generally of a floatable character.

Held: Whenever a river, with mills upon it, is floatable, and the mill-owner and those who want to float logs past the mills are desirous of using the water at the same time, all parties are entitled to reasonable use of the common boom; the right of passage is the superior, but not an usurping, excessive, or exclusive, right; the law authorizing mills puts some incumbrance upon the right of passage. (*Supra*, p. 380.)

The reasonableness of the use depends upon the nature and size of the stream, the business or purpose to which it is made subservient, and on the ever-varying circumstances of each particular case. Each case must stand upon its own facts, and can be a guide in other cases only as it may illustrate the application of general principles. (*Supra*, p. 390.)

MEASUREMENT OF WATER-POWER.

Grants and reservations relating to water and water-power are various in their nature and effect. Some refer to a certain extent of water-power sufficient for the propulsion of a specific mill or machinery: Warner *v.* Cushman, 82 Me. 168; Hammond *v.* Woodman, 41 Me. 177; Covel *v.* Hart, 56 Me. 518, 522; Elliott *v.* Sheperd, 25 Me. 371; Ashley *v.* Pease, 18 Pickering, 268. Some to a quantity of water to be restricted to a specific purpose: Deshon *v.* Porter, 38 Me. 293. Others to "such quantity of water as the grantor or his predecessor have been accustomed to use:" Avon Man'f'g Co. *v.* Andrews, 30 Conn. 476. Still others, to such quantity of water as will flow through a gate of specific dimensions under a specific head of water: Bardwell *v.* Ames, 22 Pickering, 333; Tourtellot *v.* Phelps, 4 Gray, 373. Head is a well-known material factor in determining the quantity of water which will pass through a given aperture in a given time. Canal Co. *v.* Hill, 15 Wallace, 94, 102. (Gray *v.* Saco Water Power Co., 85 Me. 528.)

The United States Supreme Court has held as follows:

A grant of a right to draw from a canal so much water as will pass through an aperture of given size and given position in the side of the canal is substantially a grant of a right to take a certain quantity of water in bulk or weight. What that quantity is may be ascertained from the character and depth of the canal, the circumstances under which the water is to be drawn, and the state of things existing at the time the grant is made.

The grantee will be entitled to draw this quantity even though it may be neceessary to have the aperture enlarged if it can be done without injury to the grantor. (Canal Co. *v.* Hill, 15 Wallace, 94.)

Where a grantor, owning all the water-power on both sides of a stream, conveyed the saw mill thereon, "with the right of use of all water not necessary in driving the wheel, or its equal, now used to carry the machinery in the shingle mill,—meaning to convey a right to all the surplus of water not required for the shingle mill or other equal machinery,"—and it appeared that, at the time of the conveyance, the shingle mill contained various other machinery besides the shingle machine:

Held, that the parties thereby fixed the measure of the water not conveyed, and that its use was not confined to the specific purpose of driving the shingle machine.

Held, also, that the owner of the shingle mill might lawfully put into it a board saw, and use the same, provided the wheel used for propelling it consumed no more water than was previously used, even if the owner of the saw mill thereby lost all his patrons. (Warner *v.* Cushman, 82 Me. 168.)

A reservation of water necessary and sufficient to carry two run of mill stones.

Held, a reservation of a quantity sufficient for the purpose with the machinery in actual or contemplated use at the mill at the time the reservation was made, and not restricted then or afterwards to such quantity as with improved machinery and facilities would perform the same work.

Held, also, to reserve an absolute right to the use of the quantity of water named; and to be a reservation of a fixed measure of power to be used for any purpose, and not confined to the grist mill. (Blake *v.* Madigan, 65 Me. 522.)

A grant by the owner of a dam of the right to use five hundred square inches of water, for the purpose of creating power, as a substitute for a prior grant, in which the head was not mentioned, carried by implication the right to draw the water from the dam, at the head of which water was ordinarily taken under the prior grant. (Oakland Woolen Co. *v.* Union Gas & Electric Co., 101 Me. 199.)

The Franklin Company, the then owner of a dam lawfully maintained across the Androscoggin River at Lewiston for raising a head of water for generating power, granted by an instrument of indenture to the City of Lewiston the right to draw from its dam "water to the extent of 600 horse-power for the purpose of pumping," etc. (the head of water being fixed at not less than 25 ft. nor more than 30 ft.). After full consideration of the subject matter of the grant, the situation, the history and character of the negotiations, and all the language used by the parties in the instrument finally signed by them as defining their rights and obligations, thereunder, *held:*

a. The grant is not of water-power, but only of water for power, and the city is entitled, not to a certain quantity of power, but only to draw a certain fixed quantity of water from which to extract as much power as it may by its own agents and appliances.

b. From the evidence and the admissions of the plaintiff it appears that the phrase "to the extent of 600 horse-power" means in its connection, efficient, practical horse-power upon a well-understood and recognized basis of seventy-five per cent. of efficiency, and hence the city is entitled to draw for pumping purposes water to the extent of 800 nominal or theoretical horse-power and no more. (Union Water Power Co. *v.* Lewiston, 101 Me. 565.)

c. It appears from the evidence that the city has been drawing water in excess of its right under the grant, and that the value of such excess drawn for six years next before the date of the writ is $3468.55 at the rate of $12.50 per H. P. (Union Water Power Co. *v.* Lewiston, 101 Me. 564, 565).

Sometime in the 80's an interesting case was tried in one of the Maine lower courts, known as the "Brunswick Water Case." Mr. J. Herbert Shedd testified as to the value of a "saw," a term used in the early days to designate the horse-power required to operate the old undershot and flutter wheels used in the saw mills on the Androscoggin River at Brunswick. His results, based on several different methods of computations, gave one "saw" equal to 120 nominal horse-power, or, "that about 120 horse-power of water might be taken to be the measure of water which was used anciently to run one saw." This was not effective horse-power based on the efficiency of the wheels, but theoretical, based on the discharge and head. He stated that the old flutter wheels had an efficiency of from one-sixth to one-eighth of the total power, and that the actual power to run an old-fashioned saw was about 15 to 20 horse-power.

Improvement of Marshes, Meadows, and Swamps.

The provisions of Revised Statutes entitled, "Improvement of Marshes, Meadows, and Swamps" (Chap. 26, Sec. 42-70), are important as bearing on developments of water courses in this state although of somewhat lesser importance than the Mill Act previously described. The first five sections read as follows:

Sec. 42. When any meadow, swamp, marsh, beach or other low land is held by several proprietors, and it becomes necessary or useful to drain or flow the same, or to remove obstructions in rivers or streams leading therefrom, such improvements may be effected under the direction of commissioners in the manner hereinafter provided.

Sec. 43. Such proprietors, or a majority of them in interest, may apply by petition to the Supreme Judicial Court sitting in the county where the lands or any part of them lie, setting forth the proposed improvements and the reasons therefor, and the court shall cause notice of the petition to be given in such manner as it may judge proper, to any proprietors who have not joined in the petition, that they may appear and answer thereto.

Sec. 44. If upon hearing, it appears that the proposed improvements will be for the general advantage of the proprietors, the court may appoint three suitable persons as commissioners, who shall be sworn to the faithful discharge of their duties; view the premises, notify parties concerned, hear them as to the best manner of making the improvements, and prescribe the measures to be adopted for that purpose.

Sec. 45. They shall, according to the tenor of the petition and order of court, cause dams or dikes to be erected on the premises, at such places and in such manner as they direct; may order the land to be flowed thereby for such periods of each year as they deem most beneficial; and cause ditches to be opened on the premises, and obstructions in any rivers or streams leading therefrom to be removed; and they shall meet from time to time, as may be necessary, to cause the works to be completed according to their directions.

Sec. 46. They may employ suitable persons to erect the dams or dikes, or to perform the other work, under their direction, for such reasonable wages as they may agree upon; unless the proprietors do the same in such time and manner as the commissioners direct.

Organization of Corporations.

The procedure for the organization of corporations in this State is in accordance with the provisions of law as follows: Rev. Stats., Chap. 47; Pub. Laws, 1903, Chap. 235; Pub. Laws, 1905, Chaps. 85, 162, 171, 172; Pub. Laws, 1907, Chaps. 16, 71, 86, 109, 154, 172, 185.

Section 2 of Chapter 47 of the Revised Statutes has an important bearing on proposed legislation for the creation of drainage districts, and the state supervision of the construction of dams and control of reservoirs. The section in question is as follows:

Acts of incorporation, passed since March seventeen, eighteen hundred and thirty-one, may be amended, altered or repealed by the legislature, as if express provision therefor were made in them, unless they contain an express limitation; but this section shall not deprive the courts of any power which they have at common law over a corporation or its officers.

This State has adopted the policy of Maine's water powers for the use only of Maine's industries and has incorporated this policy in Statute law as shown by the act to prohibit corporations from transmitting power beyond the confines of the State, and which reads as follows:

Sec. 1. No corporation, unless expressly authorized so to do by special act of legislation, shall transmit or convey beyond the confines of the state for the purpose of furnishing power, heat or light, any electric current generated directly or indirectly by any water power in this state; nor sell or furnish, directly or indirectly, to any person, firm or corporation, any electric current so generated to be transmitted or conveyed beyond the confines of the state for any of such purposes. Nothing in this act, however, shall prevent any railroad corporation doing business in this state from transmitting electric current, however generated, beyond the confines of the state for the purpose of operating its road between some point in this state and any point or points beyond its confines.

Sec. 2. Any corporation violating any of the provisions of this act may be dissolved and its franchises be forfeited to the state upon proper proceedings to be instituted by the attorney general whenever directed by the governor.

Sec. 3. This act shall not apply to any corporation now engaged in conveying or transmitting electric current beyond the confines of the state or chartered or empowered so to do, nor affect or impair any existing contracts for the transmission of electric current beyond the confines of the state. (Public Laws, 1909, Ch. 244.)

State Supervision of Dams.

Section 43 of the Mill Act (Rev. Stats., 94) provides as follows:

The governor, with the advice and consent of the council, shall annually appoint a competent and practical engineer, a citizen of the state, who shall hold said office until his successor is appointed and qualified, and who shall upon petition of ten resident taxpayers of any town or several towns, the selectmen or assessors of any town, or the county commissioners of any county, inspect any dam or reservoir located in such town or county, erected for the saving of water for manufacturing or other uses and after personal examination and hearing the testimony of witnesses summoned for the purpose, he shall forthwith report to the governor his opinion of the safety and sufficiency thereof.

The paragraph above quoted was adopted in 1875. The next section provides that, in case the dam is reported as unsafe, the owners shall immediately repair same and in default thereof may be enjoined from the use of the dam, and the waters behind the dam may be discharged therefrom. When the dam is reported as safe the expenses of inspection shall be paid by the state, and when adjudged unsafe and insufficient, by the owner or occupant of the dam.

Since 1883 to the present time, nine separate accounts, totaling $260.57, have been paid by the state under the above provisions of law, and it is safe to assume that a less number of inspections, if any, have entered the decree of unsafe and insufficient.

State Water Storage Commission.

The act creating the State Water Storage Commission was passed in 1909, Chapter 212, Section 4 providing as follows:

Every person, firm or corporation before commencing the erection of a dam for the purpose of developing any water-power in this state, or the creation or improvement of a water-storage basin or reservoir for the purpose of controlling the waters of any of the lakes or rivers of the state, shall file with said commission for its information and use copies of plans for the construction of any such dam or storage basin or reservoir and a statement giving the location, height and nature of the proposed dam and appurtenant structures, and the estimated power to be developed thereby, and in case a dam is to be constructed solely for the purpose of water storage and not for the development of a water power at its site, plans and statements shall be filed with the commission showing the extent of the land to be flowed, the estimated number of cubic feet of water that may be stored and the estimated effect upon the flow of the stream or streams to be affected thereby. Every person, firm or corporation shall, as soon as practicable, after this act takes effect, file similar plans, reports and estimates in relation to any dam or storage basin or reservoir then in the process of construction by them.

There are no mandatory provisions compelling the filing of plans, and there is absolutely no mention of a state examination of the sufficiency of the design or provision for inspection during construction.

Cases Cited.

WATER RESOURCES.

ST. JOHN RIVER BASIN.

Stream Flow.

Only two gaging stations were maintained in this basin during 1912, both on the main St. John River, one at Fort Kent and the other at Van Buren.

ST. JOHN RIVER AT FORT KENT.

This station, which is located at the foot bridge that crosses the St. John near Fort Kent postoffice, a short distance above the confluence of Fish River with the St. John, was established October 13, 1905. It is about 15 miles below the mouth of the St. Francis River and about 50 miles above Grand Falls, Canada, an important undeveloped power.

Monthly discharge of St. John River at Fort Kent, Maine.

[Drainage area, 4880 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	....	....	1,400	0.287	0.33
February	....	....	900	.184	.20
March	....	....	1,600	.328	.38
April	62,700	....	16,500	3.38	3.77
May	51,600	24,400	39,900	8.18	9.43
June	59,400	5,490	23,000	4.71	5.26
July	4,760	1,390	2,260	.463	.53
August	36,600	1,740	9,550	1.96	2.26
September	7,330	1,970	3,180	.652	.73
October	25,900	3,140	7,560	1.55	1.79
November	38,000	7,170	14,800	3.03	3.38
December	6,690	4,900	5,520	1.13	1.30
The year	62,700	....	10,500	2.15	29.36

Note.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

ST. JOHN RIVER AT VAN BUREN.

This station is located at the International Bridge across St. John River 14 miles above Grand Falls, N. B. The gage rod was first placed on the pier of the saw dust carrier at Hammonds Mill. At the time of the establishment of the regular station in 1910 the relationship of the two gages was found and the old records of gage height interpreted into daily discharge. The monthly estimates of discharge for the entire period are given below.

Monthly discharge of St. John River at Van Buren, Maine.

[DRAINAGE AREA, 8270 SQUARE MILES]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1908					
May 4-31	108,000	57,600	90,200	10.90	11.35
June	82,900	20,900	38,600	4.67	5.21
July	17,600	6,740	11,500	1.39	1.60
August	12,400	5,330	7,630	.923	1.06
1909					
May 10-31	134,000	43,200	89,500	10.80	8.84
June	40,300	11,300	19,300	2.33	2.60
July	22,300	11,000	15,900	1.92	2.21
August	22,000	5,100	9,820	1.19	1,37
September	66,500	8,720	18,000	2.18	2.43
October	71,600	12,400	23,400	2.83	3.26
November	19,600	10,800	13,900	1.68	1.87
December	18,200	12,100	15,000	1.81	.81
1910					
May 7-31	59,700	16,800	31,200	3.77	3.50
June	32,200	7,600	18,500	2.24	2.50
July	7,110	2,270	4,890	.591	.68
August	8,100	1,910	4,690	.567	.65
September	8,340	1,570	3,570	.432	.48
October	7,110	1,250	3,430	.415	.48
November	13,900	4,330	7,050	.852	.95
December	5,220	875	1,800	.218	.25
1911					
January	1,610	1,010	1,340	0.162	0.19
February	1,010	1,010	1,010	.122	.13
March	1,830	920	1,070	.129	.15
April	72,800	1,830	12,900	1.56	1.74
May	134,000	17,600	53,500	6.47	7.46
June	25,200	6,020	13,200	1.60	1.78
July	7,970	3,370	5,410	.654	.75
August	18,200	2,180	5,840	.706	.81
September	7,480	2,180	3,880	.469	.52
October	5,560	2,180	3,570	.432	.50
November	6,260	2,300	3,500	.423	.47
December	....	....	2,700	.326	.38
The year	134,000	920	9,060	1.10	14.88
1912					
May 6-31	99,200	46,200	72,600	8.78	8.49
June	103,000	15,800	44,600	5.39	6.01
July	14,900	4,780	7,670	.927	1.07
August	52,600	5,230	15,600	1.89	2.18
September	10,300	4,900	6,580	.796	.89
October	44,000	5,920	11,900	1.44	1.66
November	58,200	15,300	25,500	3.08	3.44
December	....	13,200	18,200	2.20	2.54

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

ST. CROIX RIVER BASIN.

Description.

St. Croix River is formed by two principal branches: the East Branch, also known as the Upper St. Croix, is the outlet of the Schoodic Lake system, including Grand and Spednic lakes; the West Branch is formed by the Grand Lake system, including Sysladobsis, Grand and Big lakes. The St. Croix, including the East Branch, forms nearly half of the eastern boundary of Maine, and its total length is about 100 miles. Tributaries are small and unimportant. The total drainage area is 1473 square miles, the East or principal branch having 644 square miles and the West Branch 674 square miles at their junction. The river discharges into Passamaquoddy Bay.

The basin is in general lower than that of any other of the larger streams of the State flowing into the Atlantic, its headwaters having an elevation of about 540 feet.

The St. Croix Flowage Case.

The St. Croix Paper Co. has in operation a paper mill at Woodland on the St. Croix River. Early in 1912 the company started the construction of a concrete dam at what is known as Grand Falls about 7 miles above Woodland and 1-2 mile below the junction of the East and West branches of the St. Croix River. The dam is to be of the Ambursen type 1100 feet long and with a maximum height of about 38 feet above the bed of the river. On the American side a hydro-electric plant will be erected with a design for an ultimate total wheel capacity of 12,600 horsepower. The head will vary from 44 to 50 feet. The horsepower at average low water is estimated as 4000. Two pairs of 54 inch Hercules wheels will be installed with provision for a future unit of 1 pair of 54 inch wheels. The power generated will be transmitted and used in the Woodland mill.

The dam will back water up the East Branch and up the West Branch to the town of Princeton at the outlet of Leweys Lake creating a lake of about 12 square miles in area. A portion of the land to be thus flooded is on Indian Township and is State land held in trust by the State of Maine for the benefit of the Passamaquoddy tribe of Indians, and entirely subject to the control of the Governor and Council as defined by Chapter 13, Section 42 of the Revised Statutes of Maine.

In November 1912 the Executive Council instructed the Chief Engineer of the State Water Storage Commission to make an engineering investigation of the case in the field.

TIMBER VALUATION.

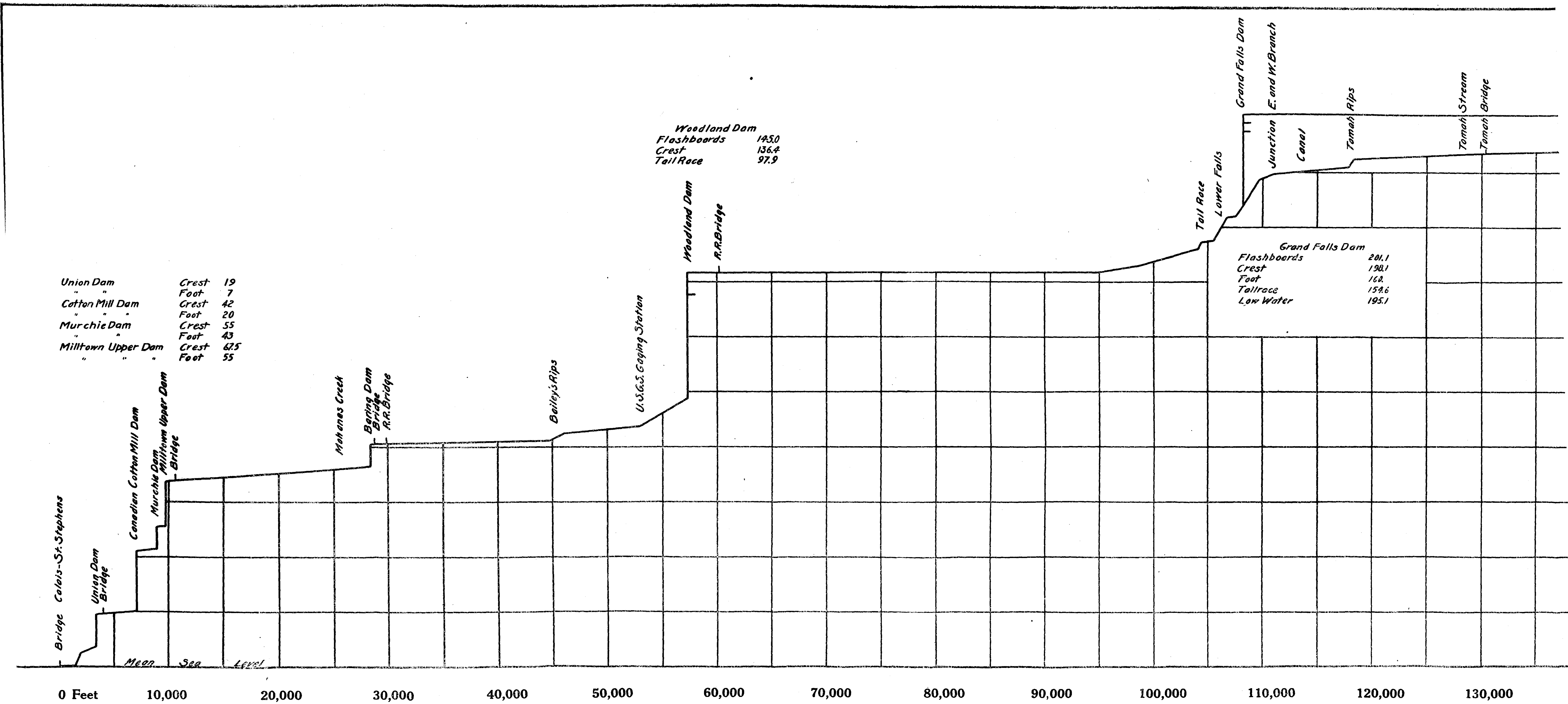
The land to be flowed on Indian Township is of unequal value, some being swampy and subject to the annual overflow of the St. Croix River, while other sections are covered by a thick and heavy growth of valuable timber. The Executive Council appointed a special commission to estimate and appraise the value of the timber that would be thus destroyed. The estimate is as follows:

266,000 feet Pine logs at $7 per M.	$1,862 00
30,000 " Hemlock logs at $4 per M.	120 00
2,500 cords Spruce pulp wood at $3 per cord	7,500 00
1,500 " Fur pulp wood at $2 per cord	3,000 00
100 " Hard wood at $1 per cord	100 00
Land and small growth after being cut	1,000 00
Total	$13,582 00

TERMS OF SETTLEMENT.

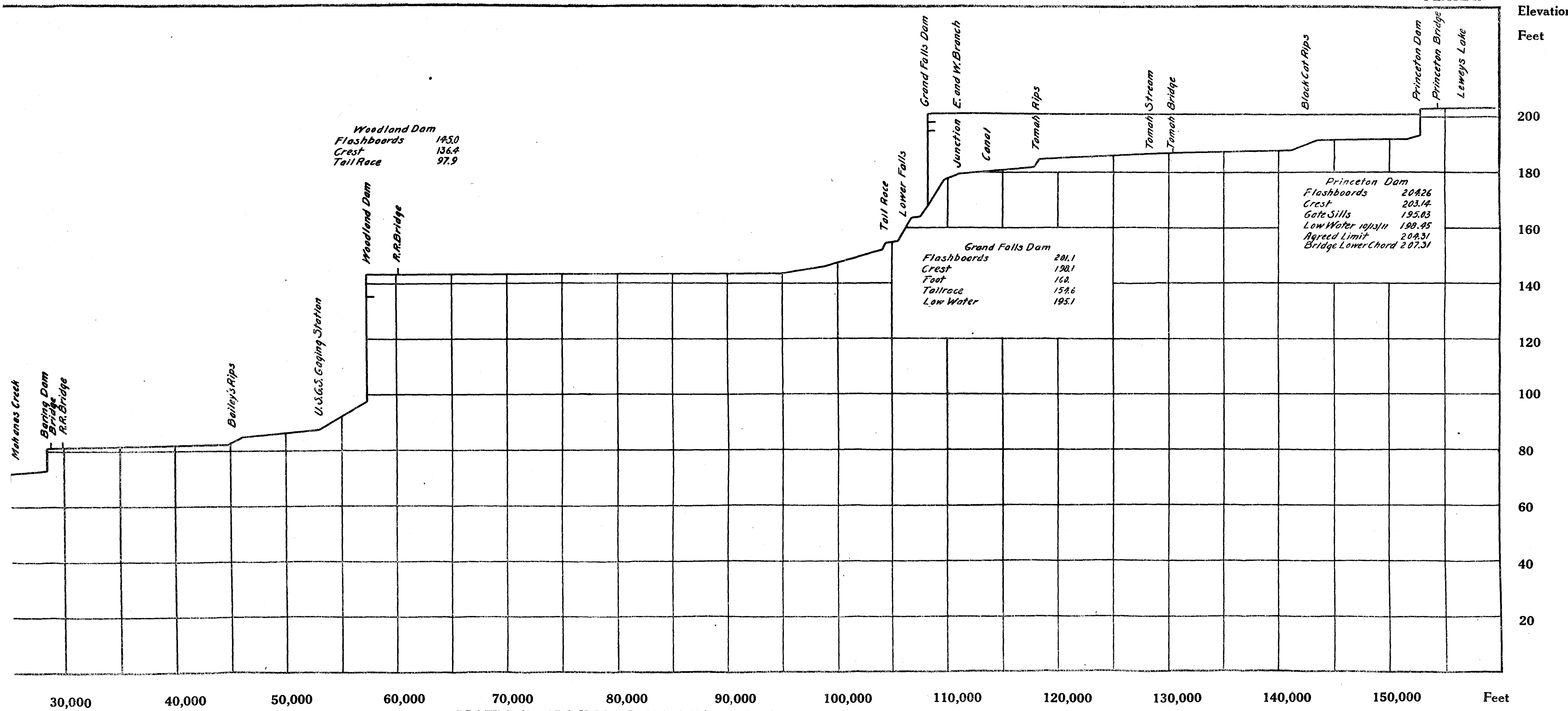
After numerous conferences between a committee of the Executive Council, representatives of the St. Croix Paper Co. and inhabitants of the town of Princeton, an agreement was reached in March, 1913. The deed covering the agreement contained the following provisions:

First: State of Maine grants the St. Croix Paper Co. the rights of flowage on 1768 acres more or less, on Indian Township and the right to cut the timber on same as well as on certain so called islands of 168 acres more or less, within the flowage tract.



PROFILE ST. CROIX RIVER AND WEST BRANCH

PLATE II



PROFILE ST. CROIX RIVER AND WEST BRANCH

Second: The St. Croix Paper Co. is to so construct its Grand Falls dam that the back water from same shall not exceed an elevation of 204.31 feet (State Water Storage Commission datum), equivalent to 199.21 feet (M. C. R. R. datum) at a point just below the highway bridge at Princeton, Maine.

Third: The St. Croix Paper Co. is to reconstruct the present Princeton dam on a design that shall provide that the maximum flood height shall not exceed that specified above, and further, that the design shall not permit the water above the dam to be lowered below low water mark.

Fourth: That the design for both dams shall be made subject to the approval of the Chief Engineer of the Maine State Water Storage Commission or his successor in office before the dams are completed. These designs are to be on the basis of a possible flood run-off of 28 cubic feet per second per square mile on the drainage area of 1320 square miles at Grand Falls.

Fifth: That the St. Croix Paper Co. shall construct and place suitable monuments under the supervision and subject to the approval of said Chief Engineer, indicating the high water and low water levels as determined under this agreement.

