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OF THE VARIOUS

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FOR THE YEAR 1916

VOLUME IV

SECOND ANNUAL REPORT

OF THE

Public Utilities Commission,

State of Maine

FOR THE

YEAR ENDING OCTOBER 31,

1916

TOPOGRAPHY, GEOLOGY AND WATER RESOURCES DEPARTMENT

WATERVILLE
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1917

PUBLIC UTILITIES COMMISSION OF THE STATE OF MAINE.

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GENERAL STATEMENT.

Since the organization of this Commission at the close of 1914, it has continued to carry on and amplify largely the work of the State Water Storage Commission, having received by an Act creating the Public Utilities Commission, by the Legislature of 1913, all "powers vested in said Board together with the duties and privileges now conferred upon said Board by law."

If the Water Storage Commission was created by the Legislature in 1909 as a temporary commission, the Legislature of 1911 changed that temporary nature to one of permanency by giving to it the powers and imposing upon it the duties of the State Survey Commission. The particular duty imposed upon it (Water Storage Commission) was to secure such data as it was possible for it to secure in relation to possible storage reservoirs for the conservation of the flood waters of the State; that is to say, to find out where storage basins or reservoirs might be made for holding back for use in dry times the extra run-off caused by the melting of the snows in the spring time and the extra run-off at all times.

The Water Storage Commission made its report on this phase of the work, and placed on file such maps and data as it was possible to secure with the limited amount of time and money that it had at its disposal. The data used in compiling this report had been practically all gathered and arranged by the State Survey Commission, in co-operation with the United States Geological Survey.

No extended surveys were made of the areas of the ponds and lakes represented on the map, but such areas were taken or computed from plans or maps already in existence