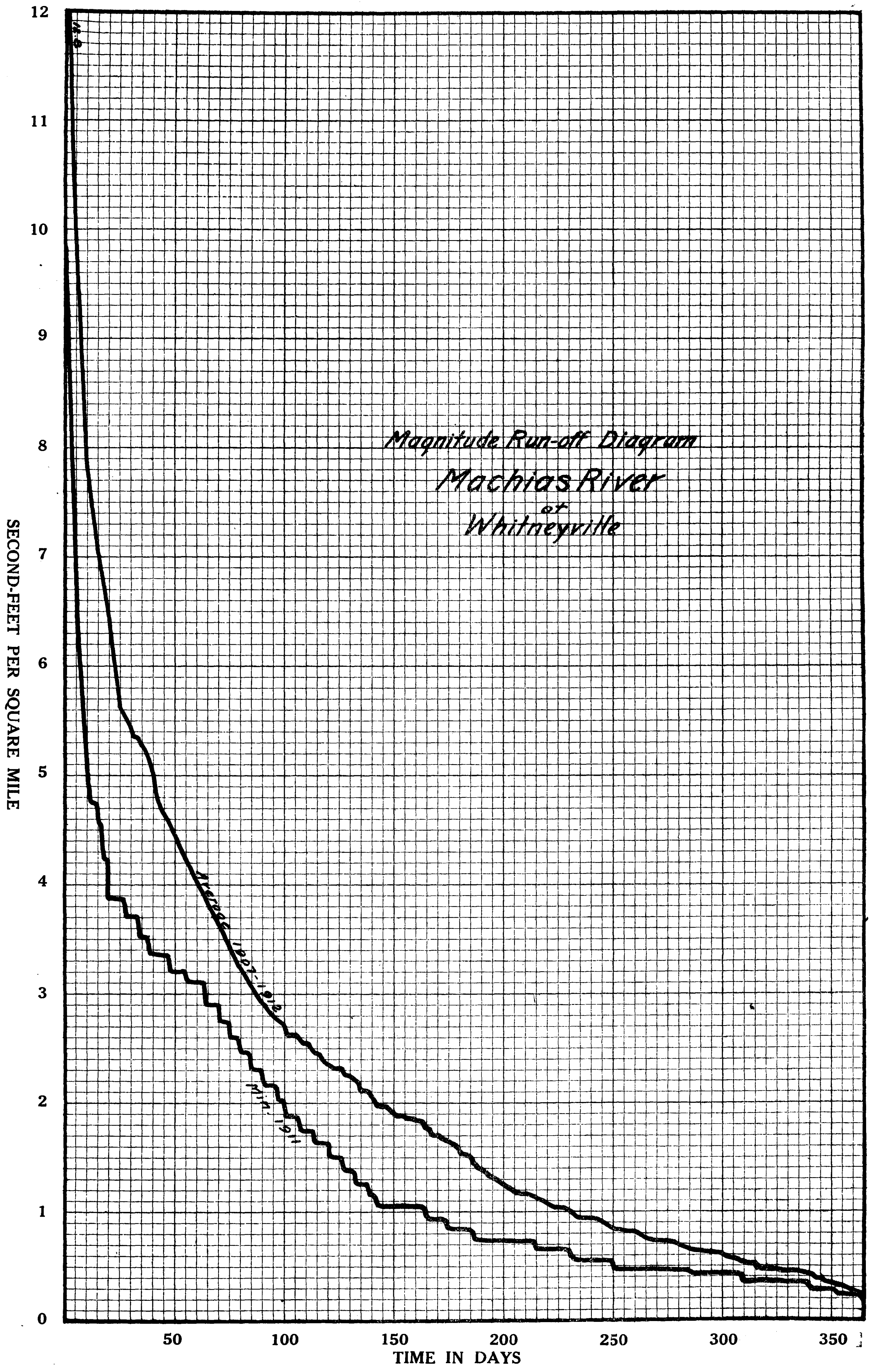
PROFILE OF RIVER.

In connection with the work outlined above, a profile of St. Croix River has been developed from tide water at Calais to Leweys Lake at Princeton. Distances were obtained from the maps of the main river of the U. S. Coast and Geodetic Survey and of the West Branch from the property map of the St. Croix Paper Co. as filed in this office, surveyed by Mr. E. Lisherness. The level lines from Calais to Woodland dam were run by Mr. C. F. Pray, civil engineer of Calais. From this latter point to Princeton the levels were run by engineers of this office. Plate II is a profile of the river as thus developed.

STREAM FLOW.

The gaging station on the St. Croix River near Woodland was discontinued in December 1911 on account of the increase of inaccuracy of the record. Log jams occurred on an island a short distance below the station causing back water at the gage which could not be intelligently interpreted without a large number of discharge measurements, which the appropriations did not allow. It was found that the bed of the river was gradually filling up from a deposit of fine pulp from the mill above.

The station on the West Branch at Baileyville was discontinued to October, 1912, as the observer left the vicinity. The station will be flooded out during 1913 by the construction of the concrete dam at Grand Falls 1-2 mile below the junction of the two branches. The discharge measurements covered quite a range in gage height but as some were made during back water caused by log jams, it is considered that a sufficiently accurate rating curve cannot be constructed on which to base computations of daily discharge.


Magnitude Run-off Diagram
Machias River
at
Whitneyville
Average 1907-1912
Min. 1911
SECOND-FEET PER SQUARE MILE
TIME IN DAYS
0
1
2
3
4
5
6
7
8
9
10
11
12
50
100
150
200
250
300
350

MACHIAS RIVER BASIN.

STREAM FLOW.

MACHIAS RIVER AT WHITNEYVILLE.

This station was established October 17, 1903, and was originally located at the bridge of the Washington County Railroad, near Whitneyville, about 8 miles above the mouth of the river. On October 3, 1905, the gage was transferred to the wooden highway bridge, about one-half a mile up stream from the railroad bridge.

Plate 3 is the run-off magnitude diagram of Machias River computed from the discharge records at the Whitneyville gaging station. The use of the curve is described on pages 27-30 of this report. The minimum curve is for the year 1911 and the average curve for the years 1907-1912, inclusive or the period for which complete yearly estimates of discharge are available. The diagram for this river is applicable for coastal streams with similar types of topography and forest conditions and where the precipitation is approximately the same.

Monthly discharge of Machias River at Whitneyville, Maine.

[DRAINAGE AREA, 465 SQUARE MILES]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	1,210	433	737	1.58	1.82
February	1,880	387	765	1.65	1.78
March	....	698	1,790	3.85	4.44
April	3,880	1,000	1,940	4.17	4.65
May	4,800	587	1,740	3.74	4.31
June	5,680	191	1,840	3.96	4.42
July	698	132	319	.686	.79
August	642	300	403	.867	1.00
September	482	260	328	.705	.79
October	6,340	224	1,030	2.22	2.56
November	4,690	875	1,560	3.35	3.74
December	2,290	534	1,130	2.43	2.80
The year	6,340	132	1,130	2.43	33.10

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

UNION RIVER BASIN.

STREAM FLOW.

Three gaging stations were maintained in this basin during 1912, namely Union River at Amherst, Green Lake Stream at Lakewood, and Branch Lake Stream near Ellsworth. Run-off data at the two former stations are given below. Owing to the probable change of the bed of the river in Branch Lake Outlet, it has not been feasible to make estimates of daily discharge.

UNION RIVER AT AMHERST.

This station was established July 25, 1909 and is located at the highway bridge 3-4 mile west of Amherst Post Office on the road to Bangor, and about a mile below the highway bridge at the old Tannery dam. Prior to 1912 discharge measurements were not sufficient on which to base a rating curve. Such a curve has now been developed, however, and monthly estimates for the entire period are given below.

Monthly discharge of Union River at Amherst, Maine.

[DRAINAGE AREA, 140 SQUARE MILES]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1909.					
August	36	15	21.5	.154	.18
September	2,110	14	145	1.04	1.16
October	1,150	156	373	2.66	3.07
November	931	182	325	2.32	2.59
December	628	....	299	2.14	2.47
The year	....	....	....	....	....

Monthly discharge of Union River at Amherst, Maine—Concluded.

[Drainage area 140 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1910					
January			200	1.43	1.65
February			450	3.21	3.34
March		321	563	4.02	4.64
April	966	284	570	4.07	4.54
May	753	128	312	2.23	2.57
June	187	103	145	1.04	1.16
July	175	38	75.0	.536	.62
August	222	34	87.4	.624	.72
September	55	23	37.7	.269	.30
October	57	22	33.0	.236	.27
November	80	39	55.3	.395	.44
December			79.5	.568	.65
The year			216	1.54	20.90
1911					
January			100	0.714	0.82
February			40	.286	.30
March			120	.857	.99
April			904	6.46	7.21
May	869	173	357	2.55	2.94
June	369	83	175	1.25	1.40
July	96	37	55.2	.394	.45
August	143	39	68.1	.486	.56
September	72	40	58.2	.416	.46
October	83	27	46.2	.330	.38
November	319	31	130	.929	1.04
December			404	2.89	3.33
The year			205	1.46	19.88
1912					
January			400	2.86	3.30
February			220	1.57	1.69
March			650	4.64	5.35
April	1,680		867	6.19	6.91
May	862	304	478	3.41	3.93
June	1,070	100	448	3.20	3.57
July	119	35	64.7	.462	.53
August	126	21	78.0	.557	.64
September	96	14	68.2	.487	.54
October	651	72	200	1.43	1.65
November	948	282	535	3.82	4.26
December	876	226	466	3.33	3.84
The year	1,680	14	373	2.66	36.21

Note.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1909, 1910, 1911, and 1912, will be published in Water Supply Paper No. 321.

GREEN LAKE STREAM AT LAKEWOOD.

This gaging station was established July 2, 1909, and is located on the highway bridge across Green Lake Stream about 1-4 mile down the stream from the dam at the outlet of Green Lake.

Monthly discharge of Green Lake Stream at Lakewood, Maine.

[DRAINAGE AREA, 47 SQUARE MILES]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	....	....	20	0.426	0.49
February	....	....	30	.638	.69
March	....	....	120	2.55	2.94
April	376	....	263	5.60	6.25
May	268	141	163	3.47	4.00
June	248	77	160	3.40	3.79
July	77	49	64.9	1.38	1.59
August	62	59	61.2	1.30	1.50
September	146	59	117	2.49	2.78
October	146	38	79.5	1.69	1.95
November	38	*19	23.0	.489	.55
December	70	26	50.2	1.07	1.23
The year	376	....	95.8	2.04	27.76

* Flow simply leakage through dam.

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

PENOBSCOT RIVER BASIN.

STREAM FLOW.

Records are available for 1912 from the following station in this basin:

West Branch Penobscot River, Millinocket.
Penobscot River, West Enfield.
East Branch Penobscot River, Grindstone.
Mattawamkeag River, Mattawamkeag.
Piscataquis River, Foxcroft.
Kenduskeag Stream near Bangor.

WEST BRANCH PENOBSCOT RIVER AT MILLINOCKET.

The discharge at this station has been furnished since 1901 by the engineers of the Great Northern Paper Co. For the year 1912 there are only available at the present time, the monthly average and the computations based thereon.

Monthly discharge of West Branch Penobscot River at Millinocket, Me.

[DRAINAGE AREA, 1880 SQUARE MILES]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	....	....	2,060	1.10	1.27
February	....	....	2,040	1.09	1.18
March	....	....	2,030	1.08	1.24
April	....	....	2,300	1.22	1.36
May	....	....	6,630	3.53	4.07
June	....	....	7,510	4.00	4.46
July	....	....	3,400	1.81	2.09
August	....	....	2,390	1.27	1.46
September	....	....	2,210	1.18	1.32
October	....	....	2,240	1.19	1.37
November	....	....	6,340	3.37	3.76
December	....	....	3,270	1.74	2.01
The year	....	....	3,520	1.88	25.59

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

PENOBSCOT RIVER AT WEST ENFIELD.

This station was established November 5, 1901 and is located on the steel highway bridge about 1000 feet below the mouth of Piscataquis River.

Plate 4 is the magnitude run-off diagram for the West Enfield station. The use of the curve is described on pages 27-30 of this report. The minimum curve is for the year 1911 and the average curve for the years 1907-1912, inclusive, or the period for which complete yearly estimates of discharge are available. The diagram for this river is applicable for rivers of large drainage area and especially for various possible water power privileges on the main Penobscot River from Medway to Bangor.

Monthly discharge of Penobscot River at West Enfield, Maine.

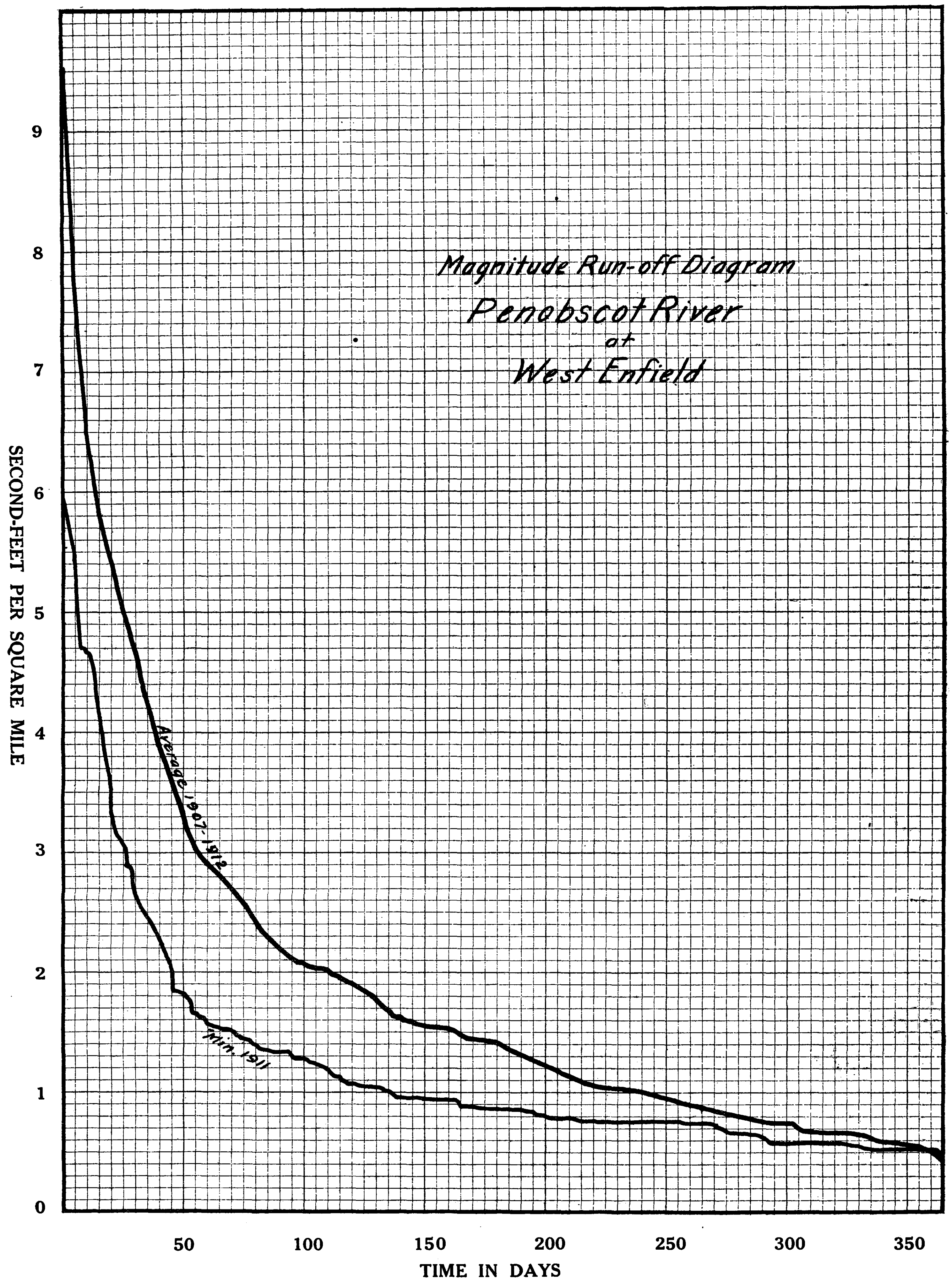
[DRAINAGE AREA, 6600 SQUARE MILES]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	....	....	8,400	1.27	1.46
February	....	....	6,800	1.03	1.11
March	....	....	12,000	1.82	2.10
April	59,200	....	32,900	4.98	5.56
May	45,100	20,600	26,500	4.02	4.64
June	56,000	10,700	25,100	3.80	4.24
July	9,720	5,300	7,680	1.16	1.34
August	20,200	5,540	11,200	1.70	1.96
September	10,300	3,950	6,640	1.01	1.13
October	49,500	5,770	12,800	1.94	2.24
November	63,200	13,500	25,500	3.86	4.31
December	17,000	6,650	11,300	1.71	1.97
The year	63,200	....	15,500	2.35	32.06

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will pe published in Water Supply Paper No. 321.

EAST BRANCH PENOBSCOT RIVER AT GRINDSTONE.

The gaging station was established October 23, 1902, at the Bangor & Aroostook Railroad bridge, one-half mile south of the railroad station at Grindstone. It is about 8 miles above the junction of the East Branch of the Penobscot with the Penobscot at Medway. No water power is used on the river


Magnitude Run-off Diagram
Penobscot River
at
West Enfield
Average 1907-1912
Min. 1911
SECOND-FEET PER SQUARE MILE
TIME IN DAYS
0
1
2
3
4
5
6
7
8
9
50
100
150
200
250
300
350

above the station, but dams are maintained at the outlet of several of the lakes and ponds near the source of the river, and the impounded water is used for log driving.

Monthly discharge of East Br. Penobscot River at Grindstone, Maine.

[DRAINAGE AREA, 1100 SQUARE MILES]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	....	....	750	.682	.79
February	....	....	480	.436	.47
March	....	....	1,000	.909	1.05
April	11,900	....	5,100	4.64	5.18
May	10,100	3,320	5,140	4.67	5.38
June	10,100	3,320	5,370	4.88	5.44
July	3,470	830	1,760	1.60	1.84
August	4,390	495	2,060	1.87	2.16
September	2,760	590	1,140	1.04	1.16
October	13,800	766	2,530	2.30	2.65
November	11,400	1,840	4,290	3.90	4.35
December	2,650	1,380	1,760	1.60	1.84
The year	13,800	....	2,610	2.37	32.31

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

MATTAWAMKEAG RIVER AT MATTAWAMKEAG.

The gaging station, which was established August 26, 1902, is located at the Maine Central Railroad bridge in the village of Mattawamkeag, about half a mile from the mouth of the river.

Monthly discharge of Mattawamkeag River at Mattawamkeag, Me.

[DRAINAGE AREA, 1500 SQUARE MILES.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	....	....	2,110	1.41	1.63
February	....	....	1,400	.933	1.01
March	....	....	2,300	1.53	1.76
April	12,200	....	8,280	5.52	6.16
May	12,000	3,710	6,110	4.07	4.69
June	19,500	2,360	7,030	4.69	5.23
July	2,200	258	743	.495	.57
August	7,480	906	3,300	2.20	2.54
September	1,880	660	1,190	.793	.88
October	7,990	1,380	2,830	1.89	2.18
November	15,000	3,070	7,310	4.87	5.43
December	3,710	....	2,640	1.76	2.03
The year	19,500	....	3,760	2.51	34.11

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

PISCATAQUIS RIVER NEAR FOXCROFT.

The gaging station, which was established August 17, 1902, is located at Lows Bridge, about half way between the villages of Guilford and Foxcroft, and is just above the mouths of Black and Salmon Streams.

Monthly discharge of Piscataquis River at Foxcroft, Maine.

[DRAINAGE AREA, 286 SQUARE MILES.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	....	....	450	1.57	1.81
February	....	....	320	1.12	1.21
March	....	....	650	2.27	2.62
April	10,100	....	2,620	9.16	10.22
May	5,460	1,020	1,830	6.40	7.38
June	4,060	148	799	2.79	3.11
July	220	51	123	.430	.50
August	1,110	100	366	1.28	1.48
September	502	58	138	.483	.54
October	7,910	100	961	3.36	3.87
November	7,010	502	1,240	4.34	4.84
December	782	220	501	1.75	2.02
The year	10,100	....	832	2.91	39.60

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

KENDUSKEAG STREAM NEAR BANGOR.

This station was established September 15, 1908 and is located at the wooden highway bridge about 6 miles northwest of the Bangor Post Office and just below the Six Mile Falls. The discharge at this point does not represent the actual discharge from the original or natural drainage basin of Kenduskeag Stream. A number of years ago an artificial cut was made for log driving purposes through a low divide between Sourdabscook Stream and Black Stream, the latter a tributary of the Kenduskeag entering it about seven miles above the gaging station. During high stages in the Sourdabscook a portion of its waters finds its way through the artificial cut into Kenduskeag. At low stages in the Sourdabscook all of the flow continues down its own channel. It is believed that all of the flow of Black Stream is into the Kenduskeag and none into the Sourdabscook.

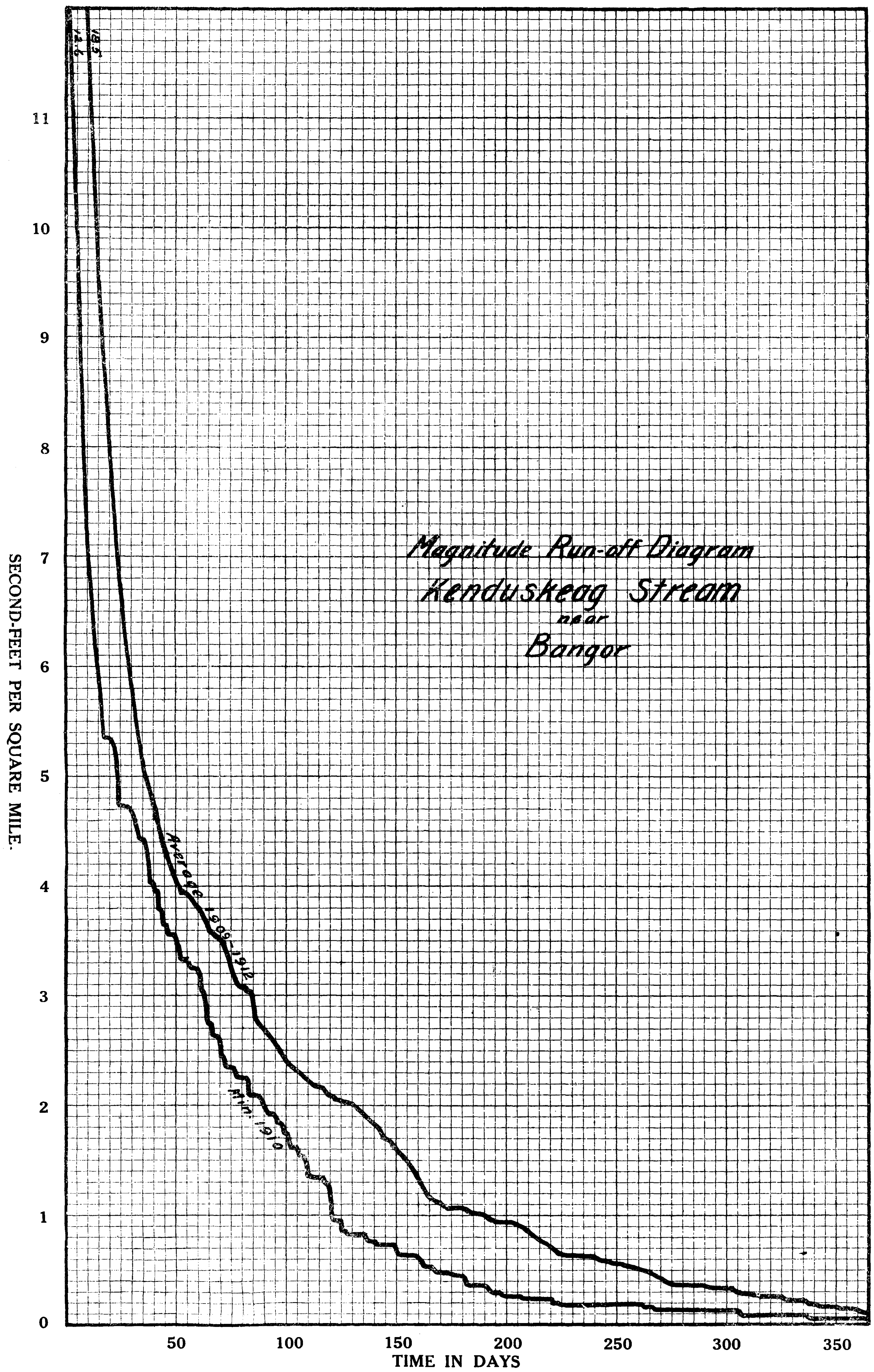
Plate 5 is the run-off magnitude curve for this station. The use of the curve is described on pages 27-30 of this report. The minimum curve is for the year 1910 and the average curve for the years 1909-1912, inclusive, or the period for which complete yearly estimates of discharge are available. This diagram is applicable for streams with relatively small drainage areas.

Monthly discharge of Kenduskeag Stream near Bangor, Maine.

[DRAINAGE AREA, 191 SQUARE MILES]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912					
January	....	....	250	1.31	1.51
February	....	....	150	.785	.85
March	....	....	400	2.09	2.41
April	2,390	....	1,260	6.60	7.36
May	1,900	262	455	2.38	2.74
June	2,600	57	493	2.58	2.88
July	94	34	61.7	.323	.37
August	156	71	105	.550	.63
September	156	45	89.4	.468	.52
October	2,820	119	514	2.69	3.10
November	2,180	414	853	4.47	4.99
December	870	398	575	3.01	3.47
The year	2,820	....	433	2.27	30.83

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.


Magnitude Run-off Diagram
Kenduskeag Stream
near
Bangor
Average 1909-1912
Min. 1910
SECOND-FEET PER SQUARE MILE.
TIME IN DAYS
0
1
2
3
4
5
6
7
8
9
10
11
50
100
150
200
250
300
350

COASTAL BASIN NO. 3.

Description.

This basin includes the coastal streams between the Penobscot River and the Kennebec River, located largely in Waldo, Knox, Lincoln and Sagadahoc counties. The more important rivers of this basin are the St. George, Medomak, Pemaquid, Damariscotta and Sheepscot rivers.

Stream Flow.

Gaging stations have not been maintained on any of the rivers of this coastal basin and in making estimates of run-off, the records of the stations in other portions of the State will have to be used with due consideration to the topography and relative precipitation.

Lake Storage.

Planimeter measurements of the areas of the lakes and ponds in the basin have been made and are given in the tables below. The U. S. Geological Survey topographic maps cover a small portion of this basin but the balance is very inadequately mapped and the areas determined may be very considerably in error.

Storage in Coastal Basin No. 3.

CONNECTED WITH GOOSE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
*Swan Lake......	Swanville........	2.36	5	328,966,000	5	328,966,000
Total........	....	2.36				328,966,000

Measured from U. S. Geol. Survey Atlas sheets.

Storage in Coastal Basin No. 3—Continued.

CONNECTED WITH WESCOT STREAM.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Ames Pond........	Waldo..........	0.11	....	....	5	15,333,000
Hurd Pond........	Swanville.........	0.11	....	....	5	15,333,000
Pond............	Swanville.........	0.06	....	....	5	8,364,000
Total........	....	0.28				39,030,000

CONNECTED WITH PASSAGASSAWAKEAG RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage: Feet.	Present Storage: Cubic feet.	Possible Storage: Feet.	Possible Storage: Cubic feet.
Clements Pond...	Brooks..........	0.09	....	....	5	12,545,000
Corson Pond.....	Brooks..........	0.10	....	....	5	13,939,000
Half Moon Pond..	Brooks..........	0.10	....	....	5	13,939,000
Passagassawakeag Pond..........	Brooks..........	0.28	....	....	5	39,030,000
Pond............	Knox & Morrill...	0.05	....	....	5	6,970,000
Pond............	Morrill..........	0.05	....	....	5	6,970,000
Pond............	Waldo..........	0.09	....	....	5	12,545,000
Ross Pond.......	Morrill..........	0.21	....	....	5	29,272,000
Smith Pond......	Knox..........	0.08	....	....	5	11,151,000
Smiths Pond.....	Morrill..........	0.37	....	....	5	51,575,000
Total........	....	1.42				197,936,000

CONNECTED WITH DUCK TRAP RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage: Feet.	Present Storage: Cubic feet.	Possible Storage: Feet.	Possible Storage: Cubic feet.
Andrews Pond....	Lincolnville......	0.40	....	....	5	55,757,000
Knights Pond....	Northport.......	0.19	....	....	5	26,484,000
Pitcher Pond.....	Lincolnville and Northport.....	1.04	....	....	5	144,968,000
Tilden Pond......	Belmont.........	0.56	....	....	5	78,060,000
Total........	....	2.19				305,269,000

CONNECTED WITH MEGUNTICOOK RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage: Feet.	Present Storage: Cubic feet.	Possible Storage: Feet.	Possible Storage: Cubic feet.
Fletchers Pond...	Lincolnville......	0.10	....	....	5	13,939,000
Megunticook Lake	Camden, Lincolnville & Hope...	2.40	5	334,541,000	5	334,541,000
Norton Pond.....	Lincolnville......	0.17	....	....	5	23,697,000
Thomas Pond....	Lincolnville and Searsmont.....	0.06	....	....	5	8,364,000
Total........	....	2.73		334,541,000		380,541,000

Storage in Coastal Basin No. 3—Continued.

CONNECTED WITH GOOSE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
*Hosmer Pond....	Camden.........	0.10	....	....	5	13,939,000
Total........	....	0.10				13,939,000

* Measured from U. S. Geol. Survey Atlas sheets.

CONNECTED WITH ST. GEORGE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
*Alford Lake.....	Hope...........	0.96	....	....	5	133,816,000
*Chickawaukie Pond..........	Rockland and Rockport......	0.53	3	44,327,000	4	59,102,000
*Crawfords Pond..	Union & Warren.	0.74	2	41,260,000	10	206,300,000
*Fish Pond......	Hope...........	0.21	....	....	5	29,272,000
*Grassy Pond....	Rockport........	0.20	5	27,878,000	5	8,364,000
Green Pond......	Morrill..........	0.06	....	....	5	27,878,000
*Hobbs Pond.....	Hope...........	0.38	....	....	5	52,969,000
Ledge Pond......	Montville........	0.06	....	....	5	8,364,000
*Lermond Pond...	Hope...........	0.24	....	....	5	33,454,000
*Lily Pond.......	Hope...........	0.04	....	....	5	5,576,000
Little Pond......	Morrill..........	0.08	....	....	5	11,151,000
Little Pond......	Searsmont.......	0.06	....	....	5	8,364,000
*Maces Pond.....	Rockport........	0.05	3	4,182,000	7	9,757,000
Moody Pond.....	Searsmont.......	0.40	....	....	5	55,757,000
Newbert Pond....	Appleton........	0.10	....	....	5	13,939,000
North Pond......	Warren.........	0.37	....	....	5	51,575,000
*Oyster River Pond..........	Rockport........	0.17	13	46,585,000	13	46,585,000
Pond...........	Appleton........	0.08	....	....	5	11,151,000
Pond...........	Montville........	0.02	....	....	5	2,788,000
Pond...........	Searsmont.......	0.09	....	....	5	12,545,000
Quantabacook Pond..........	Searsmont & Morrill........	1.24	....	....	10	345,691,000
*Rocky Pond.....	Rockport........	0.02	....	....	5	2,788,000
Round Pond......	Union...........	0.33	....	....	5	45,999,000
St. Georges Pond..	Liberty..........	1.79	....	....	5	249,511,000
Sennebec Pond...	Appleton & Union	0.93	....	....	10	259,269,000
Seven Tree Pond..	Union & Warren.	0.95	5	132,422,000	5	132,422,000
South Pond......	Warren.........	1.17	....	....	5	163,088,000
Stevens Pond.....	Liberty..........	0.67	....	....	5	93,393,000
Trues Pond.......	Montville........	0.37	5	51,575,000	5	51,575,000
Western Pond....	Waldoboro.......	0.23	....	....	5	32,060,000
Whiteoak Pond...	Warren.........	0.10	....	....	5	13,939,000
Total........	....	12.64		348,229,000		2,178,442,000

* Measured from U. S. Geol. Survey Atlas sheets.

Storage in Coastal Basin No. 3—Continued.

CONNECTED WITH GOOSERIVER STREAM.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE.		POSSIBLE STORAGE.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Southwest Pond...	Waldoboro.......	0.13	....	....	...5	18,121,000
Total........	....	0.13				18,121,000

CONNECTED WITH MEDOMAK RIVER.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE.		POSSIBLE STORAGE.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Clark Pond.......	Washington......	0.23	....	....	5	32,060,000
Little Medomak Pond..........	Waldoboro.......	0.14	....	....	5	19,515,000
Medomac Pond...	Waldoboro.......	0.50	....	....	10	139,392,000
Pond............	Appleton........	0.13	....	....	5	18,121,000
Pond............	Appleton........	0.08	....	....	5	11,151,000
Washington Pond.	Washington......	1.06	....	....	5	147,756,000
Total........	....	2.14				367,995,000

CONNECTED WITH MUSCONGUS SOUND.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE.		POSSIBLE STORAGE.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
*Webber Pond....	Bremen.........	0.37	....	....	5	51,575,000
Total........	....	0.37				51,575,000

* Measured from U. S. Geological Survey Atlas sheets.

Storage in Coastal Basin No. 3—Continued.

CONNECTED WITH PEMAQUID RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Biscay Pond	Damariscotta, Bremen, Bristol	0.71	....	....	5	98,968,000
*Boyd Pond	Bristol	0.08	....	....	5	11,151,000
Duck Puddle Pond	Waldoboro Nobleboro	0.29	....	....	5	40,424,000
*Hastings Pond	Bristol	0.01	....	....	5	1,394,000
Little Pond	Damariscotta	0.14	....	....	5	19,515,000
McCurdy Pond	Bremen	0.29	....	....	5	40,424,000
Muddy Pond	Damariscotta	0.28	....	....	5	39,030,000
Pemaquid Pond	Damariscotta, Nobleboro, Waldoboro	2.57	....	....	5	358,237,000
*Pond	Bristol	0.03	....	....	5	4,182,000
Pond	Waldoboro	0.10	....	....	5	13,939,000
Total	....	4.50				627,264,000

* Measured from U. S. Geol. Survey Atlas sheets.

CONNECTED WITH CAMPBELL BROOK.

Campbell Ponds	Bristol	0.08	....	....	5	11,151,000
Total	....	0.08				11,151,000

CONECTED WITH DAMARISCOTTA RIVER.

Damariscotta Pond	Newcastle, Jefferson, Nobleboro.	7.45	5	1,038,471,000	8	1,661,552,000
*Pond	Boothbay & Boothbay Harbor	0.04	....	....	5	5,576,000
Pond	Washington	0.03	....	....	5	4,182,000
Total	....	7.52		1,038,471,000		1,671,310,000

* Measured from U. S. Geol. Survey Atlas sheets.

CONNECTED WITH SHEEPSCOT RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Accidental Pond..	Palermo.........	0.03	....	....	5	4,182,000
*Adams Pond....	Boothbay........	0.10	....	....	5	13,939,000
Beach Pond......	Palermo.........	0.10	....	....	5	13,939,000
Belden Pond.....	Palermo.........	0.05	....	....	5	6,970,000
Branch Pond.....	Palermo.........	0.40	5	55,757,000	5	55,757,000
Cedar Pond......	Palermo.........	0.06	....	....	5	8,364,000
* Deer Meadow Pond..........	Jefferson........	0.09	....	....	5	12,545,000
* Dyers Long Pond	Jefferson........	0.56	3	46,836,000	6	93,671,000
Foster Pond......	Palermo.........	0.03	....	....	5	4,182,000
* Fox Pond......	Windsor.........	0.02	....	....	5	2,788,000
* Horn Pond.....	Jefferson........	0.04	....	....	5	5,576,000
James Pond......	Somerville.......	0.33	....	....	10	91,999,000
* Lily Pond......	Edgecomb.......	0.09	....	....	5	12,545,000
* Little Dyer Pond	Jefferson........	0.17	....	....	5	23,697,000
* Long Pond.....	Somerville.......	0.71	....	....	10	197,937,000
* Moody Pond....	Windsor.........	0.05	....	....	5	6,970,000
Moose Pond......	Palermo.........	0.06	....	....	5	8,364,000
Mud Pond.......	Liberty..........	0.06	....	....	5	8,364,000
* Pleasant Pond...	Whitefield & Jefferson.........	0.73	....	....	5	101,756,000
* Pond..........	Jefferson........	0.12	....	....	5	16,727,000
* Pond..........	Jefferson........	0.10	....	....	5	13,939,000
* Pond..........	Jefferson........	0.03	....	....	5	4,182,000
Pond............	Palermo.........	0.01	....	....	5	1,394,000
* Savade Pond....	Windsor.........	0.07	....	....	5	9,757,000
Sheepscot, Great Pond..........	Palermo.........	1.60	....	....	10	446,054,000
Turner Pond.....	Palermo.........	0.04	....	....	5	5,576,000
* Weary Pond....	Whitefield.......	0.06	....	....	5	8,364,000
Total........	....	5.71		102,593,000		1,179,538,000

* Measured from U. S. Geol. Survey Atlas sheets.

Summary of Storage in Coastal Basin No. 3.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Goose River............	18	2.36	7.6	328,966,000	328,966,000
Wescott Stream.........	23	0.28	82.2	....	39,030,000
Passagassawakeag River..	43	1.42	30.3	....	197,936,000
Duck Trap River........	35	2.19	16.0	....	305,269,000
Megunticook River......	25	2.73	9.2	334,541,000	380,541,000
Goose River............	8	0.10	80.0	....	13,939,000
St. George River........	225	12.64	17.8	348,229,000	2,178,442,000
Gooseriver Stream.......	11	0.13	84.6	....	18,121,000
Medomak River.........	74	2.14	34.6	....	367,995,000
Muscongus Sound........	5	0.37	13.5	....	51,575,000
Pemaquid River.........	36	4.50	8.0	....	627,264,000
Campbell Brook.........	2	0.08	25.0	....	11,151,000
Damariscotta River......	57	7.52	7.6	1,038,471,000	1,671,310,000
Sheepscot River.........	228	5.71	40.0	102,593,000	1,179,538,000
Total.............	790	42.17	18.7	2,152,800,000	7,371,077,000

KENNEBEC RIVER BASIN.

Lake Storage.

In connection with the regular topographic work of the U. S. Geological Survey in the survey of the Skowhegan quadrangle, a large scale map of Moose Pond or Great Moose Lake in the towns of Harmony and Hartland was made. The map was surveyed on a scale of 2000 feet to 1 inch and with 5-foot contours.

The following table gives the capacities of the lake for varying elevations.

Areas and Capacity of Moose Pond.

Elev.	Area, sq. miles.	Capacity, cu. ft.	Total capacity.	Remarks.
237.8	*4.50	....	0	Gate sills.
238.0	4.67	25,537,000	25,537,000	
243.0	5.50	709,505,000	735,042,000	W. S., Sept. 11, 1912.
244.9	*6.21	309,868,000	1,044,910,000	Top of dam.
248.0	7.36	585,948,000	1,630,858,000	
253.0	8.24	1,087,258,000	2,718,116,000	
258.0	9.51	1,237,801,000	3,955,917,000	

* Interpolated.

There was described on page 18 the method adopted by this department of measuring the areas of lakes and ponds in the State and the determination of the present storage and possible future storage capacity of the various reservoirs. Such determinations have been made for the Kennebec River basin and are given in the subjoined tables. The areas supercede those previously published by this department, especially as given in the First Annual Report.

For many of the sites, more or less accurate information was available on their storage capacity, as the State had, in coöperation with the U. S. Geological Survey, made detailed surveys of a number of the lakes. For other lakes and ponds information was at hand on the storage in feet, such as height of dam, etc. In a large number of cases, however, no such information was avaliable and an estimate of height was made and the corresponding capacity in cubic feet computed.

In the capacity tables in the following pages, wherever the height appears as 5 feet or 10 feet it is in almost all cases the assumed or estimated height of storage. For instance, under present storage, when it was known that there was a dam at the outlet of a pond and no other information was available, the height was put as 5 feet. The height of possible storage depends on a number of factors; as to whether the drainage area above is sufficient to contribute the amount of water to fill the reservoir to that height; whether the topography at the dam site is such that it will be feasible financially to build a dam; or whether settlements around the shores of the lake will permit raising to the height as contemplated. In the various capacity tables, these detailed studies have not been made on the 5 and 10-foot assumed heights. After scanning the base map of the State, compiled in this office, if it was thought the drainage area was small or if any local conditions were known to exist, as settlements around the lake in question, the smaller height, that is, 5 feet, was adopted. In other cases the 10-foot height was used.

Storage in Kennebec River Basin.

CONNECTED WITH MOOSE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Attean Pond	T.5,R.1,N.B.K.P.	4.45			10	2,341,700,000
Barrett Pond	T.6,R.1,N.B.K.P.	0.04			5	5,576,000
Benjamin Pond	T.5,R.1,N.B.K.P.	0.21			5	29,272,000
Big Fish Pond	T.6,R.1,N.B.K.P.	0.11			5	15,333,000
Big Indian Pond	Lowell	0.10			5	13,939,000
Big Turner Pond	T.6,R.2,N.B.K.P.	0.25			5	34,848,000
Bluff Pond	T.6,R.2,N.B.K.P.	0.02			5	2,788,000
Bog Pond	T.2,R.8,W.B.K.P.	0.03			5	4,182,000
Bog Pond	T.5,R.1,N.B.K.P.	0.17			5	23,697,000
Bog Brook Pond	Lowell	0.12			10	33,454,000
Boundary Pond	T.2,R.8,W.B.K.P.	0.14			5	19,515,000
Brassua Lake	Ts. 1 & 2, R. 2, N. B. K. P., Taunton, Raynham	5.43			18	3,512,000,000
Clearwater Pond	T.5,R.1,N.B.K.P.	0.06			5	8,364,000
Crocker Pond	T.5,R.2,N.B.K.P.	0.48			10	133,816,000
Fish Pond	T.3,R.2,N.B.K.P.	0.38			10	105,938,000
Grace Pond	T. 3, R. 6, B. K. P. W. K. R.	0.24			5	33,454,000
Grass Pond	T.6,R.1,N.B.K.P.	0.01			5	1,394,000
Heald Pond	Moose River Pl.	0.27			5	37,636,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH MOOSE RIVER—Concluded.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Holeb Pond	T.6,R.1,N.B.K.P.	2.00	....	....	10	627,000,000
Horseshoe Pond	T.5,R.1,N.B.K.P.	0.11	....	....	5	15,333,000
Jim Mac Pond	T.5,R.3,N.B.K.P.	0.03	....	....	5	4,182,000
Kinne Pond	T.6,R.1,N.B.K.P.	0.04	....	....	5	5,576,000
Lang Pond	T. 3, R. 7, B. K. P. W. K. R.	0.25	....	....	5	34,848,000
Little Big Wood Pond	T.5,R.2,N.B.K.P.	0.88	7	171,731,000	17	417,061,000
Little Brassua Lake	Sandwich	0.12	....	....	A	....
Little Dermot Pond	T.2,R.1,N.B.K.P.	0.34	....	....	5	47,393,000
Little Fish Pond	T.6,R.1,N.B.K.P.	0.04	....	....	5	5,576,000
Little Indian Pond	Lowell	0.02	....	....	5	2,788,000
Little Turner Pond	T.6,R.2,N.B.K.P.	0.06	....	....	5	8,364,000
Long Bog	T.6,R.1,N.B.K.P.	0.03	....	....	5	4,182,000
Long Pond	Ts. 6, R. 1 & 2, N. B. K. P.	0.14	....	....	5	19,515,000
Long Pond	T. 3 & 4, R. 1, N. B. K. P.	4.66	8	625,000,000	8	625,000,000
Loon Pond	T.6,R.1,N.B.K.P.	0.02	....	....	5	2,788,000
Luther Pond	T.3,R.2,N.B.K.P.	0.22	....	....	5	30,666,000
Mill Pond	Lowell	0.08	....	....	5	11,151,000
Misery Pond	T.2, R. 7, B. K. P. W. K. R.	0.08	5	11,151,000	10	22,303,000
Moores Pond	T. 4, R. 7, B. K. P. W. K. R.	0.07	....	....	5	9,757,000
Mud Pond	Lowell	0.01	....	....	5	1,394,000
Mud Pond	T.5,R.1,N.B.K.P.	0.58	....	....	5	80,847,000
Mud Pond	T.6,R.1,N.B.K.P.	0.01	....	....	5	1,394,000
Mud Pond	T.3,R.2,N.B.K.P.	0.14	....	....	5	19,515,000
Muskrat Pond	T.3,R.2,N.B.K.P.	0.15	....	....	5	20,909,000
Parlin Pond	T. 2, R. 6, T. 3, R. 7, B. K. P. W. K. R.	1.40	5	195,149,000	5	195,149,000
Pond	Brassua	0.10	....	....	5	13,939,000
Pond	Lowell	0.02	....	....	5	2,788,000
Pond	Lowell	0.01	....	....	5	1,394,000
Pond	Lowell	0.02	....	....	5	2,788,000
Pond	T.5,R.1,N.B.K.P.	0.08	....	....	5	11,151,000
Pond	T.6,R.1,N.B.K.P.	0.01	....	....	5	1,394,000
Pond	T.6,R.1,N.B.K.P.	0.01	....	....	5	1,394,000
Pond	T.3,R.2,N.B.K.P.	0.01	....	....	5	1,394,000
Pond	T.2,R.3,N.B.K.P.	0.06	....	....	5	8,364,000
Pond	T. 3, R. 6, B. K. P. W. K. R.	0.20	....	....	5	27,878,000
Rock Pond	T.6,R.2,N.B.K.P.	0.01	....	....	5	1,394,000
Sherman Pond	T.6,R.1,N.B.K.P.	0.02	....	....	5	2,788,000
Snake Pond	T. 3, R. 7, B. K. P. W. K. R.	0.02	....	....	5	2,788,000
Toby Pond	T. 5, R. 7, B. K. P. W. K. R., T. 5, R. 1, N. B. K.P.	0.06	....	....	5	8,364,000
Trout Pond	Lowell	0.07	....	....	5	9,757,000
Unknown Pond	T.1,R.8,W.B.K.P.	0.07	....	....	5	9,757,000
Upper Pond	T. 2, R. 7, B. K. P. W. K. R.	0.04	....	....	5	5,576,000
Wood Pond	Ts. 3 & 4, R. 1, N. B. K. P.	3.23	....	....	B	....
Y. Pond	T.3,R.2,N.B.K.P.	0.04	....	....	5	5,576,000
Total	....	28.07		1,003,031,000		8,688,081,000

A Included in Brassua Lake.
B Included in Attean Pond.

Storage in Kennebec River Basin—Continued.

CONNECTED WITH KOKADJO (ROACH) RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
First Kokadjo (Roach) Lake...	T. A, R. 13, W. E. L. S.	4.77	8	1,093,000,000	8	1,093,000,000
Fourth Kokadjo (Roach) Lake...	T. A, R. 12, W. E. L. S.	0.24	....	....	5	33,454,000
Pond...........	T. A, R. 12, W. E. L. S.	0.08	....	....	5	11,151,000
Pond...........	T. A, R. 12, W. E. L. S.	0.02	....	....	5	2,788,000
Pond...........	T. 1, R. 12, W. E. L. S.	0.06	....	....	5	8,364,000
Second Kokadjo (Roach) Lake...	T. 1, R. 12, W. E. L. S.	0.99	6	167,000,000	8	234,000,000
Third Kokadjo (Roach) Lake...	T. A, R. 12, W. E. L. S.	0.97	....	....	5	135,210,000
Trout Pond......	T. A, R. 12, W. E. L. S.	0.17	....	....	5	23,697,000
Total.......	....	7.30		1,260,000,000		1,541,664,000

CONNECTED WITH MOOSEHEAD LAKE.

Fitzgerald Pond...	T. 2, R. 6, B. K. P. E. K. R.......	0.50	....	....	5	69,696,000
Kidney Pond.....	Middlesex Canal..	0.13	....	....	5	18,121,000
Lucky Pond......	T. 1, R. 14, W. E. L. S.	0.08	....	....	5	11,151,000
Moosehead Lake..	T. 2, R. 6, B. K. P. E. K. R., Tomhegan, Big W., Little W., T. 3, R. 15. Ts. A & 1, R. 14, W. E. L. S., East Middlesex, Middlesex, Greenville, Days Academy, Grant	116.00	7.5	23,735,000,000	9.5	30,247,000,000
Pond...........	Middlesex Canal..	0.11	....	....	5	15,333,000
Pond...........	Middlesex Canal..	0.04	....	....	5	5,576,000
Pond...........	T.2,R.3,N.B.K.P.	0.03	....	....	5	4,182,000
Prong Pond......	T. A 2, R 13 & 14, W. E. L. S.....	0.83	....	....	5	115,695,000
Socatean Pond....	T.2,R.4,N.B.K.P.	0.24	....	....	5	33,454,000
Tomhegan Pond..	T. 1 & 2, R. 3, N. B. K. P.......	0.42	....	....	5	58,545,000
Total.......	....	118.38		23,735,000,000		30,578,753,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH MAIN RIVER BETWEEN MOOSEHEAD LAKE AND THE FORKS.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE.		POSSIBLE STORAGE.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Baker Pond......	Moxie Gore......	0.13	....	....	5	18,121,000
Baker Pond......	Spaulding.......	0.30	....	....	5	41,818,000
Black Brook Pond	Moxie Gore......	0.54	....	....	5	75,272,000
Burnham Pond...	T. 2, R. 6, B. K. P. W. K. R......	0.26	....	....	5	36,242,000
Chase Stream Pond	10,000 Acre Tract & T. 2, R. 7, B. K. P. W. K. R.	0.07	....	....	5	9,757,000
Cold Stream Pond.	T. 2, R. 6, Ts. 2 & 3, R. 7, B. K. P. W. K. R......	0.52	....	....	5	72,484,000
Dead Stream Pond	West Forks......	0.09	....	....	5	12,545,000
Dimmick Pond, north...........	Spaulding.......	0.06	....	....	5	8,364,000
Dimmick Pond, south...........	Spaulding.......	0.12	....	....	5	16,727,000
Ellis Pond........	10,000 Acre Tract	0.14	....	....	5	19,515,000
Fish Pond........	Moxie Gore......	0.02	....	....	5	2,788,000
Foster Pond......	T.1,R.1,N.B.K.P..	0.18	....	....	5	25,091,000
Frypan Pond.....	Squaretown......	0.03	....	....	5	4,182,000
Horseshoe Pond...	East Moxie......	0.03	....	....	5	4,182,000
Horseshoe Pond...	10,000 Acre Tract	0.07	....	....	5	9,757,000
Island Pond......	10,000 Acre Tract	0.05	....	....	5	6,970,000
Indian Pond......	T. 1, R. 7, B. K. P. W. K. R......	1.55	11.5	524,352,000	19	1,009,436,000
Knights Pond....	Chase Stream....	0.01	....	....	5	1,394,000
Knights Pond....	Squaretown & Moxie Gore....	0.19	....	....	5	26,484,000
Little Indian Pond	Squaretown......	0.02	....	....	5	2,788,000
Long Pond.......	10,000 Acre Tract	0.03	....	....	5	4,182,000
Mountain Pond...	Spaulding.......	0.06	....	....	5	8,364,000
Mosquito Pond...	The Forks.......	0.15	....	....	5	20,909,000
Moxie Pond......	The Forks, Bald Mountain, East Moxie.........	2.71	9	705,000,000	20	1,600,000,000
Mud Pond........	Moxie Gore......	0.03	....	....	5	4,182,000
Mud Pond........	10,000 Acre Tract	0.02	....	....	5	2,788,000
Perry Pond.......	10,000 Acre Tract	0.11	....	....	5	15,333,000
Pond............	The Forks.......	0.05	....	....	5	6,970,000
Pond............	T. 2, R. 7, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Pond............	10,000 Acre Tract	0.02	....	....	5	2,788,000
Prescott Pond....	Moxie Gore......	0.03	....	....	5	4,182,000
Round Pond......	Squaretown......	0.07	....	....	5	9,757,000
Round Pond......	10,000 Acre Tract	0.05	....	....	5	6,970,000
Round Pond.....	T. 1, R. 7, B. K. P. W. K. R......	0.24	....	....	5	33,454,000
Wilson Pond.....	West Forks......	0.03	....	....	5	4,182,000
Total........	....	8.02		1,229,352,000		3,133,554,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH DEAD RIVER, NORTH BRANCH.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE. Feet.	PRESENT STORAGE. Cubic feet.	POSSIBLE STORAGE. Feet.	POSSIBLE STORAGE. Cubic feet.
Arnold Pond	Coburn Gore	0.27	....	....	5	37,636,000
Barnard Pond	Eustis	0.10	....	....	5	13,939,000
Big Greenbush Pond	Jim Pond	0.04	....	....	5	5,576,000
Blanchard Pond	T.2,R.5,W.B.K.P.	0.10	....	....	5	13,939,000
Chain of Ponds	T.2,R.6,W.B.K.P.	1.20	5	150,500,000	20	802,900,000
Chase Pond	Jim Pond	0.04	....	....	5	5,576,000
Crosby Pond	Coburn Gore	0.23	....	....	5	32,060,000
Hathorn Pond	Coburn Gore	0.22	....	....	5	30,666,000
Horseshoe Pond	Chain of Ponds	0.05	....	....	5	6,970,000
Horseshoe Pond	Coburn Gore	0.03	....	....	5	4,182,000
Jim Pond	T. 1, R. 5, W. B. K. P.	0.47	5	69,700,000	20	319,200,000
Little Greenbush Pond	Jim Pond	0.03	....	....	5	4,182,000
Moose Horn Lake	Coburn Gore	0.48	....	....	5	66,908,000
Mud Pond	Coburn Gore	0.01	....	....	5	1,394,000
North Boundary Pond	T.3,R.6,W.B.K.P.	0.02	....	....	5	2,788,000
Northwest Pond	T.3,R.6,W.B.K.P.	0.08	....	....	5	11,151,000
Otter Pond	Chain of Ponds	0.04	....	....	5	5,576,000
Pond	Jim Pond	0.07	....	....	5	9,757,000
Pond	Jim Pond	0.02	....	....	5	2,788,000
Round Mountain Pond	Alder Stream	0.12	....	....	5	16,727,000
Shallow Pond	Jim Pond	0.07	....	....	5	9,757,000
Snow Pond	Alder Stream	0.05	....	....	5	6,970,000
South Boundary Pond	T.3,R.6,W.B.K.P.	0.02	....	....	5	2,788,000
Tea Pond	Jim Pond	0.06	....	....	5	8,364,000
Tim Pond	Tim Pond	0.46	5	83,600,000	10	203,500,000
Viles Pond	Jim Pond	0.04	....	....	5	5,576,000
Welhern Pond	Eustis	0.10	....	....	5	13,939,000
Total	....	4.42		303,800,000		1,644,809,000

CONNECTED WITH DEAD RIVER, SOUTH BRANCH.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE. Feet.	PRESENT STORAGE. Cubic feet.	POSSIBLE STORAGE. Feet.	POSSIBLE STORAGE. Cubic feet.
Dead River Pond	Dallas	0.90	....	....	5	125,453,000
Greeley Pond	Dallas	0.13	....	....	5	18,121,000
Jones Pond	Wyman	0.08	....	....	5	11,151,000
Pond	Lang Pl.	0.15	....	....	5	20,909,000
Pond	Sandy River Pl.	0.02	....	....	5	2,788,000
Redington Pond, First	Redington	0.06	....	....	5	8,364,000
Redington Pond, Second	Redington	0.06	....	....	5	8,364,000
Redington Pond, Third	Redington	0.06	....	....	5	8,364,000
Total	....	1.46				203,514,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH DEAD RIVER BETWEEN JUNCTION NORTH AND SOUTH BRANCHES AND LONG FALLS.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Butler Pond	Flagstaff	0.08	....	....	5	11,151,000
Butler Pond	T. 4, R. 5, B. K. P. W. K. R.	0.21	....	....	5	29,272,000
Deer Pond	T. 4, R. 5, B. K. P. W. K. R.	0.08	....	....	5	11,151,000
Flagstaff Lake	Flagstaff	1.43	12	470,000,000	22	2,000,000,000
Jones Pond	T. 4, R. 3, B. K. P. W. K. R.	0.06	....	....	5	8,364,000
Pond	Jerusalem	0.02	....	....	5	2,788,000
Pond	T. 4, R. 5, B. K. P. W. K. R.	0.02	....	....	5	2,788,000
West Carry Pond	Carrying Place	1.21	10	360,000,000	10	360,000,000
Total		3.11		830,000,000		2,425,514,000

CONNECTED WITH DEAD RIVER BETWEEN LONG FALLS AND MOUTH OF SPENCER STREAM.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Fish Pond	T. 2, R. 4, B. K. P. W. K. R.	0.01	....	....	5	1,394,000
High Pond	T. 2, R. 4, B. K. P. W. K. R.	0.02	....	....	5	2,788,000
Pond	T. 2, R. 4, B. K. P. W. K. R.	0.28	....	....	5	39,030,000
Pond	T. 2, R. 4, B. K. P. W. K. R.	0.18	....	....	5	25,091,000
Pond	T. 3, R. 4, B. K. P. W. K. R.	0.03	....	....	5	4,182,000
Pond	T. 3, R. 4, B. K. P. W. K. R.	0.26	....	....	5	36,242,000
Spring Lake	T. 3, R. 4, B. K. P. W. K. R.	1.06	0	....	0	....
Total		1.84				108,727,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH SPENCER STREAM, DEAD RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Baker Pond......	T. 5, R. 6, B. K. P. W. K. R......	0.25	....	....	30	373,600,000
Bear Pond.......	T. 3, R. 5, B. K. P. W. K. R......	0.02	....	....	5	2,788,000
Beck Pond.......	T. 3, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Blakeslee Pond...	T. 5, R. 6, B. K. P. W. K. R......	0.38	....	....	10	105,938,000
Davis Pond......	T. 5, R. 6, B. K. P. W. K. R......	0.04	....	....	10	11,151,000
Douglas Pond....	Kibby..........	0.22	....	....	5	30,666,000
Fish Pond........	T. 4, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Fish Pond........	T. 4, R. 6, B. K. P. W. K. R......	0.03	....	....	5	4,182,000
Hall Pond........	T. 5, R. 7, B. K. P. W. K. R......	0.13	....	....	5	18,121,000
Horseshoe Pond...	T. 3, R. 5, B. K. P. W. K. R......	0.15	....	....	5	20,909,000
Iron Pond........	T. 5, R. 6, B. K. P. W. K. R......	0.07	....	....	5	9,757,000
Kibby Pond......	Kibby..........	0.02	....	....	5	2,788,000
King & Bartlett Pond..........	T. 4, R. 5, B. K. P. W. K. R......	0.81	....	....	40	1,070,500,000
Little Bartlett Pond..........	T. 4, R. 5, B. K. P. W. K. R......	0.14	....	....	40	241,100,000
Parker Pond......	T. 3, R. 5, B. K. P. W. K. R......	0.13	....	....	5	18,121,000
Pond............	T. 3, R. 5, B. K. P. W. K. R......	0.02	....	....	5	2,788,000
Pond............	T. 3, R. 5, B. K. P. W. K. R......	0.06	....	....	5	8,364,000
Pond............	T. 3, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Pond............	T. 3, R. 5, B. K. P. W. K. R......	0.24	....	....	5	33,454,000
Pond............	T. 4, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Pond............	T. 4, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Pond............	T. 4, R. 6, B. K. P. W. K. R......	0.03	....	....	5	4,182,000
Pond............	T. 5, R. 6, B. K. P. W. K. R......	0.02	....	....	5	2,788,000
Pond............	T. 5, R. 6, B. K. P. W. K. R......	0.02	....	....	5	2,788,000
Rock Pond.......	T. 5, R. 6, B. K. P. W. K. R......	0.22	....	....	5	30,666,000
Spectacle Pond...	T. 4, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
Spencer Ponds....	T. 3, R. 5, T. 4, R. 6, B. K. P. W. K. R..........	2.36	12	870,000,000	16	1,500,000,000
Whipple Pond....	T. 5, R. 7, B. K. P. W. K. R......	0.27	....	....	6	45,163,000
Total........	....	5.87		870,000,000		3,583,270,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH DEAD RIVER FROM SPENCER STREAM TO MOUTH.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Alder Pond.......	Ts. 2 & 3, R. 5, B. K. P. W. K. R..	0.28	....	....	5	39,030,000
Fish Pond........	T. 2, R. 6, B. K. P. W. K. R......	0.21	....	....	5	29,272,000
Pond	T. 1, R. 4, B. K. P. W. K. R......	0.06	....	....	5	8,364,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.03	....	....	5	4,182,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.01	....	....	5	1,394,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.03	....	....	5	4,182,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.02	....	....	5	2,788,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.03	....	....	5	4,182,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.02	....	....	5	2,788,000
"	T. 2, R. 5, B. K. P. W. K. R......	0.05	....	....	5	6,970,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.12	....	....	5	16,727,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.18	....	....	5	25,091,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.10	....	....	5	13,939,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.16	....	....	5	22,303,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.33	....	....	5	45,999,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.10	....	....	5	13,939,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.08	....	....	5	11,151,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.04	....	....	5	5,576,000
"	T. 3, R. 6, B. K. P. W. K. R......	0.20	....	....	5	27,878,000
Total........	....	2.09				291,331,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH AUSTIN STREAM.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Austin Pond	Bald Mountain	0.31	....	....	5	43,212,000
Chase Bog	Spaulding	0.02	....	....	5	2,788,000
Chase Pond	Moscow	0.16	....	....	5	22,303,000
Heald Pond	Spaulding	0.03	....	....	5	4,182,000
Heald Pond, north	Spaulding	0.04	....	....	5	5,576,000
Heald Pond, south	Spaulding	0.04	....	....	5	5,576,000
Little Austin Pond	Bald Mountain	0.18	....	....	5	25,091,000
Little Chase Pond	Moscow	0.01	....	....	5	1,394,000
Mink Ponds	Moscow	0.01	....	....	5	1,394,000
Palmer Pond	Mayfield	0.13	....	....	5	18,121,000
Withee Pond	Mayfield	0.01	....	....	5	1,394,000
Total		0.94				131,031,000

CONNECTED WITH MAIN RIVER BETWEEN THE FORKS AND SOLON.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Decker Pond	Caratunk	0.02	....	....	5	2,788,000
Doughnut Pond	Caratunk	0.01	....	....	5	1,394,000
East Carry Pond	T. 2, R. 3, B. K. P. W. K. R.	0.71	....	....	5	98,968,000
Emerton Ponds	Pleasant Ridge	0.02	....	....	5	2,788,000
Grass Pond	T. 2, R. 4, B. K. P. W. K. R.	0.11	....	....	5	15,333,000
Jackson Pond	Concord	0.02	....	....	5	2,788,000
Kilgore Pond	Ts. 1 & 2, R. 4, B. K. P. W. K. R.	0.14	....	....	5	19,515,000
Long Pond	The Forks	0.04	....	....	5	5,576,000
Lower Otter Pond	T. 1, R. 4, B. K. P. W. K. R.	0.51	....	....	5	71,090,000
Merrill Pond	Concord	0.04	....	....	5	5,576,000
Mill Pond	Pleasant Ridge	0.04	....	....	5	5,576,000
Moores Bog	Caratunk	0.04	....	....	5	5,576,000
Moss Pond	T. 1, R. 4, B. K. P. W. K. R.	0.10	....	....	5	13,939,000
Pleasant Pond	Spaulding, Caratunk, The Forks	1.64	4	182,882,000	12	548,646,000
Pierce Ponds	T. 2, R. 4, B. K. P. W. K. R.	2.44	10	620,000,000	10	620,000,000
Pond	Moscow	0.02	....	....	5	2,788,000
"	Caratunk	0.01	....	....	5	1,394,000
"	Ts. 1 & 2, R. 4, B. K. P. W. K. R.	0.03	....	....	5	4,182,000
"	T. 2, R. 4, B. K. P. W. K. R.	0.03	....	....	5	4,182,000
"	T. 2, R. 4, B. K. P. W. K. R.	0.01	....	....	5	1,394,000
"	T. 2, R. 4, B. K. P. W. K. R.	0.02	....	....	5	2,788,000
"	T. 2, R. 4, B. K. P. W. K. R.	0.02	....	....	5	2,788,000
Robinson Pond	Spaulding, Caratunk	0.06	....	....	5	8,364,000
Turner Pond	Moscow	0.01	....	....	5	1,394,000
Upper Otter Pond	T. 1, R. 4, B. K. P. W. K. R.	0.38	....	....	5	52,969,000
Youngs Pond	Pleasant Ridge	0.02	....	....	5	2,788,000
Total		6.49		802,882,000		1,504,584,000

CONNECTED WITH CARRABASSETT RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Beans Pond	Pleasant Ridge	0.05	....	....	5	6,970,000
Beaver Pond	Jerusalem	0.006	....	....	5	836,000
Black Hill Pond	Embden	0.05	....	....	5	6,970,000
Boyden Pond	Embden	0.01	....	....	5	1,394,000
Butler Pond	Lexington, Kingfield	0.12	....	....	5	16,727,000
Dutton Pond	Kingfield	0.14	8	31,224,000	12	46,836,000
Embden Pond	Embden	2.37	4	264,287,000	12	792,862,000
Fahi Pond	Embden	0.25	4	27,878,000	8	55,757,000
Gilman Pond	Lexington, New Portland	0.28	5	39,030,000	10	78,060,000
Grindstone Pond	Kingfield	0.01	....	....	5	1,394,000
Hancock Pond	Embden	0.45	4	50,181,000	10	125,453,000
Indian Pond	Lexington	0.30	....	....	5	41,818,000
Judkins Pond	Lexington	0.44	....	....	5	61,332,000
Lily Pond	Freeman, New Portland	0.15	....	....	5	20,909,000
Middle Carry Pond	T. 2, R. 3, B. K. P. W. K. R.	0.30	....	....	5	41,818,000
Pond	Jerusalem	0.01	....	....	5	1,394,000
"	Jerusalem	0.01	....	....	5	1,394,000
"	New Vineyard	0.07	....	....	5	9,757,000
"	T. 2, R. 3, B. K. P. W. K. R.	0.04	....	....	5	5,576,000
Porters Pond	Strong & New Vineyard	0.84	....	....	5	117,089,000
Reddington Pond	Jerusalem	0.12	....	....	5	16,727,000
Reddington Pond	Crockertown	0.28	....	....	5	39,030,000
Rowe Pond	Pleasant Ridge	0.27	....	....	8	60,217,000
Sandy Pond	Embden	0.16	....	....	5	22,303,000
Spruce Pond	Lexington	0.11	....	....	5	15,333,000
Tufts Pond	Kingfield	0.25	....	....	10	69,696,000
Total	....	7.086		412,600,000		1,657,652,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH SANDY RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Clear Water Pond	Industry, Farmington	1.08	5	156,100,000	15	496,236,000
East Pond	T.2,R.1,W.B.K.P.	0.04	....	....	5	5,576,000
Locks Pond	Chesterville	0.24	....	....	5	33,454,000
Mosher Pond	Fayette	0.11	....	....	5	15,333,000
Norcross Pond	Chesterville	0.37	....	....	5	51,575,000
North Pond	Chesterville	0.12	....	....	5	16,727,000
North Pond	Wilton	0.35	5	48,787,000	10	97,574,000
Pease Pond	Wilton	0.15	....	....	5	20,900,000
Perry Pond	Chesterville	0.11	....	....	5	15,333,000
Pond	Avon	0.12	....	....	5	16,727,000
"	Chesterville	0.09	....	....	5	12,545,000
"	Freeman	0.04	....	....	5	5,576,000
"	Freeman	0.04	....	....	5	5,576,000
"	Industry	0.04	....	....	5	5,576,000
"	Jay	0.05	....	....	5	6,970,000
"	Madrid	0.04	....	....	5	5,576,000
"	New Sharon, Vienna	0.10	....	....	5	13,939,000
"	New Sharon	0.05	....	....	5	6,970,000
"	Perkins	0.02	....	....	5	2,788,000
"	Phillips	0.08	....	....	5	11,151,000
"	Phillips	0.04	....	....	5	5,576,000
"	Redington	0.12	....	....	5	16,727,000
"	Temple	0.09	....	....	5	12,545,000
"	T.2,R.1,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.2,R.1,W.B.K.P.	0.02	....	....	5	2,788,000
"	T.2,R.1,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.2,R.1,W.B.K.P.	0.02	....	....	5	2,788,000
"	T.2,R.1,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.2,R.1,W.B.K.P.	0.01	....	....	5	1,394,000
Sand Pond	Chesterville	0.13	....	....	5	18,121,000
Sandy River Pond, No. 1	T.2,R.1,W.B.K.P.	0.02	....	....	5	2,788,000
Sandy River Pond, No. 2	T.2,R.1,W.B.K.P.	0.07	....	....	5	9,757,000
Sandy River Pond, No. 3	T.2,R.1,W.B.K.P.	0.06	....	....	5	8,364,000
Sandy River Pond, No. 4	T.2,R.1,W.B.K.P.	0.03	....	....	5	4,182,000
Shednake Pond	Chesterville	0.09	....	....	5	12,545,000
Staples Pond	Temple	0.15	....	....	5	20,909,000
Taylor Pond	Strong	0.13	....	....	5	18,121,000
Whittiers Pond	Chesterville and New Sharon	0.30	....	....	5	4,182,000
Wilson Pond	Wilton	1.20	7	234,179,000	12	401,448,000
Total	....	5.75		439,066,000		1,392,528,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH WESSERUNSETT STREAM.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Baker Pond......	Solon...........	0.07.	....	....	10	19,515,000
Powell Bog.......	Madison.........	0.009	....	....	5	1,254,000
Rowell Pond.....	Solon...........	0.02	....	....	5	2,788,000
Smith Pond......	Cornville........	0.04	....	....	5	5,576,000
Weeks Pond......	Brighton........	0.31	6	51,854,000	10	86,423,000
Wentworth Pond..	Solon, Athens....	0.29	....	....	10	80,847,000
Wesserunsett Lake	Madison.........	1.91	7	372,735,000	10	532,478,000
Wyman Pond.....	Brighton........	0.32	....	....	9	80,290,000
Total........	....	3.039		424,589,000		828,686,000

CONNECTED WITH MAIN RIVER BETWEEN SOLON AND WATERVILLE.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Bog Pond........	Hartland........	0.05	....	....	5	6,970,000
George Lake......	Skowhegan, Canaan........	0.52	....	....	5	72,484,000
Morrill Pond......	Hartland........	.21	....	....	5	29,272,000
Mud Pond........	Solon...........	.01	....	....	5	1,394,000
Oakes Pond......	Skowhegan......	0.14	....	....	5	19,515,000
Round Pond......	Skowhegan......	0.02	....	....	5	2,788,000
Sibley Pond......	Canaan, Pittsfield	0.57	....	....	10	158,907,000
Total........	....	1.52				291,330,000

CONNECTED WITH SEBASTICOOK RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Barker Pond.....	Cornville........	0.17	....	....	5	23,697,000
Cambridge Pond..	Ripley..........	0.09	....	....	5	12,545,000
Center Pond......	Sangerville.......	0.54	....	....	5	75,272,000
China Lake.......	Vassalboro, China	6.02	7	1,174,796,000	7	1,174,796,000
Como Lake.......	Harmony........	0.07	....	....	5	9,757,000
Dexter Ponds.....	Dexter, Ripley...	1.70	10	473,933,000	10	473,933,000
Douglas Pond....	Palmyra.........	0.08	....	....	10	22,303,000
Duck Pond.......	Freedom........	0.05	....	....	5	6,970,000
Evans Pond......	China...........	0.02	....	....	5	2,788,000
Half Moon Pond..	St. Albans.......	0.05	....	....	10	13,939,000
Hicks Pond......	Palmyra.........	0.02	....	....	5	2,788,000
Indian Pond......	St. Albans.......	1.00	12	334,541,000	12	334,541,000
Little Indian Pond	St. Albans.......	0.25	....	....	10	69,696,000
Lovejoy Pond....	Albion..........	0.57	4	63,563,000	6	95,344,000
Madawaska Pond.	Palmyra.........	0.06	....	....	5	8,364,000
Main Stream Pond	Harmony........	0.42	....	....	10	117,090,000
Moose Lake......	Hartland, Harmony.........	5.50	7	1,044,910,000	15	2,718,116,000
Mowers Pond.....	Corinna.........	0.06	....	....	5	8,364,000
Mud Pond........	St. Albans.......	0.03	....	....	5	4,182,000
Mud Pond........	China...........	0.03	....	....	5	4,182,000
Mud Pond........	Hartland........	0.02	....	....	5	2,788,000

Storage in Kennebec River Basin—Continued.

CONNECTED WITH SEBASTICOOK RIVER—Concluded.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Mud Pond	Winslow	0.08	....	....	5	11,151,000
Pattee Pond	Winslow	1.63	6.5	221,075,000	6.5	221,075,000
Perry Pond	Harmony	0.03	....	....	5	4,182,000
Plymouth Pond	Plymouth	2.02	7	394,201,000	10	563,144,000
Pond	Brighton	0.04	....	....	5	5,576,000
"	Corinna	0.28	....	....	5	39,030,000
"	Corinna	0.40	....	....	5	55,757,000
"	Corinna, Newport	0.13	....	....	5	18,121,000
"	Dexter	0.19	....	....	5	26,484,000
"	Dixmont	0.13	....	....	5	18,121,000
"	Parkman	0.04	....	....	5	5,576,000
Rogers Pond	Ripley	0.40	....	....	10	111,514,000
Sandy Pond	Freedom	0.62	6	103,708,000	10	172,846,000
Sebasticook Lake	Newport	6.50	5	906,048,000	7	1,268,467,000
Skinner Pond	Dixmont	0.13	....	....	10	36,242,000
Stafford Pond	Hartland	0.17	....	....	5	23,697,000
Starbird Pond	Hartland	0.16	....	....	5	22,303,000
Stetson Pond	Stetson	0.62	4	69,138,000	5	86,423,000
Stuarts Pond	Palmyra, Newport	0.30	....	....	5	41,818,000
Unity Pond	Burnham, Unity	4.26	2	237,524,000	8	950,096,000
Weymouth Pond	Corinna	0.12	....	....	5	16,727,000
Whites Pond	Palmyra	0.25	....	....	5	34,848,000
Wilson Bog	Winslow	0.70	8	156,119,000	8	156,119,000
Total	....	35.95		5,179,556,000		9,070,772,000

CONNECTED WITH MESSALONSKEE STREAM.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
East Pond	Smithfield, Oakland	2.69	4	289,971,000	10	749,929,000
Ellis Pond	Oakland, Belgrade	0.88	6	147,198,000	6	147,198,000
Great Pond	Belgrade, Rome	12.81	7	2,499,857,000	7	2,499,857,000
Hamilton Pond	Belgrade	0.03	....	....	5	4,182,000
Kidder Pond	Vienna	0.03	....	....	5	4,182,000
Little Pond	Rome	0.31	....	....	8	69,138,000
Long Pond	Mount Vernon, Belgrade, Rome	4.11	2	229,161,000	5	572,901,000
McGrath Pond	Oakland, Belgrade	0.76	6	127,126,000	6	127,126,000
Messalonskee Lake	Belgrade, Sidney, Oakland	5.35	6	894,897,000	6	894,897,000
Moose Pond	Mount Vernon	0.11	....	....	5	15,333,000
North Pond	Smithfield, Mercer, Rome	3.26	0	....	8	727,069,000
Pond	Belgrade	0.03	....	....	5	4,182,000
"	Manchester	0.01	....	....	5	1,394,000
"	Manchester, Sidney	0.05	....	....	5	6,970,000
"	Rome	0.03	....	....	5	4,182,000
"	Rome	0.06	....	....	5	8,364,000
"	Sidney, Manchester	0.06	....	....	5	8,364,000
"	Sidney	0.04	....	....	5	5,576,000
"	Sidney	0.02	....	....	5	2,788,000
"	Sidney	0.04	....	....	5	5,576,000
Smith Pond	Smithfield	0.01	....	....	5	1,394,000
Ward Pond	Sidney	0.10	....	....	5	13,939,000
Total	....	30.79		4,188,210,000		5,874,541,000

CONNECTED WITH COBBOSSEECONTEE STREAM.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Annabassacook Lake	Winthrop, Monmouth	2.19	3	183,161,000	6	366,322,000
Berry Pond	Wayne, Winthrop	0.26	....	....	5	36,242,000
Buker Pond	Litchfield	0.09	....	....	5	12,545,000
Carlton Pond	Readfield, Winthrop	0.52	....	....	5	72,484,000
Cobbosseecontee Pond	Winthrop, Manchester, Monmouth, West Gardiner, Litchfield	8.50	4	947,866,000	4	947,866,000
Cochnewagon Pond	Monmouth	0.59	7	115,138,000	10	164,483,000
Dexter Pond	Wayne	0.18	....	....	5	25,091,000
Double Head Pond	Litchfield	0.02	....	....	5	2,788,000
Horseshoe Pond	West Gardiner	0.10	....	....	5	13,939,000
Jamies Pond	Manchester, Farmingdale	0.08	....	....	5	11,151,000
Jimmy Pond	Litchfield	0.05	....	....	5	6,970,000
Loon Pond	Litchfield	0.04	....	....	5	5,576,000
Maranacook Lake	Winthrop, Readfield	2.57	4	286,590,000	5	358,238,000
Narrows Pond	Winthrop	0.82	....	....	5	114,301,000
Pleasant Pond	Litchfield	1.09	4	121,550,000	10	303,875,000
Pond	Readfield	0.08	....	....	5	11,151,000
"	Winthrop	0.02	....	....	5	2,788,000
Purgatory Pond	Litchfield	0.68	5	94,787,000	10	189,573,000
Richard Pond	Winthrop	0.13	....	....	5	18,121,000
Sanborn Pond	Farmingdale, Manchester	0.16	....	....	5	22,303,000
Sand Pond	Monmouth, Litchfield	0.27	....	....	5	37,636,000
Shed Pond	Manchester	0.10	....	....	....	....
Torsey Pond	Readfield, Mount Vernon	1.14	5	158,907,000	5	158,907,000
Wilson Pond	Monmouth, Winthrop, Wayne	0.86	4	95,902,000	5	119,877,000
Total	....	20.54		2,003,901,000		3,002,227,000

CONNECTED WITH MAIN RIVER BETWEEN WATERVILLE AND MOUTH.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Bradley Pond	Topsham	0.03	....	....	5	4,182,000
Dam Pond	Augusta	0.16	....	....	5	22,303,000
Gardiner Pond	Wiscasset	0.10	....	....	5	13,939,000
Greeley Pond	Augusta	0.08	....	....	5	11,151,000
Joy Pond	Pittston	0.03	....	....	5	4,182,000
Little Togus Pond	Augusta	0.14	....	....	5	19,515,000
Longfellow Pond	Whitefield, Windsor	0.05	....	....	5	6,970,000
Nehumkeag Pond	Pittston	0.27	....	....	6	45,163,000
Nequasset Pond	Woolwich	0.67	4	74,714,000	5	93,393,000
Pond	Augusta, Windsor	0.11	....	....	5	15,333,000
"	North Sidney	0.04	....	....	5	5,576,000
Spectacle Pond	Vassalboro, Augusta	0.22	....	....	5	30,666,000
Three cornered Pond	Augusta	0.29	....	....	5	40,424,000
Threemile Pond	Vassalboro, Windsor	1.63	8	363,535,000	10	454,418,000
Togus Pond	Augusta	1.01	5	140,786,000	5	140,786,000
Tolman Pond	Augusta	0.10	....	....	5	13,939,000
Weber Pond	Vassalboro	1.90	6	317,814,000	7	370,783,000
Total	....	6.83		896,849,000		1,292,723,000

Summary of Storage in Kennebec River Basin.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Moose River..........	735	28.07	26.1	1,003,031,000	8,688,081,000
Roach River..........	109	7.30	14.9	1,260,000,000	1,541,664,000
Moosehead Lake.........	396	118.38	3.3	23,735,000,000	30,578,753,000
Between Moosehead Lake and The Forks........	330	8.02	41.2	1,229,352,000	3,133,554,000
Total above mouth Dead River.......	1,570	161.77	9.7	27,227,383,000	43,942,052,000
Dead River, North Branch	195	4.42	44.2	303,800,000	1,644,809,000
Dead River, South Branch	168	1.46	115.0	....	203,514,000
Dead River between junction North and South branches and Long Falls	137	3.11	44.1	830,000,000	2,425,514,000
Dead River between Long Falls & Spencer Stream	46	1.84	25.0	....	108,727,000
Spencer Stream.........	218	5.87	37.1	870,000,000	3,583,270,000
Dead River below Spencer Stream..............	114	2.09	54.6	....	291,331,000
Total in Dead River.	878	18.79	46.7	2,003,800,000	8,257,165,000
Total above The Forks...	2,448	180.56	13.5	29,231,183,000	52,199,217,000
Austin Stream..........	97	0.94	103.2	....	131,031,000
Main river between The Forks and Solon.......	195	6.49	30.1	802,882,000	1,504,584,000
Carrabasset River.......	401	7.09	56.6	412,600,000	1,657,652,000
Sandy River...........	644	5.75	112.0	439,066,000	1,392,528,000
Wesserunsett Stream.....	142	3.04	46.7	424,589,000	828,686,000
Main river between Solon and Waterville........	343	1.52	225.8	....	291,330,000
Total above Waterville............	4,270	205.39	20.8	31,310,320,000	58,005,028,000
Sebasticook River.......	975	35.95	27.1	5,179,556,000	9,070,772,000
Messalonskee Stream.....	205	30.79	6.7	4,188,210,000	5,874,541,000
Cobbosseecontee Stream..	221	20.54	10.8	2,003,901,000	3,002,227,000
Main river below Waterville................	230	6.83	33.7	896,849,000	1,292,723,000
Total for basin......	5,900	299.50	19.7	43,578,836,000	77,245,291,000

POWER PROJECTS.

Engineering studies have been continued on the hydraulic development of the main Kennebec River. Certain possible power sites have been selected and computations made of the possible water power that might be developed at these points. The following table shows the various projects selected. The first column is the project number; second, the name or location; third, the distance in miles from Augusta; fourth, the drainage area at the site; fifth, the elevation of the water surface at the foot of the dam; sixth, the present or proposed head to be developed; seventh, the wheel developments in horsepower at the present sites. The projects selected include those at present developed with a total head of 189 feet and a total wheel development of 42,211 horsepower. The total head of the new projects is 647 feet and the grand total head after deducting those included twice is 789 feet.

Power Projects—Kennebec River.

Project No.	LOCATION.	Miles from Augusta.	Drainage area, square mile.	Elevation, foot of dam, feet.	Head feet.	Present wheel development, H. P.
1	Above Indian Pond	117	1,250	940	80	....
2	Hulling Machine	110	1,350	860	70	....
3	Chase Stream	106	1,370	730	130	....
4	Mile Brook	98	1,570	580	150	....
5	Carratunk, Upper Ferry	89	2,480	480	40	....
6	Carrying Place Rips	84	2,540	430	40	....
7	Bingham	75	2,620	341	45	....
8	Solon Dam	66.2	2,740	280	27	3,000
9	Solon Dam	66.2	2,740	280	40	....
10	Madison Dam	51.9	3,230	223	19	6,728
11	Hollingsworth & Whitney Dam	51.0	3,230	195	28	7,700
12	Bombazee Rips	45.3	3,900	146	12	....
13	Skowhegan Dam	37.6	3,950	123	20	3,500
14	Skowhegan Pool	37.6	3,950	123	40	....
15	Shawmut Dam	24.2	4,250	91	23	4,000
16	Fairfield Dam	21.1	4,260	78	11	1,683
17	Hollingsworth & Whitney Dam	18.6	4,270	55	23	6,000
18	Lockwood Dam	17.4	4,270	33	21	3,300
19	Augusta Dam	0.0	5,550	6	17	6,300

AMOUNT OF WATER USED.

There is given in the Second Annual Report of this Commission, pages 159 to 170, a detailed description of a method of regulating Moosehead Lake for storage purposes, both in the interest of log driving and of water powers. The creation of further storage is recommended by the construction of a dam at the outlet of Brassua Lake. It was shown on page 167 of said report that with such additional storage and with the proper regulation of Moosehead, a constant flow from this lake could be obtained, including the driest known year, of 1280 second feet from August 1 to April 30 of each year and of 2600 second feet during the log driving season of May, June and July. With these figures of flow as the base data, further computations have been made of the power that might be developed at the various projects above.

PRESENT DEVELOPMENTS.

The assumption is made that the value of a horsepower is $1.50 per month, 24-hour service. By the construction of the Brassua Lake storage and the proper operation of Moosehead Lake, an increased flow will result during the months of low water. The subjoined table shows for the various developed projects the extra horsepower that might be obtained and the value of same for the period from 1902 to 1912.

The total excess horsepower is seen to be 464,213 with a total value of $696,320. The average value of the excess horsepower at present developed is $63,300. This amount capitalized at 5% totals $1,266,000, which sum might be advantageously spent on the development of Brassua Lake and the improvement of Kennebec River.

Increased Horsepower of Developed Plants in Kennebec River.

Year.	Project No. 8, Solon. Head 27'.		Project No. 10, Madison. Head 19'.		Project No. 11, H. & W. Madison. Head 28'.		Project No. 13, Skowhegan. Head 20'.		Project No. 15, Shawmut. Head 23'.	
	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.
1902	2,360	$3,540	1,660	$2,490	2,440	$3,660	1,740	$2,610	2,000	$3,000
1903	4,010	6,015	2,810	4,215	4,140	6,210	2,970	4,455	3,420	5,130
1904	6,530	9,795	4,600	6,900	6,770	10,155	4,830	7,245	5,560	8,340
1905	6,790	10,185	4,790	7,185	7,050	10,575	5,030	7,545	5,790	8,685
1906	6,310	9,465	4,440	6,660	6,540	9,810	4,670	7,005	5,370	8,055
1907	4,710	7,065	3,320	4,980	4,890	7,335	3,490	5,235	4,010	6,015
1908	4,810	7,215	3,390	5,085	4,990	7,485	3,560	5,340	4,100	6,150
1909	8,980	13,470	6,320	9,480	9,320	13,980	6,640	9,960	7,640	11,460
1910	1,140	1,710	800	1,200	1,180	1,770	850	1,275	970	1,455
1911	15,380	23,075	10,835	16,253	15,970	23,955	11,410	17,115	13,144	19,671
1912	5,280	7,930	3,720	5,580	5,470	8,200	3,910	5,860	4,500	6,760

Year.	Project No. 16, Fairfield. Head 11'.		Project No. 17, H. & W., Waterville. Head 23'.		Project No. 18, Lockwood. Head 21'.		Project No. 19, Augusta. Head 17'.		Total.	
	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.	Total H. P.	Value at $1.50 per month.
1902	960	$1,440	2,000	$3,000	1,740	$2,760	1,480	$2,220	16,480	$24,720
1903	1,630	2,445	3,420	5,130	3,120	4,680	2,510	3,765	28,030	42,045
1904	2,660	3,990	5,560	8,340	5,080	7,620	4,110	6,165	45,700	68,550
1905	2,770	4,155	5,790	8,685	5,280	7,920	4,290	6,435	47,580	71,370
1906	2,570	3,855	5,370	8,055	4,910	7,365	3,970	5,955	44,150	66,225
1907	1,920	2,880	4,010	6,015	3,670	5,505	2,970	4,455	32,990	49,485
1908	1,960	2,940	4,100	6,150	3,740	5,610	3,030	4,545	33,680	50,520
1909	3,660	5,490	7,640	11,460	6,990	10,485	5,660	8,490	62,850	94,275
1910	470	705	970	1,455	890	1,335	720	1,080	7,990	11,985
1911	6,290	9,435	13,114	19,671	11,974	17,961	9,706	14,559	107,793	161,695
1912	2,150	3,230	4,500	6,760	4,110	6,150	3,330	4,980	36,970	55,450
	Total..	......	......	......	......	......	....	....	464,213	$696,320

PROPOSED NEW DEVELOPMENTS.

A number of new projects have been under consideration for development and computations for the amount of power that might be generated at the various sites have been made.

The results are tabulated and are given below: first, the horsepower that could be developed during the minimum month of each year; second, the horsepower that could be developed for six months of each year and which can be considered the economical limit of wheel capacity; third, the average horsepower that could be developed each year.

The various projects are given below and are numbered in accordance with the table on page 129. Those numbers omitted are for present developments but the results have been presented in the section immediately preceding.

Project No. 1, above Indian Pond; 117 miles from Augusta; drainage area 1250 square miles; elevation foot of dam 940; head 80 feet, minimum power 9310 H. P.

Project No. 2, Hulling machine; 110 miles from Augusta; drainage area 1350 square miles; elevation foot of dam 860; head 70 feet, minimum power 8140 H. P.

Project No. 3, Chase Stream; 106 miles from Augusta; drainage area 1370 square miles; elevation foot of dam 730; head 130 feet; minimum power 15,100 H. P.

Project No. 4, Mile Brook; 98 miles from Augusta; drainage area 1570 square miles; elevation foot of dam 580; head 150 feet; minimum power 17,410 H. P.

Project No. 5, Carratunk, Upper Ferry; 89 miles from Augusta; drainage area 2480 square miles; elevation foot of dam 480; head 40 feet, minimum power 5100 H. P.

Project No. 6, Carrying Place Rips; 84 miles from Augusta; drainage area 2540 square miles; elevation foot of dam 430; head 40 feet, minimum power 5130 H. P.

Project No. 7, Bingham; 75 miles from Augusta; drainage area 2620 square miles; elevation foot of dam 341; head 45 feet; minimum power 5850 H. P.

Project No. 9, Solon Dam; 66.2 miles from Augusta; drainage area 2740 square miles; elevation foot of dam 280; head 40 feet; minimum power 5240 H. P.

Project No. 12, Bombazee Rips; 45.3 miles from Augusta; drainage area 3900 square miles; elevation foot of dam 146; head 12 feet; minimum power 1940 H. P.

Project No. 14, Skowhegan Pool; 37.6 miles from Augusta; drainage area 3950 square miles; elevation foot of dam 123; head 40 feet; minimum power 6520 H. P.

The total power that could be developed for the ten new developments during the minimum month for the 11 years, from 1902 to 1912 inclusive, is 88,100 horsepower.

The total power that might be developed during 6 months of the year and which represents a possible new wheel development on the Kennebec River is 120,000 horsepower.

The summary results are given in the tables below:

Power Computations—Kennebec River.

HORSEPOWER DEVELOPED DURING MINIMUM MONTH.

Project Number.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	Average.
1	9,380	9,310	9,310	9,310	9,310	9,310	9,310	9,310	9,310	9,310	9,310	9,320
2	8,840	8,140	8,520	8,140	8,270	8,330	8,140	8,330	8,140	8,270	8,460	8,330
3	16,520	15,100	15,580	15,100	15,340	15,580	15,100	15,460	15,220	15,460	15,800	15,500
4	21,760	17,410	18,770	17,410	18,220	18,770	17,410	18,900	17,680	18,500	19,300	18,600
5	9,320	5,310	5,820	5,100	6,150	5,790	5,170	7,790	5,350	5,640	6,190	6,150
6	9,530	5,350	5,900	5,130	6,190	5,820	5,210	6,410	5,390	5,680	6,260	6,080
7	11,000	6,010	6,710	5,850	7,030	6,670	5,890	7,280	7,200	6,460	7,160	7,020
9	10,400	5,390	6,080	5,240	6,370	6,040	5,350	6,660	5,460	5,900	6,550	6,310
12	3,870	2,020	2,010	2,250	2,370	2,680	1,960	3,040	2,140	1,940	3,010	2,480
14	13,000	6,770	6,700	7,570	7,970	9,100	6,620	10,300	7,210	6,520	10,200	8,360
Total	113,620	80,810	85,400	81,100	87,220	88,090	80,160	93,480	83,100	83,680	92,240	88,100

HORSEPOWER THAT CAN BE DEVELOPED FOR SIX MONTHS EACH YEAR.

Project Number.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	Average.
1	9,450	9,380	9,380	9,380	9,380	9,450	9,380	9,380	9,380	9,380	9,450	9,400
2	9,350	9,030	8,970	8,520	8,840	9,480	8,710	8,840	8,840	8,650	8,970	8,930
3	17,700	16,990	16,870	15,930	16,640	19,710	16,280	16,640	16,640	16,170	16,900	17,000
4	25,160	22,980	22,710	19,580	21,900	25,840	20,810	22,030	21,900	20,670	22,600	22,400
5	11,430	8,660	10,400	7,900	8,300	15,900	7,720	9,970	9,460	8,440	10,800	9,910
6	11,720	8,920	10,670	8,000	8,440	16,450	7,860	10,260	9,790	8,550	11,000	10,200
7	11,700	10,300	12,500	9,200	10,100	19,400	9,040	10,200	11,500	9,860	12,900	11,500
9	12,800	9,680	11,800	8,440	9,030	18,400	8,340	11,170	10,810	9,140	11,900	11,000
12	5,410	3,760	4,320	3,140	3,420	8,460	3,380	4,340	4,990	3,640	4,860	4,520
14	18,300	12,700	14,600	10,600	11,600	28,600	11,430	14,630	15,470	12,190	16,500	15,100
Total	133,020	112,400	122,220	100,690	107,650	171,690	102,950	117,460	118,780	106,690	125,880	120,000

AVERAGE HORSEPOWER PER YEAR.

Project Number.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	Average.
1	11,910	11,820	11,850	11,800	11,840	11,860	12,360	11,700	11,200	11,970	11,800	11,800
2	12,260	11,370	11,660	11,100	11,530	11,840	11,320	11,460	11,260	10,970	11,500	11,500
3	23,400	21,480	22,100	21,000	21,800	22,510	25,310	22,550	21,270	20,580	21,800	22,100
4	34,820	29,160	31,040	27,730	30,160	32,150	28,830	29,700	28,460	26,540	30,000	29,900
5	20,150	13,660	15,190	12,240	13,520	16,440	11,190	14,710	13,170	10,790	14,300	14,100
6	20,820	14,030	15,640	12,600	13,940	16,940	11,420	15,160	13,500	11,020	14,700	14,500
7	24,400	16,300	18,200	14,600	16,500	19,800	13,200	17,700	15,600	12,700	17,200	16,900
9	23,000	15,250	17,110	13,550	15,330	18,570	12,210	16,640	14,570	11,810	16,100	15,800
12	9,370	5,690	6,760	5,290	6,360	8,960	4,860	6,520	6,730	4,490	7,420	6,590
14	31,690	19,890	22,830	20,070	21,770	30,360	16,420	22,030	22,350	15,150	25,100	22,500
Total	211,820	158,650	172,380	149,980	162,750	189,430	146,940	168,170	158,110	136,020	169,920	166,000

STREAM FLOW.

The following gaging stations have been maintained in the Kennebec Basin during 1912:

Moose River at Rockwood.
Kennebec River at The Forks.
Kennebec River at Waterville.
Dead River at The Forks.
Sandy River at Farmington.
Sebasticook River at Pittsfield.
Cobbosseecontee Stream at Gardiner.

MOOSE RIVER NEAR ROCKWOOD.

The gaging station was established September 7, 1902, and discontinued December 31, 1908, but was re-established May 16, 1910. It is located 4 miles west of Kineo, near the village of Rockwood, and 2 miles from the mouth of the river.

Monthly discharge of Moose River at Rockwood, Maine.

[DRAINAGE AREA, 680 SQUARE MILES.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	1,170	....	564	0.829	0.96
February	496	....	352	.518	.56
March	1,170	238	414	.609	.70
April	5,280	733	2,120	3.12	3.48
May	5,940	2,680	3,900	5.74	6.62
June	3,670	2,340	2,900	4.26	4.75
July	2,290	207	696	1.02	1.18
August	968	238	606	.891	1.03
September	584	303	445	.654	.44
The year	....	....	....	....	....

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

KENNEBEC RIVER AT THE FORKS.

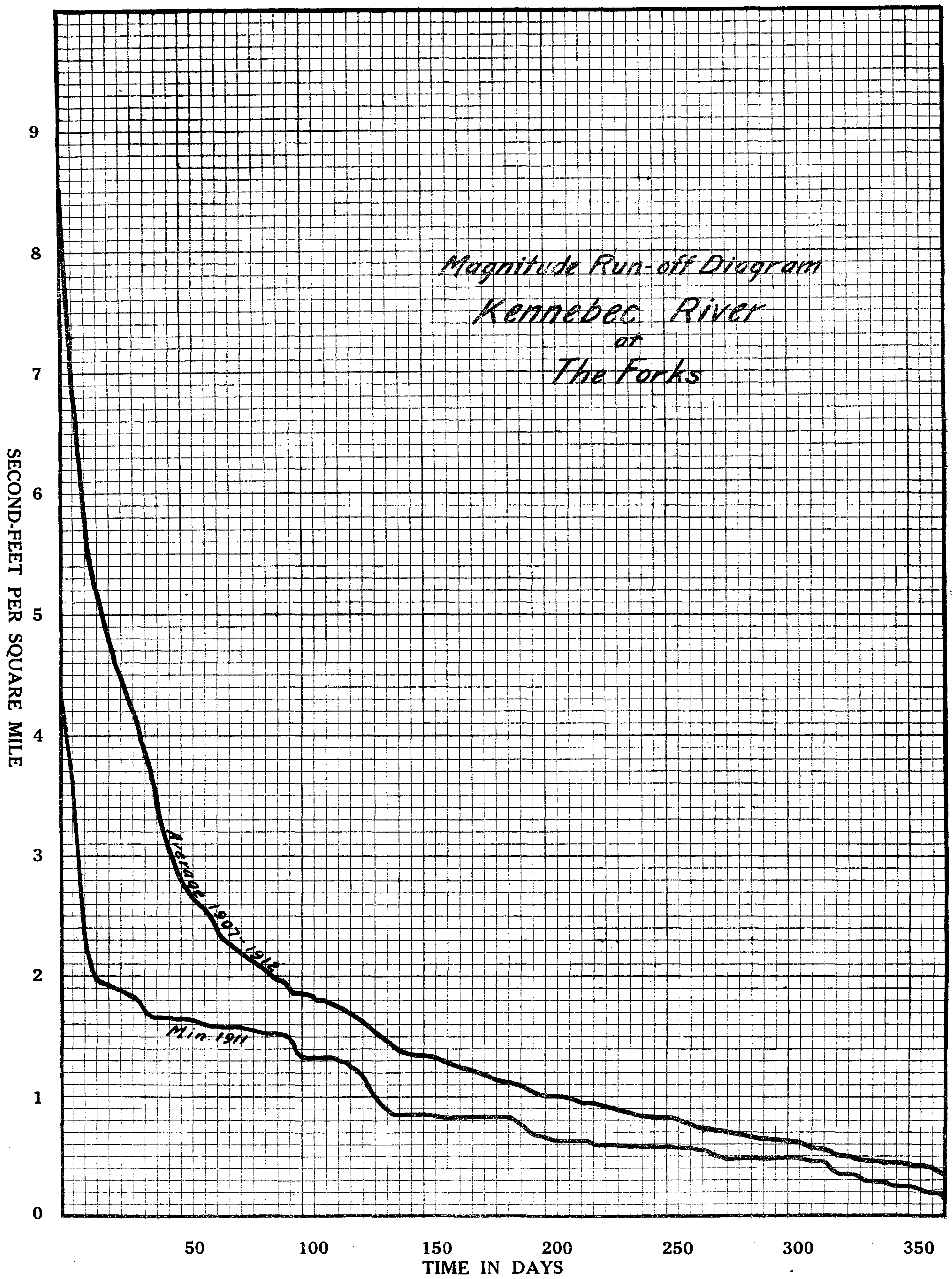
This station is located at the wooden highway bridge across Kennebec River at The Forks, about 2,000 feet above the mouth of Dead River. It was established September 28, 1901.

The nearest dam used for storage is about 12 miles above the station, at the outlet of Indian Pond. From about May 1 to July 31 considerable fluctuation in gage height, ranging from 2 to over 5 feet, occurs daily, owing to regulation of flow for log driving.

On June 21, 1912 an automatic gage of the Barrett & Lawrence type was established at this station in coöperation with the Hollingsworth & Whitney Co. and continued in operation until the freezing up of the river.

This type of instrument provides for a continuous record of the height of the river. Extensive variations occur each day during the log driving season and the station is an important one in connection with the study of the regulation of Moosehead Lake. The record of the daily discharge as interpreted from the automatic gage should be accurate within a very small percent.

Plate 6 is the run-off magnitude curve for this station. The use of the curve is described on pages 27-30 of this report. The minimum curve is for the year 1911 and the average curve for the years 1907-1912 inclusive, or the period for which complete yearly estimates of discharge are available. This diagram is perhaps only applicable for water power investigation on the upper Kennebec River. The discharge of the river is largely dependent on the artificial operation of Moosehead Lake as a storage reservoir and computations based on this curve might not apply to other streams.


Magnitude Run-off Diagram
Kennebec River
at
The Forks
Average 1907-1918
Min. 1911
SECOND-FEET PER SQUARE MILE
9
8
7
6
5
4
3
2
1
0
50
100
150
200
250
300
350
TIME IN DAYS

Monthly discharge of Kennebec River at The Forks, Maine.

[DRAINAGE AREA 1570 SQUARE MILES.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	....	....	750	0.478	0.55
February	....	....	1,400	.892	.96
March	....	....	1,200	.764	.88
April	5,560	....	2,460	1.57	1.75
May	14,400	2,800	8,520	5.43	6.26
June	13,400	2,380	4,990	3.18	3.55
July	3,520	2,100	2,760	1.76	2.03
August	3,380	886	2,130	1.36	1.57
September	2,220	953	1,610	1.03	1.15
October	1,810	896	1,430	.911	1.05
November	3,500	861	1,520	.968	1.08
December	2,540	1,460	1,830	1.17	1.35
The year	14,400	....	2,550	1.62	22.17

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

KENNEBEC RIVER AT WATERVILLE.

Records of flow of Kennebec River at the dam of Hollingsworth & Whitney Company of Waterville, Maine, have been furnished since 1893.

Monthly discharge of Kennebec River at Waterville, Maine.

[DRAINAGE AREA, 4270 SQUARE MILES.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	4,010	928	3,040	0.712	.82
February	3,730	1,160	3,010	.705	.76
March	8,670	1,460	4,750	1.11	1.28
April	45,500	5,740	21,500	5.04	5.62
May	35,300	11,900	20,400	4.78	5.51
June	36,300	3,610	12,200	2.86	3.19
July	5,640	2,200	3,810	.892	1.03
August	7,470	1,640	4,590	1.07	1.23
September	6,340	1,500	3,540	.829	.92
October	24,600	1,330	5,730	1.34	1.54
November	25,700	4,650	7,330	1.72	1.92
December	7,310	1,630	4,750	1.11	1.28
The year	45,500	928	7,880	1.85	25.10

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

DEAD RIVER AT THE FORKS.

A station on Dead River, about 1 1-2 miles west of The Forks was established September 29, 1901, discontinued August 15, 1907, and re-established March 16, 1910.

Monthly discharge of Dead River at The Forks, Maine.

[DRAINAGE AREA, 878 SQUARE MILES.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	....	....	473	0.539	0.62
February	....	....	270	.308	.33
March	....	....	650	.740	.85
April	10,900	....	4,360	4.97	5.54
May	21,900	2,470	5,860	6.67	7.69
June	6,140	780	2,040	2.32	2.59
July	665	240	353	.402	.46
August	2,560	282	1,280	1.46	1.68
September	2,560	325	811	.924	1.03
October	5,100	510	1,230	1.40	1.61
November	3,730	965	1,570	1.79	2.00
December	1,510	902	1,140	1.30	1.50
The year	21,900	....	1,670	1.90	25.90

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

SANDY RIVER NEAR FARMINGTON.

The gaging station was established June 22, 1910. It is located at the Fairbanks bridge about 3 miles above Farmington and 8 miles above the dam at Farmington Falls.

Monthly discharge of Sandy River near Farmington, Maine.

[DRAINAGE AREA, 270 SQUARE MILES.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1911.					
January	....	....	100	0.370	0.43
February	....	....	80	.296	.31
March	....	....	130	.481	.55
April	....	....	1,110	4.11	4.59
May	3,400	121	694	2.57	2.96
June	517	67	207	.767	.86
July	431	13	69.6	.258	.30
August	517	38	134	.496	.57
September	517	83	144	.533	.59
October	1,140	83	306	1.13	1.30
November	923	167	375	1.39	1.55
December	2,040	221	542	2.01	2.32
The year	3,400	....	324	1.20	16.33
1912.					
January	....	....	170	0.630	0.73
February	....	....	130	.481	.52
March	....	....	300	1.11	1.28
April	5,680	....	1,890	7.00	7.81
May	6,200	353	1,330	4.93	5.68
June	2,800	67	433	1.60	1.78
July	101	38	58.8	.218	.25
August	1,420	67	181	.670	.77
September	391	52	106	.393	.44
October	6,720	83	622	2.30	2.65
November	5,520	317	686	2.54	2.83
December	1,640	353	908	3.36	3.87
The year	6,720	38	568	2.10	28.61

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1911 and 1912 will be published in Water Supply Paper No. 321.

SEBASTICOOK RIVER AT PITTSFIELD.

The gaging station on the Sebasticook River which was established July 3, 1908, is located at the steel highway bridge just above the Maine Central Railroad bridge across the river in the town of Pittsfield, Maine.

About 800 feet upstream from the gaging station is a dam which furnishes power to the Robert Dobson Co. and the Smith Woolen Co. About 5 miles below the station is the Sebasticook Power Company's dam.

Plate 1, opposite page 30, is the magnitude run-off diagram for this river. The use of the curve is described on pages 27-30 of this report. The minimum curve is for the year 1911 and the average curve for the years 1909-1912 or the period for which complete yearly estimates of discharge are available. This curve can probably be used in water power computations on many streams in the central part of the State. The amount of lake storage in this basin is characteristic of many other drainage basins. The general type of topography is common. The proportion of forested area is not large, relatively speaking, and the rainfall over the basin is normal.

Monthly discharge of Sebasticook River at Pittsfield, Maine.

[DRAINAGE AREA, 320 SQUARE MILES.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	668	193	431	1.35	1.56
February	438	176	310	.969	1.05
March	1,420	142	711	2.22	2.56
April	4,070	1,090	2,480	7.75	8.65
May	1,650	416	724	2.26	2.61
June	2,080	125	810	2.53	2.82
July	270	60	202	.631	.73
August	374	158	258	.806	.93
September	352	71	245	.766	.85
October	1,040	50	330	1.03	1.19
November	2,200	485	1,040	3.25	3.63
December	706	310	477	1.49	1.72
The year	4,070	50	665	2.08	28.30

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

COBBOSSEECONTEE STREAM AT GARDINER.

The discharge of Cobbosseecontee Stream at the dam of the Gardiner Water Power Company at Gardiner has been furnished by the S. D. Warren Co. since 1890.

The entire drainage basin is now mapped on the standard topographic sheets of the U. S. Geological Survey. The drainage area as measured from them is 220 square miles. In the previous annual reports of this Commission and in the various publications of the U. S. Geological Survey, the drainage area has been taken as 240 square miles. In close studies of the run-off of this basin correction should be made in all past records as the earlier records of run-off in second feet per square mile and depth in inches are in error, being about 10% too small.

Monthly discharge of Cobbosseecontee Stream at Gardiner, Maine.

[DRAINAGE AREA, 220 SQUARE MILES.]

Month.	Discharge in second-feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	200	0	158	.718	.83
February	230	0	194	.882	.95
March	800	0	381	1.74	2.01
April	1,130	285	761	3.46	3.86
May	1,000	0	310	1.41	1.63
June	1,580	0	468	2.13	2.38
July	260	0	213	.968	1.12
August	260	0	225	1.02	1.18
September	260	0	184	.837	.93
October	210	0	174	.791	.91
November	260	0	211	.959	1.07
December	260	0	210	.955	1.10
The year	1,580	0	290	1.32	17.97

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

ANDROSCOGGIN RIVER BASIN.

Lake Storage.

The systematic measurement of the areas of the lakes and ponds in this basin has been made from the following sources of information: Special maps of the Umbagog-Rangeley system of lakes as surveyed under the direction of this department; the regular topographic sheets of the U. S. Geological Survey; Hitchcocks atlas of New Hampshire, and large scale plans in the State Assessors Office. In a few cases county atlases were used, where more reliable maps were not available. The estimates of possible storage are in accordance with the methods as explained on page 19 of this report.

Storage in Androscoggin River Basin.

CONNECTED WITH MAIN RIVER ABOVE MOUTH OF MAGALLOWAY RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
B Pond	Upton	0.30	....	....	5	41,818,000
Beaver Pond	T.3,R.5,W.B.K.P.	0.05	....	....	5	6,970,000
Beaver Bog Pond	T. 3, R. 5, W. B. K. P. and Tim Pond	0.24	....	....	5	33,454,000
Big Island Pond	T.3,R.5,W.B.K.P.	0.55	....	....	5	76,666,000
C Pond	C Surplus	0.37	....	....	5	51,575,000
Cupsuptic Pond	T.4,R.5,W.B.K.P.	0.14	10	39,030,000	10	39,030,000
East Ponds	T.4,R.2,W.B.K.P.	0.22	....	....	5	30,666,000
Eddy Pond	T.2,R.1,W.B.K.P.	0.02	....	....	5	2,788,000
Ell Pond	T.3,R.5,W.B.K.P.	0.07	....	....	5	9,757,000
Fifth Pond	T.3,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
First Pond	T.3,R.5,W.B.K.P.	0.02	....	....	5	2,788,000
Flatiron Pond	T.3,R.3,W.B.K.P.	0.04	....	....	5	5,576,000
Fox Pond	T.4,R.3,W.B.K.P.	0.03	....	....	5	4,182,000
Fourth Pond	T.3,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
Grant Pond	T.3,R.6,W.B.K.P.	0.04	....	....	5	5,576,000
Gull Pond	Dallas	0.56	....	....	5	78,060,000
Johns Pond	T.3,R.3,W.B.K.P.	0.34	....	....	5	47,393,000
Kemankeag Pond	T.3,R.3,W.B.K.P.	0.07	....	....	5	9,757,000
Kennebago Lake	Ts. 3, R. 3 & 4, W. B. K. P.	2.74	8	1,118,042,000	18	2,528,690,000
Little Beaver Pond	Magalloway Pl.	0.09	....	....	5	12,545,000
Little Island Pond	T.3,R.5,W.B.K.P.	0.06	....	....	5	8,364,000
Little Kennebago Pond	T.3,R.4,W.B.K.P.	0.26	....	(*a*)	....	....
Long Pond	T.2,R.1,W.B.K.P.	0.89	....	....	5	124,059,000
Long Pond	Ts. D & E, R. 1	0.42	....	....	5	58,545,000
Long Pond	T.3,R.5,W.B.K.P.	0.06	....	....	5	8,364,000
Metalock Pond	T. 6, R. 1	0.10	....	....	5	13,939,000
Mooselucmaguntic Lake	Rangeley, Rangeley Pl., Richardson, T. 4, R. 2, W. B. K. P.	25.95	13	8,632,597,000	13	8,632,597,000
Moxie Pond	T. D, R. 1	0.01	....	....	5	1,394,000
Pond	Rangeley Pl	0.05	....	....	5	6,970,000
"	Rangeley Pl	0.02	....	....	5	2,788,000
"	T.2,R.1,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.2,R.1,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.4,R.3,W.B.K.P.	0.02	....	....	5	2,788,000
"	T.4,R.4,W.B.K.P.	0.03	....	....	5	4,182,000
"	T.4,R.5,W.B.K.P.	0.05	....	....	5	6,970,000
Pond-in-River	T.C and C Surplus	0.83	....	....	8	185,113,000
Quimby Pond	Rangeley	0.27	....	....	5	37,636,000
Rangeley Lake	Rangeley and Rangeley Pl.	9.76	4	1,055,476,000	4	1,055,476,000
Richardson Lake	Richardson, T.C & Magalloway	13.08	18	5,632,142,000	18	5,632,142,000
Richardson Ponds	T.4,R.2,W.B.K.P.	0.77	10	214,664,000	10	214,664,000
Round Pond	Rangeley	0.18	....	....	5	25,091,000
Round Pond	T. E	0.07	....	....	5	9,757,000
Sabbathday Pond	T. E	0.08	....	....	5	11,151,000
Second Pond	T.3,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
Secret Pond	T.3,R.5,W.B.K.P.	0.02	....	....	5	2,788,000
Sunday Pond	Magalloway	0.02	....	....	5	2,788,000
Third Pond	T.3,R.5,W.B.K.P.	0.02	....	....	5	2,788,000
Umbagog Lake	Magalloway, Upton and N. H.	15.80	10	3,132,138,000	10	3,132,138,000
White Cap Pond	T.3,R.5,W.B.K.P.	0.02	....	....	5	2,788,000
Total	....	74.78		19,824,089,000		22,179,541,000

a Flowed out by Kennebago Lake.

Storage in Androscoggin River Basin—Continued.

CONNECTED WITH MAGALLOWAY RIVER. (*b*)

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Barker Pond	T.4,R.6,W.B.K.P.	0.08	....	....	5	11,151,000
Beaver Pond	T.5,R.5,W.B.K.P.	0.02	....	....	5	2,788,000
Beerau Bog	T.5,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
Big Beaver Pond	Magalloway	0.24	....	....	5	33,454,000
Black Pond	T.5,R.5,W.B.K.P.	0.08	....	....	5	11,151,000
Bowman Pond (east)	T.4,R.6,W.B.K.P.	0.04	....	....	5	5,576,000
Bowman Pond (west)	T.4,R.6,W.B.K.P.	0.03	....	....	5	4,182,000
Cranberry Pond	Magalloway	0.21	....	....	5	29,272,000
Diamond Pond	Stewartstown, N. H.	0.38	....	....	5	52,969,000
Lincoln Pond	Parkertown	0.46	....	....	5	64,120,000
Little Diamond Pond	Stewartstown, N. H.	0.13	....	....	5	18,121,000
Long Pond	Lynchtown	0.03	....	....	5	4,182,000
Lower Metallic Pond	T.5,R.3,W.B.K.P.	0.03	....	(*c*)	....	....
Moose Bog	T.4,R.6,W.B.K.P.	0.09	....	....	5	12,545,000
Otter Pond	T.5,R.5,W.B.K.P.	0.005	....	....	5	697,000
Parmacheenee Lake	T.5,R.4,W.B.K.P.	1.33	12	444,940,000	12	444,940,000
Pond	T.5,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.5,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.5,R.5,W.B.K.P.	0.01	....	....	5	1,394,000
"	T.4,R.6,W.B.K.P.	0.02	....	....	5	2,788,000
"	T.4,R.6,W.B.K.P.	0.10	....	....	5	13,939,000
Rump Pond	T.5,R.5,W.B.K.P.	0.05	....	....	5	6,970,000
Sawyer Lake	Lincoln, Parkertown, Lynchtown	10.50	47	8,000,000,000	47	8,000,000,000
Sturtevant Pond	Magalloway	0.70	....	....	5	97,574,000
Sunday Pond	T.5,R.4,W.B.K.P.	0.03	....	....	5	4,182,000
Trout Pond	Dixville, N. H.	0.06	....	....	5	8,364,000
Upper Metallic Pond	Parkertown	0.02	....	(*c*)	....	....
Total	....	14.675		8,444,940,000		8,834,541,000

b Sawyer Lake will probably hold run-off of entire drainage area above it.
c Flowed out by Sawyer Lake.

Storage in Androscoggin River Basin—Continued.

CONNECTED WITH MAIN RIVER ABOVE RUMFORD.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Akers Pond	Errol, N. H.	0.63	....	....	10	175,634,000
Beaver Pond	T. D, R. 1	0.04	....	....	5	5,576,000
Birch Pond	Roxbury	0.02	....	....	5	2,788,000
Bunker Pond	Roxbury	0.08	....	....	5	11,151,000
Concord Pond	Woodstock	0.16	....	....	5	22,303,000
Corner Pond	Dummer, N. H.	0.13	....	....	10	36,242,000
Dummer Ponds	Dummer, N. H.	0.32	....	....	10	89,211,000
Ellis Pond	Roxbury	1.24	....	....	5	172,846,000
Horseshoe Pond	Andover	0.07	....	....	5	9,757,000
Howard Pond	Hanover	0.30	5	41,818,000	5	41,818,000
Little Concord Pond	Woodstock	0.05	....	....	5	6,970,000
Little Ellis Pond	Byron	0.66	....	....	5	91,999,000
Millsfield Ponds	Millsfield, N. H.	0.44	....	....	10	122,665,000
Moose Pond	Millsfield, N. H.	0.06	....	....	10	16,727,000
Mountain Brook Pond	D	0.15	....	....	5	20,909,000
Munn Pond	Errol, N. H.	0.13	....	....	10	36,242,000
North Pond	Woodstock	0.46	5	64,120,000	5	64,120,000
Pond	Errol, N. H.	0.13	....	....	10	36,242,000
"	Byron & Roxbury	0.08	....	....	5	11,151,000
"	Rumford	0.01	....	....	5	1,394,000
Rock Pond	Millsfield, N. H.	0.19	....	....	10	52,969,000
Round Pond	Greenwood	0.16	5	22,303,000	5	22,303,000
South Pond	Greenwood	0.46	5	64,120,000	5	64,120,000
Spencer Pond	T. D, R. 1	0.02	....	....	5	2,788,000
Success Pond	Milan, N. H.	0.44	....	....	10	122,665,000
Surplus Pond	Andover, North Surplus	0.02	....	....	5	2,788,000
Swift River Pond	T. E	0.02	....	....	5	2,788,000
Trout Pond	Mason	0.02	....	....	5	2,788,000
Wentworth Pond	Wentworth, Location, N. H.	0.13	....	....	10	36,242,000
Total	....	6.62		192,361,000		1,285,196,000

CONNECTED WITH MAIN RIVER BETWEEN RUMFORD AND LEWISTON.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Abbot Pond	Sumner	0.04	....	....	5	5,576,000
Allen Pond	Green	0.28	....	....	5	39,030,000
Anasagunticook Lake	Hartford and Canton	0.87	5	121,271,000	5	121,271,000
Androscoggin Pond	Leeds and Wayne	5.99	....	....	10	1,699,917,000
Auburn Lake	Auburn	3.47	6	580,428,000	6	580,428,000
Basin, The	Auburn	0.11	....	....	5	15,333,000
Basin Pond	Fayette	0.05	....	....	5	6,970,000
Bear Pond	Hartford and Turner	0.48	....	....	5	66,908,000
Berry Pond	Green	0.03	....	....	5	4,182,000
Black Pond	Turner	0.03	....	....	5	4,182,000
Bonney Pond	Leeds	0.05	....	....	5	6,970,000
Boody Pond	Vienna	0.01	....	....	5	1,394,000
Brettons Pond	Livermore	0.29	....	....	5	40,424,000
Bunganock Pond	Hartford	0.08	....	(*d*)	....	....
Burgess Pond	Fayette	0.04	....	....	5	5,576,000
Cranberry Pond	Fayette	0.04	....	....	5	5,576,000

d Drained by R. F. & R. L. R. R.

Storage in Androscoggin River Basin—Continued.

CONNECTED WITH MAIN RIVER BETWEEN RUMFORD AND LEWISTON—Concluded.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Crotched Pond....	Monmouth, Readfield, Fayette...	1.68	10	468,357,000	10	468,357,000
Crystal Pond.....	Turner..........	0.05	....	....	5	6,970,000
Cushman Pond...	Sumner.........	0.02	....	....	5	2,788,000
Davids Pond.....	Fayette.........	0.48	....	....	5	66,908,000
Flying Pond......	Mt. Vernon, Vienna........	0.59	....	....	5	82,241,000
Forest Pond......	Canton..........	0.07	....	....	5	9,757,000
Hales Pond.......	Fayette.........	0.11	....	....	5	15,333,000
Half Moon Pond..	Carthage........	0.12	....	....	5	16,727,000
Island Pond......	Leeds...........	0.03	....	....	5	4,182,000
Kimball Pond....	Vienna..........	0.04	....	....	5	5,576,000
Labrador Pond...	Sumner.........	0.15	....	....	5	20,909,000
Little Bear Pond..	Hartford........	0.17	....	....	5	23,697,000
Little Labrador Pond..........	Sumner.........	0.02	....	....	5	2,788,000
Little Wilson Pond	Turner..........	0.17	0	....	5	23,697,000
Long Pond.......	Livermore.......	0.33	....	....	5	45,999,000
Long Pond.......	Turner..........	0.02	....	....	5	2,788,000
Lovejoy Pond....	Readfield, Fayette	0.57	....	....	5	79,453,000
Moose Hill Pond..	E. Livermore....	0.14	....	....	5	19,515,000
Mt. Vernon Pond.	Mt. Vernon......	0.20	....	....	5	27,878,000
Mud Pond........	Turner..........	0.03	....	....	5	4,182,000
Mud Pond........	Peru............	0.01	....	....	5	1,394,000
Nelson Pond......	Livermore.......	0.02	....	....	5	2,788,000
North Pond......	Sumner.........	0.22	4	24,533,000	5	30,666,000
Northeast Pond...	Hartford........	0.01	....	....	5	1,394,000
Parker Pond......	Chesterville, Fayette, Mt. Vernon, Vienna...	2.48	....	....	5	345,692,000
Pickerel Pond....	Wayne..........	0.18	....	....	5	25,091,000
Pleasant Pond....	Turner..........	0.27	....	....	5	37,636,000
Pleasant Pond....	Sumner.........	0.17	4	18,957,000	5	23,697,000
Pocasset Lake....	Wayne..........	0.89	....	....	5	124,059,000
Pond	Carthage, Mexico.	0.09	....	....	5	12,545,000
"	Mexico..........	0.04	....	....	5	5,576,000
"	Mexico..........	0.05	....	....	5	6,970,000
"	Temple..........	0.07	....	....	5	9,757,000
Round Pond......	Livermore.......	0.25	....	....	5	34,848,000
Round Pond......	Turner..........	0.02	....	....	5	2,788,000
Sandy Bottom Pond..........	Turner..........	0.05	....	....	5	6,970,000
Shagg Pond......	Woodstock......	0.08	4.5	10,036,000	5	11,151,000
South Pond......	Buckfield........	0.05	....	....	5	6,970,000
Swan Pond.......	Hartford........	0.03	....	....	5	4,182,000
Tilton Pond......	Fayette.........	0.16	....	....	5	22,303,000
Washburn Pond...	Woodstock......	0.02	2	1,115,000	3	1,673,000
Webbs Pond......	Carthage & Weld.	3.98	....	....	5	554,780,000
Worthley Pond...	Peru............	0.54	....	....	5	75,272,000
Total........	....	26.53		1,224,697,000		4,881,684,000

Storage in Androscoggin River Basin—Concluded.

CONNECTED WITH LITTLE ANDROSCOGGIN RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Bryant Pond	Woodstock, Greenwood	0.41	4	45,721,000	5	57,151,000
Green Pond	Oxford	0.06	....	....	5	8,364,000
Hall Pond	Paris	0.08	....	....	5	11,151,000
Hicks Pond	Greenwood	0.13	5	18,121,000	5	18,121,000
Hogan Pond	Oxford	0.26	....	....	5	36,242,000
Indian Pond	Greenwood	0.09	0	....	5	12,545,000
Little Pennessewassee Pond	Norway	0.17	5	23,697,000	8	37,915,000
Lower Range Pond	Poland	0.43	5	59,939,000	5	59,939,000
Marshall Pond	Hebron & Oxford	0.22	....	....	5	30,666,000
Middle Range Pond	Poland	0.59	4	82,241,000	4	82,241,000
Moose Pond	Paris	0.13	4.5	16,309,000	7.5	27,181,000
Moose Pond	Otisfield	0.28	....	....	5	39,030,000
Mud Pond	Oxford	0.03	....	....	5	4,182,000
Mud Pond	Greenwood	0.07	....	....	5	9,757,000
North Pond	Norway	0.25	2	13,939,000	5	34,848,000
Oversett Pond	Greenwood	0.02	....	....	5	2,788,000
Pennessewassee Pond	Norway	1.38	5	192,361,000	5	192,361,000
Sand Pond	Norway	0.11	....	....	5	15,333,000
Saturday Pond	Otisfield	0.29	....	....	5	40,424,000
Speck Pond	Norway	0.01	....	....	5	1,394,000
Taylor Pond	Auburn	0.98	4	109,283,000	4	109,283,000
Thompson Pond	Casco, Poland, Otisfield, Oxford	6.82	5	950,654,000	5	950,654,000
Tripp Pond	Poland	1.15	5	160,301,000	5	160,301,000
Twitchell Pond	Greenwood	0.24	6	40,145,000	10	66,908,000
Upper Range Pond	New Gloucester	0.59	2	32,896,000	2	32,896,000
Whitney Pond	Oxford	0.28	....	....	5	39,030,000
Worthley Pond	Poland	0.08	....	....	5	11,151,000
Total	....	15.15		1,745,607,000		2,091,856,000

CONNECTED WITH MAIN RIVER BETWEEN LEWISTON AND BRUNSWICK.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Caesar Pond	Bowdoin	0.10	....	....	5	13,939,000
Little Sabattus Pond	Greene	0.05	....	....	5	6,970,000
Loon Pond	Webster	0.11	0	....	0	....
No Name Pond	Lewiston	0.22	0	....	0	....
Pond	Bowdoin	0.02	....	....	5	2,788,000
Sabattus Pond	Greene, Wales, Webster	4.56	6	762,753,000	6	762,753,000
Sutherland Pond	Webster	0.06	....	....	5	8,364,000
Total	....	5.12		762,753,000		794,814,000

Summary of Storage in Androscoggin Basin.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Upper Androscoggin River	635	74.78	8.5	19,824,089,000	22,179,541,000
Magalloway River	460	14.68	31.4	8,444,940,000	8,834,541,000
Between Errol and Rumford	995	6.62	149.8	192,361,000	1,285,196,000
Between Rumford and Lewiston	860	26.53	32.4	1,224,697,000	4,881,684,000
Little Androscoggin River	380	15.15	25.1	1,745,607,000	2,091,856,000
Between Lewiston and mouth	178	5.12	34.8	762,753,000	794,814,000
	3,510	142.88	24.6	32,194,447,000	40,067,632,000

STREAM FLOW.

The following stations have been maintained during 1912 in this basin:

Androscoggin River at Errol, N. H.
Androscoggin River at Rumford.
Magalloway River at Aziscohos Dam.

ANDROSCOGGIN RIVER AT ERROL, N. H.

The record of flow of Androscoggin River at Errol Dam, N. H., has been furnished by Mr. Walter H. Sawyer, agent of the Union Water Power Co. since 1905. The computations are based on coefficients applied to 14 gates in the dam as computed from a few discharge measurements. The gate ratings are not as thorough as could be desired but the records as published are believed to approximate the true discharge and are considered fair.

Monthly discharge of Androscoggin River at Errol, N. H.

[DRAINAGE AREA, 1095 SQUARE MILES.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	1,920	1,450	1,650	1.51	1.74
February	1,940	1,570	1,780	1.63	1.76
March	1,940	1,300	1,570	1.43	1.65
April	2,420	1,240	1,610	1.47	1.64
May	3,300	1,660	2,180	1.99	2.29
June	6,020	1,770	3,320	3.03	3.38
July	1,890	1,400	1,680	1.53	1.76
August	1,700	1,000	1,430	1.31	1.51
September	1,900	1,030	1,500	1.37	1.53
October	1,730	976	1,410	1.29	1.49
November	....	....	1,450	1.32	1.47
December	....	....	1,450	1.32	1.52
The year	6,020	....	1,750	1.60	21.74

ANDROSCOGGIN RIVER AT RUMFORD.

The discharge of the Androscoggin River at Rumford since 1892 has been furnished through the courtesy of Mr. Charles A. Mixer, engineer, Rumford Falls Power Co.

Monthly discharge of Androscoggin River at Rumford, Maine.

[DRAINAGE AREA, 2090 SQUARE MILES.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	2,840	2,060	2,330	1.11	1.28
February	2,460	2,090	2,300	1.10	1.19
March	3,540	2,210	2,580	1.23	1.42
April	17,000	2,950	7,750	3.71	4.14
May	8,330	3,340	5,470	2.62	3.02
June	9,150	1,840	4,480	2.14	2.39
July	2,240	1,590	1,980	.947	1.09
August	3,920	1,770	2,250	1.08	1.24
September	4,740	1,480	2,360	1.13	1.26
October	12,840	1,850	3,050	1.46	1.68
November	9,170	2,400	3,150	1.51	1.68
December	4,660	1,720	2,790	1.34	1.54
The year	17,000	1,480	3,370	1.61	21.93

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

MAGALLOWAY RIVER AT AZISCOHOS DAM.

Aziscohos Dam on Magalloway River, about 15 miles above its mouth, was completed in 1911. By its construction, Sawyer Lake, was created with a storage capacity of about 8 billion cubic feet. The outlet is into Androscoggin River above the Errol dam.

Computations of discharge through the Aziscohos dam have been made by Mr. Walter H. Sawyer, Agent of Union Water Power Co., Lewiston, Maine and through his courtesy, furnished this office for publication. The lake is wholly under artificial control and the discharge represents such amounts as are required for water power interests below. The operation of the gates is so planned as to maintain as nearly a constant flow as possible at Berlin, N. H. for the extensive water power developments at that place.

Monthly discharge of Magalloway River through Aziscohos Dam.

[Drainage area, 240 square miles.]

Month.	Cubic feet.	Discharge in Second-Feet.	
		Mean.	Per sq. m.
1912.			
January	607,046,400	226.6	.94
February	245,894,400	98.1	.41
March	192,844,800	72.0	.30
April	197,683,200	76.2	.32
May	510,451,200	190.6	.79
June	1,091,491,200	421.1	1.75
July	1,013,299,200	378.3	1.58
August	1,011,571,200	377.7	1.57
September	1,530,576,000	590.5	2.46
October	1,311,379,200	489.6	2.04
November	2,348,006,400	905.8	3.77
December	3,463,344,000	1,293.0	5.39
Total	13,523,587,200		
Average per month		426.6	1.78

ROYAL RIVER BASIN.

LAKE STORAGE.

The determination of the lake areas in this basin have been based on the U. S. Geological Survey topographic maps. Little is known of the actual possibilities of storage but a uniform height of 5 feet has been assumed and the total possible storage computed on this basis.

Storage in Royal River Basin.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE.		POSSIBLE STORAGE.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Dry Pond	Gray	0.28	....	....	0	....
Lily Pond	New Gloucester	0 04	....	....	5	5,576,000
Notched Pond	Raymond, Gray and New Gloucester	0.24	5	33,454,000	5	33,454,000
Pond	Durham	0.13	....	....	5	18,121,000
Sabbathday Pond	New Gloucester	0.58	5	80,847,000	5	80,847,000
Shaker Bog	New Gloucester	0.25	....	....	5	34,848,000
Total	....	1.52		114,301,000		172,846,000

Summary of Storage in Royal River Basin.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Royal River Total	136	1.52	89.5	114,361,000	172,846,000

PRESUMPSCOT RIVER BASIN.

LAKE STORAGE.

The entire drainage area of this basin is now covered by the topographic maps of the U. S. Geological Survey. The areas of the various lakes and ponds in the basin were measured by planimeter from the topographic sheets and are given in the tables below. The method of estimating the present storage and possible storage is described on page 19 of this report.

The table immediately below gives the areas and capacities of Sebago Lake for each foot of storage on the lake. The Sebago and Gray quadrangles were the base maps on which the areas were measured. The area of the shore line was measured and the area under the 280 foot contour. The areas as given in the table for each foot of storage were interpolated between the two areas as measured on the map.

Areas and Capacities of Sebago Lake.

ELEVATION FEET.	Area, sq. miles.	Capacity of section—cu. ft.	Total capacity—cubic feet.
262.5	44.76	0	0
263	44.91	624,964,000	624,964,000
264	45.20	1,256,061,000	1,881,025,000
265	45.50	1,264,285,000	3,145,310,000
266	45.80	1,272,649,000	4,417,959,000
267	46.09	1,280,873,000	5,698,832,000
268	46.39	1,289,097,000	6,987,929,000
269	46.68	1,297,321,000	8,285,250,000
270	46.98	1,305,545,000	9,590,795,000
270.5	47.13	662,805,000	10,253,600,000

Storage in Presumpscot River Basin.

CONNECTED WITH CROOKED RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Broken Bridge Pond	Albany	0.02	....	....	5	2,788,000
Chalk Pond	Albany	0.04	....	....	5	5,576,000
Cooks Pond	Casco	0.04	....	....	5	5,576,000
Duck Pond	Waterford	0.01	....	....	5	1,394,000
Furlong Pond	Greenwood, Albany, Norway	0.02	....	....	5	2,788,000
Hutchinson Pond	Albany	0.12	....	....	5	16,727,000
Island Pond	Harrison, Waterford	0.20	....	....	5	27,878,000
Keewaydin Lake	Stoneham	0.41	....	....	5	45,721,000
Kneeland Pond	Albany	0.02	....	....	5	2,788,000
Little Pond	Otisfield	0.02	....	....	5	2,788,000
Little Pappouse Pond	Albany	0.03	....	....	5	4,182,000
Long Pond	Waterford	0.72	5.0	100,362,000	5	100,362,000
Mosquito Pond	Albany	0.005	....	....	5	697,000
Pappouse Pond	Albany	0.01	....	....	5	1,394,000
Pappouse Pond	Waterford	0.12	....	....	5	16,727,000
Parker Pond	Casco	0.26	....	....	5	36,242,000
Pleasant Pond	Casco and Otisfield	1.66	5.0	231,391,000	5	231,391,000
Proctor Pond	Albany	0.06	....	....	5	8,364,000
Songo Pond	Albany	0.29	....	....	5	40,424,000
Virginia Lake	Stoneham	0.21	....	....	5	29,272,000
Weymouth Pond	Stoneham	0.02	....	....	5	2,788,000
Whitney Pond	Stoneham	0.01	....	....	5	1,394,000
Total	....	4.295		331,753,000		587,261,000

CONNECTED WITH SONGO RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Anonymous Pond	Harrison	0.73	8	162,810,000	8	162,810,000
Bear Pond	Waterford	0.37	7	72,205,000	7	72,205,000
Black Pond	Sweden	0.01	....	....	5	1,394,000
Bog Pond	Harrison	0.04	....	....	5	5,576,000
Bog Pond	Waterford	0.06	....	....	5	8,364,000
Brandy Pond	Naples	1.11	8	247,560,000	8	247,560,000
Highland Lake	Bridgton	2.10	7	409,812,000	7	409,812,000
Ingalls Pond	Bridgton	0.13	....	....	5	18,121,000
Keoka Lake	Waterford	0.72	7.5	150,543,000	7.5	150,543,000
Long Lake	Bridgton, Harrison, Naples	9.55	8	2,129,909,000	8	2,129,909,000
Moose Pond	Waterford	0.28	....	....	5	39,030,000
Otter Pond	Bridgton	0.17	....	....	5	23,697,000
Sandy Creek Pond	Bridgton	0.03	....	....	5	4,182,000
Stearns Pond	Sweden	0.37	7	72,205,000	7	72,205,000
Wood Pond	Bridgton	0.63	5	87,817,000	5	87,817,000
Total	....	16.30		3,332,861,000		3,433,225,000

Storage in Presumpscot River Basin—Concluded.

CONNECTED WITH SEBAGO LAKE.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Adams Pond	Bridgton	0.17	....	....	5	23,697,000
Browns Pond	Sebago	0.13	....	....	5	18,121,000
Coffee Pond	Casco	0.17	....	....	5	23,697,000
Dumpling Pond	Casco	0.05	....	....	5	6,970,000
East Sebago Pond	Sebago	0.02	....	....	5	2,788,000
Holt Pond	Bridgton, Naples	0.10	....	....	5	13,939,000
Mill Brook Pond	Sebago	0.03	....	....	5	4,182,000
Nubble Pond	Raymond	0.05	....	....	5	6,970,000
Panther Pond	Raymond	2.10	4.7	275,157,000	4.7	275,157,000
Peabody Pond	Bridgton, Naples, Sebago	1.09	3	91,162,000	3	91,162,000
Perley Pond	Sebago	0.04	....	....	5	5,576,000
Pond	Casco	0.04	....	....	5	5,576,000
"	Naples	0.19	....	....	5	26,484,000
"	Windham	0.04	....	....	5	5,576,000
Rattlesnake Pond	Casco, Raymond	1.25	4.7	163,780,000	4.7	163,780,000
Raymond Pond	Raymond	0.64	5	89,211,000	5	89,211,000
Sebago Lake	Windham, Standish, Sebago, Naples, Casco, Raymond	44.80	8	10,253,600,000	8	10,253,600,000
Thomas Pond	Casco, Raymond	0.71	5.5	108,865,000	5.5	108,865,000
Trickey Pond	Naples	0.48	4	53,526,000	4	53,526,000
Webbs Pond	Casco	0.02		....	5	2,788,000
Total	....	52.12		11,035,301,000		11,181,665,000

CONNECTED WITH PLEASANT RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Allen Mill Pond	Gray	0.09	....	....	5	12,545,000
Collins Pond	Windham	0.09	....	....	5	12,545,000
East Raymond Pond	Raymond	0.14	....	....	5	19,515,000
Little Sebago Pond	Gray, Windham	2.94	10	819,625,000	10	819,625,000
Pond	Gray and Raymond	0.03	....	....	5	4,182,000
Total	....	3.29		819,625,000		868,412,000

CONNECTED WITH MAIN RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage. Feet.	Present Storage. Cubic feet.	Possible Storage. Feet.	Possible Storage. Cubic feet.
Duck Pond	Falmouth, Windham	0.96	5	133,816,000	5	133,816,000
Goose Pond	Cumberland, Falmouth, Gray	0.31	5	43,212,000	5	43,212,000
Little Duck Pond	Windham	0.05	....	....	5	6,970,000
Tuttle Pond	Windham	0.09	....	....	5	12,545,000
Total	....	1.41		177,028,000		196,543,000

Summary of Storage in Presumpscot River Basin.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Crooked River	136	4.30	27.6	331,753,000	587,261,000
Songo River	244	16.30	15.0	3,332,861,000	3,433,225,000
Sebago Lake	56	52.12	1.1	11,035,301,000	11,181,665,000
Pleasant River	48	3.29	14.6	819,625,000	868,412,000
Main River	132	1.41	93.7	177,028,000	196,543,000
Total	616	77.42	8.0	15,696,568,000	16,267,106,000

Stream Flow.

PRESUMPSCOT RIVER AT OUTLET SEBAGO LAKE.

The record of flow of Sebago Lake has been kept since 1887 and has been furnished from time to time by the S. D. Warren Co.

It is noted in the First Annual Report, page 350, that the maximum discharge of Presumpscot River was 13,800 sec. ft. from a drainage area of 420 square miles, during the unprecedented flood of March 1st, 1896. This office has since been informed by Mr. Henry W. Foster, engineer of the S. D. Warren Co., that this measurement was made at Cumberland Mills, and furthermore, that the gates at the outlet of Sebago Lake and at the outlet of Little Sebago Lake were practically closed at the time, permitting a combined discharge of only about 370 sec. ft. at the outlets in question. The remaining discharge of 13,400 sec. ft. came from the area of 114 square miles between the outlets of the lakes and Cumberland Mills. This would indicate a maximum flood run-off of 118 sec. ft per square mile. *a.*

a. Mr. Henry W. Foster in a paper entitled "Hydraulic Development of Presumpscot River," presented before the Maine Society of Civil Engineers, Proceedings, Vol. 2, gives the drainage area as 115.8 square miles with a resulting unit run-off of 116 second feet per square mile.

Monthly discharge of Presumpscot River at Sebago Lake Outlet, Me.

[DRAINAGE AREA 436 SQUARE MILES.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	545	182	496	1.14	1.31
February	547	188	487	1.12	1.21
March	543	33	358	.821	.95
April	543	107	345	.791	.88
May	540	168	469	1.08	1.24
June	538	180	471	1.08	1.20
July	598	185	491	1.13	1.30
August	667	310	575	1.32	1.52
September	667	222	601	1.38	1.54
October	678	223	611	1.40	1.61
November	680	228	601	1.38	1.54
December	823	233	678	1.56	1.80
The year	823	33	516	1.18	16.10

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

SACO RIVER BASIN.

Lake Storage.

The systematic measurement of the areas of the lakes and ponds of this basin has been completed, maps used being the topographic sheets of the U. S. Geological Survey and Hitchcock's Atlas of New Hampshire. The estimates of possible storage are in accordance with the methods as explained on page 19 of this report.

Storage in Saco River Basin.

CONNECTED WITH MAIN RIVER IN NEW HAMPSHIRE.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Conway Pond.....	Eaton & Conway.	2.28	9	572,064,000	9	572,064,000
Davis Pond......	Madison.........	0.13	....	....	5	18,121,000
Echo Pond.......	Conway.........	0.02	....	....	5	2,788,000
Mountain Pond...	Chatham........	0.19	....	....	5	26,484,000
Pea Porridge Pond	Madison.........	0.25	....	....	5	34,848,000
Pequawket Pond..	Conway.........	0.13	....	....	5	18,121,000
Pudding Pond....	Conway.........	0.03	....	....	5	4,182,000
Robertson Pond..	Conway.........	0.06	....	....	5	8,364,000
Robertsons Pond..	Eaton...........	0.19	....	....	5	26,484,000
Sawyer Pond.....	Livermore.......	0.10	....	....	5	13,939,000
Webb Pond......	Chatham........	0.22	....	....	5	30,666,000
Total........	....	3.60		572,064,000		756,061,000

Storage in Saco River Basin—Continued.

CONNECTED WITH MAIN RIVER BETWEEN NEW HAMPSHIRE LINE AND OSSIPEE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Barker Pond	Hiram, Sebago	0.33	5	45,999,000	7	64,399,000
Beaver Pond	Bridgton	0.11	....	....	5	15,333,000
Beaver Pond	Denmark	0.13	....	....	5	18,121,000
Berry Pond	Sweden	0.01	....	....	5	1,394,000
Black Pond	Fryeburg	0.03	....	....	5	4,182,000
Bog Pond	Fryeburg	0.06	....	....	5	8,364,000
Boston Pond	Denmark	0.02	....	....	5	2,788,000
Bradley Pond	Lovell	0.05	....	....	5	6,970,000
Bryant Pond	Hiram	0.01	....	....	5	1,394,000
Burnt Meadow Pond	Brownfield	0.08	....	....	10	22,303,000
Charles Pond	Fryeburg	0.16	....	....	10	44,605,000
Clays Pond	Fryeburg	0.04	....	....	5	5,576,000
Clemens Pond	Hiram	0.12	....	....	5	16,727,000
Cushman Pond	Lovell	0.05	....	....	5	6,970,000
Dan Charles Pond	Lovell	0.03	....	....	5	4,182,000
Dyer Pond	Brownfield	0.002	....	....	5	279,000
Farrington Pond	Lovell	0.09	....	....	5	12,545,000
Five Kezar Ponds	Stoneham and Waterford	0.32	5	44,605,000	5	44,605,000
Granger Pond	Denmark	0.19	....	....	5	26,484,000
Great Hancock Pond	Denmark	1.52	4	169,500,000	6	254,251,000
Haley Pond	Fryeburg	0.006	....	....	5	836,000
Heald Pond	Lovell	0.12	....	....	10	33,450,000
Horseshoe Pond	Stoneham, Lovell	0.21	5	29,272,000	10	58,545,000
Hunt Pond	Fryeburg	0.008	....	....	5	1,115,000
Keys Pond	Sweden	0.28	5	39,030,000	10	78,060,000
Kezar Pond	Fryeburg	2.03	....	....	....	....
Kezar Lake	Lovell	3.92	....	....	4	437,133,000
Kimball Pond	Fryeburg	0.82	....	....	5	114,301,000
Little Pond	Denmark	0.09	....	....	5	12,545,000
Little Pond	Fryeburg	0.01	....	....	5	1,394,000
Little Clemens Pond	Hiram	0.04	....	....	5	5,576,000
Lovewell Pond	Fryeburg	1.66	....	....	....	....
Long Pond	Denmark	0.09	....	....	5	12,545,000
Middle Pond	Hiram	0.06	....	....	10	16,727,000
Moose Pond	Bridgton, Denmark	2.60	9.8	710,341,000	12	869,806,000
Mud Pond	Denmark	0.01	....	....	5	1,394,000
Noah Eastman Pond	Lovell	0.01	....	....	5	1,394,000
Pleasant Pond	Brownfield, Fryeburg	0.36	....	....	....	....
Pond	Denmark	0.03	....	....	5	4,182,000
Ponds	Denmark	0.08	....	....	5	11,151,000
Rattlesnake Pond	Brownfield	0.12	....	....	5	16,727,000
Southeast Pond	Sebago	0.36	....	....	5	50,181,000
Ten-mile Pond	Brownfield	0.04	....	....	5	5,576,000
Trout Pond	Stoneham	0.07	....	....	5	9,757,000
Webber Pond	Sweden	0.05	....	....	5	6,970,000
Total	....	16.426		1,038,747,000		2,310,837,000

Storage in Saco River Basin—Continued.

CONNECTED WITH OSSIPEE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Allen Pond	Parsonsfield	0.01	....	....	5	1,394,000
Bean Pond	Ossipee, N. H.	0.06	....	....	5	8,364,000
Bear Camp Pond	Sandwich, N. H.	0.44	....	....	10	122,665,000
Bickford Pond	Porter	0.32	8	71,369,000	10	89,211,000
Chapman Pond	Porter	0.02	....	....	5	2,788,000
Chocorua Ponds	Tamworth, N. H.	0.51	....	....	10	142,180,000
Colcord Pond	Porter	0.34	10	94,787,000	15	142,180,000
Dan Hole Pond	Tuftonborough, Ossipee, N. H.	0.88	....	....	10	245,330,000
Danforth Ponds	Freedom, N. H.	0.38	....	....	11	116,532,000
Dinsmore Pond	Sandwich, N. H.	0.06	....	....	5	8,364,000
Duncan Lake	Ossipee, N. H.	0.13	....	....	5	18,121,000
Elliot Pond	Tamworth, N. H.	0.25	....	....	10	69,696,000
Garland Pond	Ossipee, N. H.	0.13	....	....	10	36,242,000
Great Hill Pond	Tamworth, N. H.	0.44	....	....	5	61,332,000
Great Ossipee Lake	Watertown, Ossipee, Freedom, N. H.	5.18	6	...866,461,000	11	1,588,511,000
Hubbard Pond	Porter	0.01	....	....	5	1,394,000
Jaybird Pond	Hiram, Porter	0.01	....	....	5	1,394,000
Knowles Pond	Albany, N. H.	0.19	....	....	5	26,484,000
Long Bay	Freedom, Effingham, N. H.	1.64	....	....	11	502,925,000
Long Pond	Eaton, N. H.	0.32	....	....	5	44,605,000
Lords Pond	Parsonsfield and N. H.	0.22	10	61,332,000	12	73,599,000
Lovells Pond	Ossipee, N. H.	0.06	....	....	5	8,364,000
Lower Beech Pond	Tuftonborough, N. H.	0.44	....	....	5	61,332,000
Mine Pond	Porter	0.08	....	....	5	11,151,000
Pine River Pond	Wakefield, N. H.	1.26	12	421,520,000	12	421,520,000
Plain Pond	Porter	0.03	....	....	5	4,182,000
Pond	Porter	0.07	....	....	5	9,757,000
Province Pond	Parsonsfield, Wakefield, Effingham, N. H.	1.41	....	....	5	196,543,000
Silver Lake	Madison, N. H.	0.69	2.0	38,472,000	5.0	96,180,000
Spectacle Ponds	Porter	0.11	8	24,533,000	11	33,733,000
Spruce Pond	Parsonsfield	0.04	6	6,691,000	9	10,036,000
Stanley Pond	Hiram, Porter	0.21	....	....	10	58,545,000
Swasey Pond	Freedom, N. H.	0.38	....	....	10	105,938,000
Trafton Pond	Hiram, Porter	0.08	....	....	10	22,303,000
Trout Pond	Freedom, N. H.	0.06	....	....	5	8,364,000
Upper Beech Pond	Wolfborough, N. H.	0.32	....	....	5	44,605,000
Welch Pond	Ossipee, N. H.	0.06	....	....	5	8,364,000
White Pond	Ossipee, N. H.	0.06	....	....	5	8,364,000
White Pond	Tamworth, N. H.	0.25	....	....	5	34,848,000
Whitton Pond	Albany, N. H.	0.25	....	....	5	34,848,000
Total	....	17.40		1,585,165,000		4,482,288,000

Storage in Saco River Basin—Concluded.

CONNECTED WITH LITTLE OSSIPEE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Adams Pond	Newfield	0.19	5	26,484,000	5	26,484,000
Balch Pond	Newfield and Wakefield, N.H.	1.07	8	238,639,000	12	357,959,000
Boyd Pond	Limington	0.06	....	....	5	8,364,000
Holland East Pond	Cornish	0.16	....	....	....	....
Holland West Pond	Cornish	0.31	....	....	5	43,212,000
Little Ossipee Pond	Waterboro	1.01	4	112,629,000	4	112,629,000
Long Pond	Parsonsfield	0.40	....	....	5	55,757,000
Northwest Pond	Waterboro	0.06	....	....	5	8,364,000
Poverty Pond	Newfield, Shapleigh	0.24	....	....	15	100,362,000
Sand Pond	Baldwin	0.03	....	....	5	4,182,000
Sand Pond	Wakefield, N. H.	0.06	....	....	5	8,364,000
Shy Beaver Pond	Shapleigh	0.09	....	....	5	12,545,000
Symmes Pond	Newfield	0.06	....	....	5	8,364,000
Turner Pond	Newfield	0.05	....	....	....	....
Wards Pond	Limington	0.06	9	15,054,000	10	16,727,000
Total	....	3.85		392,806,000		763,313,000

CONNECTED WITH MAIN RIVER BELOW MOUTH OF OSSIPEE RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Barker Pond	Lyman & Dayton	0.11	....	....	5	15,333,000
Deer Pond	Hollis	0.04	....	....	5	5,576,000
Eagle Pond	Standish, Buxton	0.23	....	....	5	32,060,000
Horne Pond	Limington	0.26	7.7	55,813,000	7.7	55,813,000
Ingalls Pond	Baldwin	0.04	....	....	5	5,576,000
Little Watchic Pond	Standish	0.02	0.0	....	5	2,788,000
Swan Pond	Lyman	0.29	....	....	5	40,424,000
Watchic Pond	Standish	0.39	5.7	61,972,000	5.7	61,972,000
Total	....	1.38		117,785,000		219,542,000

Summary of Storage in Saco River Basin.

Basin.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Main River in New Hampshire	439	3.60	122.0	572,064,000	756,061,000
Main River between N. H. line and Ossipee River	400	16.43	24.3	1,038,747,000	2,310,837,000
Ossipee River	462	17.40	26.6	1,585,165,000	4,482,288,000
Little Ossipee River	172	3.85	44.7	392,806,000	763,313,000
Main River below Ossipee River	258	1.38	186.8	117,785,000	219,542,000
Total	1,730	42.66	40.6	3,706,567,000	8,532,041,000

STREAM FLOW.

SACO RIVER AT WEST BUXTON.

This station, which was established in 1907, is located at the hydro-electric plant of the Portland Electric Co. The data is furnished for publication through the courtesy of the General Manager of the Company.

Monthly discharge of Saco River at West Buxton, Maine.

[DRAINAGE AREA, 1550 SQUARE MILES.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1912.					
January	1,750	774	1,380	0.890	1.03
February	1,480	683	1,110	.716	.77
March	7,440	505	3,010	1.94	2.24
April	13,000	7,140	9,720	6.27	7.00
May	8,660	4,850	6,120	3.95	4.55
June	6,540	875	3,450	2.23	2.49
July	1,500	620	1,230	.794	.92
August	2,160	912	1,400	.903	1.04
September	2,010	557	1,120	.723	.81
October	3,930	690	1,550	1.00	1.15
November	4,660	1,400	2,950	1.90	2.12
December	2,540	1,030	1,830	1.18	1.36
The year	13,000	505	2,900	1.87	25.48

NOTE.—The complete hydrographic data for this station, including descriptions, list of discharge measurements, daily gage heights and daily discharge for 1912 will be published in Water Supply Paper No. 321.

COASTAL BASIN NO. 4.

This basin includes the drainage basins of the Kennebunk, Mousam, York and Piscataqua rivers.

Lake Storage.

The lakes given in the tables below are shown on the topographic sheets of the U. S. Geological Survey and the areas were measured by planimeter from these maps. Estimates of present storage and possible storage have been made based on whatever information was available. It should be noticed that for the Piscataqua River the drainage area of 550 square miles is measured below the mouth of Cocheco River. The lakes and ponds, however, do not include any that are wholly in the State of New Hampshire, and hence the ratio of drainage area to pond area is not given.

Storage in Coastal Basin, No. 4.

CONNECTED WITH KENNEBUNK RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Kennebunk Pond	Kennebunk	0.46	4	51,296,000	5	64,120,000
Alewives Pond	Kennebunk	0.29	....	....	5	40,424,000
Total	....	0.75		51,296,000		104,544,000

CONNECTED WITH MOUSAM RIVER.

Name.	Location.	Surface area, sq. miles.	Present Storage.		Possible Storage.	
			Feet.	Cubic feet.	Feet.	Cubic feet.
Bunganut Pond	Lyman	0.43	5	59,939,000	10	119,877,000
Emery Mills Pond	Shapleigh	0.22	....	....	5	30,666,000
Loon Pond	Acton	0.19	....	....	5	26,484,000
Mousam Pond	Acton	1.10	5	153,331,000	5	153,331,000
Pleasant Pond	Acton & Shapleigh	1.27	....	....	5	177,027,000
Pond	Alfred	0.02	....	....	5	2,788,000
Shaker Pond	Alfred	0.34	4	37,915,000	5	47,393,000
Total	....	3.57		251,185,000		557,566,000

Storage in Coastal Basin No. 4—Concluded.

CONNECTED WITH YORK RIVER.

NAME.	Location.	Surface area, sq. miles.	PRESENT STORAGE. Feet.	PRESENT STORAGE. Cubic feet.	POSSIBLE STORAGE. Feet.	POSSIBLE STORAGE. Cubic feet.
Folly Pond	York	0.07	....	....	5	9,757,000
Pond	York	0.02	....	....	5	2,788,000
"	York	0.03	....	....	5	4,182,000
York Pond	Elliot	0.09	....	....	5	12,545,000
Total	....	0.21				29,272,000

COASTAL.

Lake Agamenticus	York	0.52	....	....	5	72,484,000
Great Pond	Cape Elizabeth	0.09	....	....	5	12,545,000
Total	....	0.61				85,029,000

CONNECTED WITH PISCATAQUA RIVER BASIN.

Bauneg Beg Pond	Berwick, Sanford	0.28	5	39,030,000	5	39,030,000
Cox Pond	South Berwick	0.10	....	....	5	13,939,000
Great East Pond	Acton and Wakefield, N. H.	3.22	10	897,685,000	10	897,685,000
Hooker Pond	South Berwick	0.06	....	....	5	8,364,000
Horn Pond	Acton and Milton, N. H.	0.28	10	78,060,000	10	78,060,000
Milton Three Ponds (east)	Lebanon, Milton, N. H.	0.78	12	260,942,000	12	260,942,000
Milton Three Ponds (west)	Lebanon, Milton, N. H.	0.50	12	167,270,000	12	167,270,000
Warren Pond	South Berwick	0.07	....	....	5	9,757,000
Wilsons Pond	Acton	0.36	....	....	10	100,362,000
Total	....	5.65		1,442,987,000		1,575,409,000

Summary of Storage in Coastal Basin, No. 4.

BASIN.	Drainage area, sq. miles.	Lake surface area, sq. miles.	Ratio water surface to drainage area.	Present storage, cubic feet.	Possible storage capacity, cubic feet.
Kennebunk River.......	50	0.75	66.7	51,296,000	104,544,000
Mousam River..........	157	3.57	44.0	251,185,000	557,566,000
York River............	12	0.21	57.1	....	29,272,000
Coastal................	6	0.61	9.8	....	85,029,000
	225	5.14	43.8	302,481,000	776,411,000
Piscataqua River....	*b* 550	*a* 5.65	....	1,442,987,000	1,575,409,000

a Includes only ponds located wholly or partially in Maine.
b Maine 240 square miles; New Hampshire 310 square miles.

GEOLOGIC RESOURCES.

The two following articles on the geology of the Eastport Quadrangle and the geology of the Portland and Casco Bay quadrangles are reports based on the results of the geological investigations of these quadrangles and are here issued in advance of their publication in their respective folios. The two special reports are followed by a bibliography of Maine Geology.

GEOLOGY OF THE EASTPORT QUADRANGLE.

By Edson S. Bastin and Henry S. Williams.

The Eastport quadrangle is situated in the extreme eastern part of Maine and extends from 44° 45′ to 45° north latitude and from longitude 67° 15′ eastward to the international boundary. It includes an area of about 250 square miles, nearly half of which is water. The district is one of much geological interest because of the variety of its rocks and the abundance of fossils and has received occasional visits from Canadian and American geologists at various times since 1836. The Eastport Folio now in press represents the first effort to study and map the geology in detail, and the following paragraphs summarize very briefly some of the more important features of this folio.

The region is one of low relief, the higher hills seldom rising more than 300 feet above sea-level. Many of the hills in the northern and western parts of the quadrangle are more or less elongate in a northwest-southeast direction parallel to the trend of the principal hard rock formations. One of the characteristic features of the region is the profusion of bays and estuaries separated by long narrow peninsulas and dotted with numerous islands and the irregularity of the shore-line may be appreciated when it is stated that the distance from Eastport, the principal town, to Lubec around the shore is 100 miles, while "as the crow flies" the two towns are but 3 miles apart. The extreme irregularity of the coast line here as elsewhere in

Maine has been brought about by subsidence of the land in late geologic times which has converted the lower courses of the streams into tidal estuaries. The streams of the quadrangle are mostly of small size and their direction is controlled in general by the hard-rock geology, though minor irregularities are attributable to surface deposits of gravel, sand, and glacial till. A number of small fresh-water lakes lie wholly within the quadrangle and the larger lakes, Rocky, Boydens, and Pennamaquan, lie partly within it.

Among those portions of the eastern United States whose geology has been carefully studied, the Eastport district stands unique because of the complicated manner in which its sedimentary rocks are interbedded with a great variety of volcanic eruptive rocks and because the life forms preserved in its rocks show much closer affinities with those of western Europe than with those of contemporaneous formations in other parts of the United States. The situation of the region on a coast line of extreme irregularity where shore erosion is active results in an abundance of exposures and permits the working out of the geology in great detail and accuracy along the shores, except where Pleistocene deposits have covered the bed rock. Unfortunately much of the quadrangle back from the shore is sparsely settled, covered by a heavy growth of timber, and reveals few outcrops.

The hard rock formations of the Eastport region are all of Silurian and Devonian age with the possible exception of a few diabase dikes that may be younger. They include sediments and a great variety of igneous rocks. The latter are in part of deep-seated and in part of surface (volcanic) origin. The oldest rocks of the quadrangle, the Quoddy shale, of early Silurian age, occur in the northwest and southeast parts of the quadrangle and between them, forming a great down-faulted area, occur the younger Silurian and the Devonian rocks. The principal geologic units are the following:

Sedimentary and Effusive Igneous Rocks.		Intrusive Igneous Rocks.
Devonian	—Perry formation (unconformity).	Late Silurian or early Devonian—Granite. Silurian and later,—Diabase.
Silurian..	Eastport formation, Pembroke formation, Edmunds formation (unconformity?) Dennys formation (unconformity), Quoddy shale.	

The bedded rocks of Silurian age form a complicated succession of sediments and volcanic flows and tuffs. The volcanic rocks include rhyolites and andesites of many varieties, and diabases, many of which were probably extruded on a land surface while others were certainly laid down, as were the sediments, in the shallow waters of the ocean. The older Silurian beds comprising the Quoddy shale have been much folded, but the younger members of the series have suffered only faulting and gentle folding. The Quoddy shale and the Dennys formation carry poorly preserved fossils at a few points but the Edmunds, Pembroke, and Eastport formations are very rich in life remains. It is particularly interesting that these fossils resemble the fossils of the Silurian beds of England and Wales much more closely than they resemble those of any part of the Eastern United States.

The sediments of the Perry formation of the Devonian are red sandstones and conglomerates plainly composed of the debris of the Silurian formations just described and of the granite. With these are interbedded diabase flows. The formation has been tilted and faulted somewhat but is somewhat less disturbed than the Silurian rocks.

Diabase has been intruded in large amounts in all of the Silurian formations and some of the most conspicuous hills of the region are composed of this highly resistant rock. Granite is not found in place within the quadrangle, but outcrops a short distance to the north.

The history of the region from Devonian times until the Pleistocene is not recorded by any geologic features. In the Pleistocene or glacial epoch the region was covered by glacial ice which left its traces in deposits of boulder till and glacial gravel. Just after the ice withdrew, the land stood for a time somewhat lower than at present and deposits of glacial-marine clays were formed. These former tide-flats now appearing as nearly level lowlands, form the farm lands of the region.

The Eastport region depends for its industrial prosperity more upon the products of the sea than of the land; it possesses, however, a considerable variety of undeveloped mineral resources, including abundant supplies of the best road material, near-by supplies of granite for building, clays suitable for brick-making, and very large deposits of excellent peat. Tide-power was utilized in the past to operate a gypsum mill near North Lubec and may in the future be utilized there or at other places in the quadrangle.

PRELIMINARY REPORT ON THE GEOLOGY OF THE PORTLAND AND CASCO BAY QUADRANGLES.

By F. J. Katz.

Introduction.

Location.—The area of the Portland and Casco Bay quadrangles is included between 43° 30′ and 43° 45′ north latitude and 70° and 70° 30′ west longitude and embraces about 432 square miles of which little more than half is land. The quadrangles are situated in the southwestern part of Maine in Cumberland and York counties.

General geology and geography of the province.—The Portland and the Casco Bay quadrangles and the State of Maine which includes them belong to a geographic and geologic province which includes nearly all of New England together with Nova Scotia, most of New Brunswick, and the eastern townships of Quebec. Topographically the province has considerable diversity of form, but for the most part is an upland region. The higher portions of this region are deeply incised by rivers and streams. In their lower courses some of the rivers flow in broad mature valleys. Above the higher parts of the New England plateau rise the White Mountains of New Hampshire, the Green Mountains of Vermont, a range of lower hills in western Maine, and Mount Katahdin. The Portland region is in the low maturely dissected part of the province. As a geologic province the region is characterized by metamorphosed Paleozoic, or possibly in part older sediments and by abundance of surface volcanic rocks and of intrusive granitic and basic rocks of early and late Paleozoic age. Within this province itself there is some diversity even in regard to the major geologic features. Important variations are observed in the differences in the date and severity of the regional metamorphism and in the stratigraphic relations of the older rocks.

Topography and Drainage.

Relief.—The Portland and Casco Bay quadrangles have slight relief. The extreme range from sea level to the top of the highest hill is only 375 feet, whereas local differences in elevation between lowland or valley bottom and adjacent hilltop are from 150 to 200 feet. This is a region of small rounded hills and flat plains of limited extent. In the northern part the hills predominate and are contiguous; the plains are narrow and restricted to the valley borders. In the southern part the plains form broad uplands above which rise more or less detached low hills. These two areas of different topographic character are not sharply defined but merge along a zone extending southwesterly from Falmouth Foreside through Westbrook to South Buxton.

Shore line.—The mainland shore line from the southern border of the Portland quadrangle in Old Orchard to the northern border in Cumberland, 20 miles north-northeast, has a length of over 60 miles, and the numerous islands have an aggregate length of shore line of about an equal number of miles. The length is due in part to the few larger bays and estuaries but not a little also to the great number of small salients and reentrants which develop considerable intricacy in the shore line. There are two elements in the shore line trends which are approximately northeast and northwest. In the Casco Bay quadrangle, Cape Elizabeth and the islands strongly exhibit this feature, not merely in shore lines but also in the pronounced northeast "grain" or trend of the ridges and hollows. This "grain" is an expression of the rock structures and is exhibited also but less conspicuously in parts of the Portland quadrangle.

The shores exhibit three types; cliffs, beaches, and marshes. Cliffs are by far the most extensive and for the most part developed in the hard rocks, but at some places in till and clay deposits. There are notable rock cliffs on Cushing Island, Cliff Island, and at Cape Elizabeth Lights. Sand beaches are magnificently developed along the southern shores. These are Old Orchard Beach, of which the northern 4 miles are included in the Portland quadrangle, Scarboro Beach, 1.4 miles long; Higgins Beach, 0.7 mile long; and Bowery Beach, 0.8 mile long, all broad, hard beaches of fine sand, which are very popular bathing resorts. Besides these there are numerous smaller barrier and bayhead beaches composed of sand and shingle along the mainland and island shores. Marshy shores surround the tidal estuaries of New, Nonesuch, Fore, and Presumpscot rivers and several smaller streams.

Drainage.—The quadrangles are well drained with the exception of small areas in Cape Elizabeth and some small coastal marshes. In the Casco Bay quadrangle the drainage is by a few small brooks which empty directly into the sea. In the Portland quadrangle Presumpscot River and tributaries, Little River, Duck Pond Brook, Piscataqua River which enter from the north and west receive the drainage from the northern third of the quadrangle. Stroudwater River, Long Creek, Nonesuch River, Spurwink River, and a few other small streams have basins practically wholly within the quadrangle. They drain the southern area and discharge into several marshy estuaries. Saco River is a large stream which touches the south edge of the quadrangle and receives the drainage from a few square miles in the southwest corner.

With the exception of the marshes bordering the tidal estuaries, the undrained areas are small. They include swamps behind barrier beaches on Peaks and Long Islands and along the Cape Elizabeth and South Portland coast. There are also four small undrained areas in South Portland and Cape Elizabeth where rock basins are obstructed by glacial debris or ancient sea beaches.

Geology.

In the Portland and Casco Bay quadrangles there are rocks as old, probably as the older Paleozoic and some as young as the late Pleistocene, and they include various igneous rocks and sedimentary types, some most thoroughly recrystallized by metamorphism, and others wholly unindurated. The geologic structure and history are correspondingly complicated. Therefore some of the geologic problems remain unsolved and what follows is to be regarded as only a preliminary and tentative statement.

PALEOZOIC? ROCKS.

The oldest rocks comprise a large group of gneisses, schists, and slates, of both igneous and sedimentary origin, and granites, which are all most probably of Paleozoic age.

GNEISSES.

Distribution.—The northwestern corner of the Casco Bay quadrangle and the northeastern part of the Portland quadrangle, that is, in area limited on the south and west by a line from Bartlett Point through Woodfords to Westbrook and thence northwest, is occupied by gneisses with which there is a large amount of granite and pegmatite.

Lithologic character.—The gneisses are of three kinds, a dark, for the most part fine and even-grained biotite gneiss; light gray, medium-grained granite gneiss; and a dark gray, coarse, biotite gneiss of diorite composition.

The fine dark biotite gneisses occupy much the largest part of the area. They consist chiefly of small grains of biotite (black mica), muscovite (white mica), quartz and feldspar. Quartz and biotite are generally most abundant and approximately equal in amount. In some places the rock is made up predominantly of quartz. These rocks are wholly recrystallized by metamorphic processes. That is, they have been so altered, through physical and chemical changes induced by the pressure and heat of deep burial and mountain making deformation and by intrusion of igneous material, that their original characters are largely obscured. Their composition, however, suggests strongly that the rocks were originally mainly grits and sandstones.

The light gray granitic gneisses occur in several areas, some of considerable size, in Falmouth, Deering, Westbrook, and Windham. The rock is a gneissic biotite granite of light to medium gray color and fine to moderately coarse, even texture, and consists of potash feldspar, microcline, and orthoclase, quarts, soda lime feldspar (oligoclase), biotite, and some muscovite. The proportion of the constituents, notably the biotite, varies from place to place, and where most abundant the biotite is usually coarse. The biotite and muscovite are generally in parallel arrangement and give the rock its gneissic structure.

The diorite gneiss was found in one comparatively small area north of the city of Westbrook. This is a dark gray, coarse-grained, gneissic diorite composed of andesine feldspar, quartz, biotite, hornblende, and accessory minerals. The gneissic texture is due to large, subparallel scales of biotite.

Structure.—The biotite gneisses are intricately, closely, and minutely folded. The axial plane of the folds, the banding on the limbs of folds, and the cleavage quite uniformly strike northeast. Dips vary from highly inclined to flat and are generally northwest but not infrequently southeast. The contacts and the cleavage of the granitic gneiss parallel the cleavage of the mica gneisses which it intrudes.

The diorite gneiss is intrusive into the dark mica gneisses, partly in bands parallel to the gneissosity. The rock is presumably closely related to the gray granite gneisses, probably as a more basic phase of the same body.

Stratigraphy.—The stratigraphic relations of these rocks are not determined and there are no data on their thickness.

Age and correlation.—The gneisses if not the oldest are at least as old as any rocks in the region. The biotite gneisses are the most metamorphosed and are intruded by old and metamorphosed granitic rocks which do not appear within the other formations of the region. On the assumption that these old intrusive granites are as old or older than the undeformed granites of the neighboring Penobscot Bay region, the gneisses must be pre-Silurian in age. Hence the gneisses of the Portland region are tentatively assigned to the early Paleozoic or an earlier era.

SCHISTS.

Distribution.—Except for the area occupied by the rocks discussed above and another area of about two square miles in the southwest corner of the quadrangle, the two quadrangles are occupied by a considerable variety of rocks which may collectively be termed schists. They have in common certain general features and present the same general difficulties to study and mapping, so that they must be here treated as a unit.

Lithologic character.—Among the kinds of rock recognized in this group are the following:

1. Dark gray, brownish, and bluish quartzites in Gorham, Buxton, and the northwestern part of Scarboro townships. These are for the most part fine-grained and massive or only slightly schistose. Some are quite homogeneous and vitreous, showing only quartz and a little mica as constituents. Others are finely banded quartz-biotite rocks and still others contain considerable amount of garnet, amphibole, and other minerals.

2. Conglomeratic schist. Light to dark greenish-gray schistose rocks with vestiges of coarse fragmental texture. These rocks are generally characterized either by small blue quartz eyes, about 1-8 inch in diameter, or abundant fine amphibole needles, or both these features. They are present on the Reform School grounds and in the ridge from South Portland Heights to Fort Preble; on House Island; Little Diamond Island; and Great Diamond Island.

3. Hard gray and whitish quartzites in beds from a few inches to several feet thick and interbedded with thin gray phyllites. Some beds are fine-grained, pure, vitreous quartzites; others are coarser and distinctly fragmental. For the most part the quartzite of this formation is only slightly schistose, while the intercalated softer beds are thoroughly so. These rocks are prominently exhibited in the cliffs of Prout's Neck, Richmond Island, and in places along the Cape Elizabeth shore from McKenney Point to Zeb Cove.

4. Very fine-grained, light-gray phyllites. Some of these rocks are very micaceous, others more siliceous and slaty. They are characterized by capacity to cleave into thin plates and the glistening covering of fine mica scales on the surface of the plates. Some of these rocks are studded with numerous small crystals of garnet. They are widely developed through South Portland, Scarboro, and Cape Elizabeth, and in many of the islands.

5. Light and dark gray phyllites and mica schists of coarse and fine grain, containing abundant garnet, or kyanite, or magnetite, or other mineral, or several of these. They are found abundantly in South Portland, Scarboro, and Cape Elizabeth, and on House, Peaks, and Diamond islands.

6. Interbanded thin limestone and phyllites. Thin bands of dark fine grained crystalline limestone, which weathers to a light bluish color are interbanded with thin phyllite or schist.

The limestone and associated slates are in places studded with garnet. These rocks are exposed in Cape Elizabeth near Great Pond and on the shore, in Knightsville, on Great Diamond Island, on Chebeag Island, and in South Harpswell.

7. Black slate (graphitic quartz schist). A black fine-grained, thoroughly schistose siliceous rock containing abundant carbonaceous (graphite) matter, pyrite grains, and some mica occurs in the Reform School grounds and for 3 miles in the ridge southwest from Fort Preble, through South Portland Heights, on Little and Great Diamond Islands, Chebeag Island, Cape Elizabeth shore, and at several places in southeastern Scarboro including Prouts Neck and Blue Point Hill.

8. Chlorite schist. Fine to moderately coarse, highly cleavable, dark greenish gray to bluish black schist, consisting predominently of mica and chlorite but quite generally containing large and very abundant quartz eyes and anastomosing veins, etc. Abundant in Old Orchard, Saco, Scarboro, South Portland, Cape Elizabeth, and on Outer and Inner Green, Jewel, Cliff, Brown Cow, Eagle, Ministerial, Upper Flag, Haskell islands and elsewhere. These rocks quite generally contain disseminated crystals of iron pyrites and are heavily stained with iron rust at the surface.

9. In the southern part of the towns of Old Orchard and Saco there are quartzites, phyllites derived from argillaceous sediments, and limestones which appear to be less metamorphosed than the foregoing rocks. The quartzites and phyllites on and near Old Orchard Beach are slightly schistose gray rocks which distinctly show their original sedimentary banding. The limestones are found in a small area extending northeasterly from Lincoln Street in Saco west of the Boston and Maine Railroad to Bradley Street. In this area is some blue-gray, fine-grained limestone which is much shattered and crushed but not schistose and some slightly schistose argillaceous limestone.

10. Schistose granite. The northern part of Cape Elizabeth township north of a line from the forks of Spurwink River to Pond Cove and a small part of the eastern shore of South Portland, Cushing Island, all but the western shores of Peaks and Long islands the southeastern part of Chebeag Island, the western part of Cliff and Stone islands, Hope Island, Little Bang, Stockman, and Whaleboat islands, and the small islands

adjoining the above are occupied by whitish or light gray to dark gray rocks of various phases but of like composition and origin. For the most part these are fine to medium grained, with conspicuous mica flakes in porphyritic arrangement, and grains or knots of quartz, and in places feldspar. These rocks characteristically develop a light yellowish green color when weathered. They have the composition of granite porphyries, in places of darker more basic granite, and elsewhere, particularly along the northwest border, of very silicic or aplitic granite. The contact relations at a few localities show that this group of rocks was intruded into the sediments which surround it. The granite porphyry was folded up and mashed with the other rocks and has been rendered thoroughly schistose and its relations for the most part obscured.

11. There are numerous small irregular masses, some long dikelike bodies of dark green to black hornblende rocks, amphibole-garnet rocks, and fine-grained mica-hornblende rocks, which are basic dikes intruded into the above rocks during an early period of their history and mashed and metamorphosed along with them.

The above formations contain abundant quartz veins, and small pegmatite veins of various types. Some of the quartz veins are old and are folded and deformed with the including rocks. Others, and in particular the pegmatite, post-date the metamorphism as their constituent minerals are undeformed.

Structure.—The rocks above considered are thrown into a complex system of folds, with axes trending approximately N. 45° E. to N. 30° E. major folds, which are measured in miles, have superposed upon them minor folds in successive series of diminishing size. Of these folds the smaller, minor folds are more complicated, being very closely appressed, particularly in the softer rocks. There is also a gentle cross folding at approximately 90°. The pitch of this system of folds is dominantly southwest.

The most striking structural feature of these rocks is the schistosity or slaty cleavage which has an almost uniform northeast strike, ranging between N 45° E. and N. 30° E., with the exception of a small area in Saco and Old Orchard where the clevage trends more to the east. The dip of the cleavage is for the most part very high or vertical but locally is almost horizontal. The formations are so complexly folded that there is little constancy in the strike and dip of the bedding planes. Because of the close folding also, the contacts of the various types of rocks appear to be predominantly parallel to the trend of cleavage. The prominent and almost universal joints are in three sets of planes: One approximately vertical and paralleling the axial planes of the folds; a second at right angles to the first and nearly vertical or dipping at high angles to northeast or southwest; the third dipping at low angles 10° to 20° to the southwest. Other joints are abundant but less regularly and widely developed.

Granites and Pegmatites.

Undeformed granitic rocks occur in two areas, one within the general area of the gneissic rocks. Here there are numerous masses of pegmatite and pegmatitic granite abundantly distributed, but in generally small bodies, which traverse the gneissic rocks. These pegmatites and granites are coarse-grained rocks composed essentially of orthoclase and microcline, quartz biotite, and muscovite, and frequently also contain accessory tourmaline and garnet. These rocks cut the gneisses chiefly as dikes parallel to the cleavage but also transversely and irregularly. They are at least as young or younger than the metamorphism of the gneisses and older than the diabases described below.

In an area of about 1 by 2 miles in the southwest corner of the Portland quadrangle and extending into the adjoining quadrangle is a quartz diorite of slightly greenish, light-gray, color, medium and even-grained texture, composed of feldspars, biotite, dark hornblende, some quartz and magnetite. Around the south margin of this rock is a narrow zone of fine-grained gray porphyries and felsites. The quartz diorite invaded the quartzites and slates at a later date than the regional metamorphism of the latter.

Diabase and Gabbro Dikes.

Basic rocks in dikes are very numerous throughout the quadrangles. They are dark brown to greenish black rocks of medium to very fine and aphanitic texture. They are usually even-grained but sometimes porphyritic. The larger masses, such as the ones near Mosher's corner and about 1 1-2 miles west of Gorham, are fine-grained gabbros, composed chiefly of plagioclase and pyroxene (diallage). The smaller dikes are fine-grained to aphanitic diabases and basalts. The dikes generally follow the cleavage planes where intrusive into the schists and gneisses. They are observed cutting all the other hard rocks of the region and are the youngest rocks with the exception of the loose formations described below.

PLEISTOCENE.

Glaciation.—The surface of the hard rocks is everywhere more or less perfectly smoothed and rounded. In some places where it is protected from weathering processes the rock surfaces exhibit beautiful polishing and striation. The striæ trend from S. to S. 25° E.

In many localities there may be seen directly overlying the bed rock deposits of glacial till. This is loose or slightly consolidated, drab or blue gray, heterogeneous material, consisting of pebbles and boulders of various sizes, shapes and materials, in a matrix of gritty clay or clayey sand. There are fine examples of this on Chebeag Island and in the base of Munjoy Hill and Bramhall Hill. Stratified gravel and sand, presumably in part of direct glacial origin, but also formed by reworking and redeposition of glacial materials in the sea which covered them after retreat of the ice, are abundant. There are important deposits of such material about the higher hills in the eastern part of the Portland quadrangle. In Cape Elizabeth the higher surfaces have been very largely swept clean of glacial deposits which have been redeposited in the sags and hollows.

At some localities, notably north of Great Pond in Cape Elizabeth, between Meeting House Hill and South Portland Heights, and about 2 miles southwest of Gorham village, this reworked material of glacial origin has been redeposited in characteristic shore formations; in the first localities as wave-built barrier-beaches and terraces; in the second as a hooked spit jutting out from a rock cliff and inclosing what was a small lagoon now at an elevation of about 200 feet above sea level. Munjoy, Bramhall, and Meeting House Hills also have deposits of reworked glacial materials indicating submergence of 140 to 160 feet at the first two localities and over 100 feet at the last.

Marine Clay.

Distribution.—Clay is distributed widely throughout the lowlands about Back Cove and the estuaries of Presumpscot, Fore, New, and Saco rivers. Through the townships of Saco, Old Orchard, Scarboro, South Portland, and parts of Westbrook and Portland, the clay forms a practically continuous flat belt, roughly 6 miles wide, interrupted only by hills that are for the most part isolated and small. In a large part of this region the clay is concealed by overlying sands. In the western and northern parts of the Portland quadrangle the clay occupies the valleys and extends up several of them for some distance beyond the region here considered. Along the shore and around the estuaries the elevation of the top of the clay ranges from about tide level to 20 or 30 feet. Farther inland it slopes up to broad flats which are between 70 and 100 feet above the sea, and thence the clay rises gradually in the valleys to the north and west to a maximum height, within the region studied, of about 200 feet on Little River, in the northwest corner of the Portland quadrangle.

Appearance and character.—The clay is for the most part olive-gray to blue-gray in color. It is exceedingly fine-grained. The margins and base of the clay are in places sandy and such parts are yellowish or a light rusty brown. Although sporadic bowlders are found within the clay, it is remarkably free from sand and pebbles. The material is very uniform in grain and color (except where it is sandy) and no distinct bedding or other structures can be recognized in fresh exposures. However, when the clay in natural and artificial exposures dries, it breaks up into very small blocks bounded by uneven, approximately horizontal surfaces (bedding) and a roughly rectangular system of close and short, nearly vertical cracks. The cracks have very commonly a thin black stain. When thoroughly dry the clay is a light drab-gray in color and the stains bleach to brown.

Thickness.—In the coastal region a thickness of approximately 70 feet of clay is indicated by drill records. There is an aggregate thickness of about 100 feet on the sides of the valley of Little River. Inasmuch as the clay lies in depressions in the older formations its thickness may be expected to be irregular but in general to decrease toward the margins of the clay bodies.

Structure and stratigraphy.—The clay formation in the Portland region is a sheetlike body of fairly uniform character, having in general an approximately plane upper surface with gentle eastward and southeastward (seaward) slope. It lies unconformably upon glacial drift and is in part covered by considerable beds of sand which are traceable northwestward to the region where they merge into glacial deposits. The clay is therefore assigned to the Pleistocene, the epoch of glacial occupation of Maine. The marine origin of the clay, which is suggested by its distribution along the coastal region and in the valleys tributary to the coast, is established by the remains of marine animals it contains. The clay deposits are similar to the clam flats of the present day and are evidence that during the time of their deposition the ocean spread over and in places submerged parts of the present coastal lands to depths of more than 200 feet.

Marine? Sands.

Distribution.—In the region lying south and west of a line between Gorham and Ligonia the flat, or plain, areas are occupied by sand beds. There are notably broad areas of sand flats southwest of Gorham village in Scarboro and in Saco and lesser ones in South Portland, Buxton, and Old Orchard.

Character.—The sand is white or slightly yellowish or rusty yellow in color. It is fine to moderately coarse in grain but for the most part of medium grain, dominantly composed of quartz with a little feldspar, and some mica scales and an unimportant amount of other mineral and rock grains. The grains are partly rounded but of sufficient subangularity or angularity to be a noticeably "sharp" sand.

Structure.—The sand is evenly horizontally bedded, or very nearly horizontally. The slopes of the sand surface south of Gorham are away from the hills, about which the sand lies and both the total thickness of the sand deposit and the size of grain diminish in the direction of slope. In Scarboro the sand surfaces appear to slope eastward and southward, in which direction also the fineness and thickness of the deposit diminish. The sand overlies the marine clay. In two places there was observed an interlamination of sand and clay and a gradation in character from the pure clay to the clean sand beds. The greatest thickness measured is 32 feet. It is probable that this is near the maximum thickness for the Portland quadrangle and that the average thickness is considerably less. The sand overlies the clay conformably, and is Pleistocene in age.

Summary of Geologic History.

The Portland region, sometime early in the Paleozoic era or earlier, was the site of deposition of siliceous, argillaceous, and calcareous sediments. These are most probably marine sediments, but what and where the lands which supplied these sedimentary materials is yet undecipherable. Following the deposition and induration of these sediments they were intruded by fine-grained, granitic porphyries and subsequently by numerous small basic dikes. These rocks were all undoubtedly deeply buried by other rocks, for the next recorded event is extreme deformation by close folding and mashing of those beds which are now seen. In the course of these processes the rocks were severely metamorphosed and their secondary structures, rock cleavage, and so forth were developed. At the same time the region was probably transformed into a mountainous province. In the northern part of the quadrangle, at that time or subsequently, there were injections of granitic materials which further metamorphosed the sediments to gneisses, and by the continued or repeated regional metamorphism these granitic intrusives were themselves rendered gneissoid. The intrusion in this vicinity continued after regional deformation ceased or occurred where deformative forces were locally inoperative, so that there are numerous undeformed dikes of pegmatite. Following these early Paleozoic events there was a long period during which the region was subjected to erosive agents and, when its surface had thereby been much reduced, there was renewed volcanic activity which introduced numerous basic dikes. The region remained a land surface upon which erosion continued, so far as there is any record, up to the Pleistocene incursion of the glacial ice. The region had by that time been reduced to a low maturely dissected plateau. The ice sheets encroached on the plateau from the north and spread over the entire region and out into the Atlantic Ocean, modifying the land surface by erosion and by deposits of glacial material. On its retreat the ice left the land depressed so that the sea followed the ice, inundating the old land to depths of approximately 200 feet. The waves and currents of the advancing sea sorted and redistributed the loose glacial deposits. In the quiet depths and embayments of the sea the glacial rock floor, mud, silts, and so forth, contributed by the glaciers which still lay in the region to the north and west, were deposited as a marine clay formation. While the land was subsequently being brought up to its present elevation there were distributed in the shallowing waters of the retreating sea the sands which overlie the clay. The region seems to have been standing at about its present elevation for a short time, during which the re-established drainage system has slightly dissected the Pleistocene deposits.

Mineral Resources.

Materials of economic importance in the Portland region are rocks, sand and gravel, clay, groundwaters, and soils. The rocks of the region because of their slaty character, which is not highly enough developed to make a good slate, are little used for building except for foundations or "cellar stones" and like purposes. Almost any of the rocks will serve for such use, but the granitic gneisses are best and more quarried than other rocks and are used as well for curbing, for culverts, and so forth. Various kinds of schists and gneiss are quarried and crushed at several localities for road metal and for making concrete. The granitic gneisses, widely distributed through Deering, could furnish Portland with a large supply of such material of good quality. Quartzites and graywackes about Portland are also so used but are less desirable for road material. In and near Saco the quarries in argillaceous limestone furnish crushed rock of good grade for road metal.

Sand and gravel are abundantly spread over the region in the glacial deposits and supply surface material for roads and are used for concrete.

Clay from the marine Pleistocene formation is conveniently distributed in vast quantity. It is of excellent quality for brick making and for drain tile and other non-refractory wares of that kind. It is also mixed successfully with fire clays from other localities for the manufacture of grate bars and for glazed pipe. The clay is also useful for road building in the sandy areas of the district.

The region is well provided with groundwaters of good quality for all domestic and farm purposes. Such water is derived both from the hard rocks and from the unconsolidated deposits. In the former the groundwaters collect chiefly in the fracture systems and are reached by deep wells, some of which tap water under sufficient pressure to cause it to flow at the surface. In the unconsolidated deposits there are besides other less well defined sources of water, two principal ones being at the base of the marine clay and at the top of the clay where it is overlain by considerable sand beds. The cities of Portland and South Portland and much of Falmouth, Westbrook, and Gorham, are supplied with water from Sebago Lake which lies just north of the Portland quadrangle.

The Portland region has three chief types of soil: 1. Soils of mixed glacial and residual origin which have been modified by post-glacial accumulations of humus and over a large area by the resorting of glacial material by the sea. These soils are on the hills and slopes and are bowldery and rocky, yet they are the most fertile and are generally cultivated. 2. Soils upon the flat or gently sloping marine clay deposits. These, although less fertile because "cold" and wet, are easily and extensively cultivated and in particular produce rich hay crops. 3. The soils of the flat sandy plains which are little cultivated.

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The Public Laws of Maine, 1911, Chapter 170, amending the organic act of the State Water Storage Commission, provided for a geological survey of the State in coöperation with the U. S. Geological Survey. A great deal has been written on the geology of the State but a thorough index of the same has never been published. It was found that certain information of this nature was available in published and manuscript form, and a compilation of same has been made. It is believed that such an index will be of great value to anyone interested in this natural resource of the State.

The following bibliography has been compiled from various sources, including Bulletins of the U. S. Geological Survey entitled, Bibliography of the United States, numbers 127, 188, 189, 301, 372, 409, 444, 495, 524. Additional references were obtained from the card catalog of the Portland Society of Natural History, loaned by Mr. Arthur H. Norton, Librarian of the Society, and from a card catalog of Bowdoin College, compiled by the late Professors Leslie A. Lee and F. C. Robison, and loaned by Prof. Marshall P. Cram.

The geological index that follows is compiled largely from the bibliography and in the main is simply a geographical and mineralogical index. It includes however, a special mineralogical index, prepared in the office of the Commission, from a detailed examination of the bulletins of the U. S. Geological Survey devoted to the geology of the State of Maine.

The bibliography has not been checked in detail by the examination of every publication noted and therefore its accuracy has not been thoroughly checked. Reliance has been placed on the three sources mentioned above, namely the Bulletins of the U. S. Geological Survey and the card catalogs noted. It is believed that if any errors have crept in, they are to references that may not refer directly to Maine.

Each separate article has been given a consecutive number and the geological index refers to this numerical system.

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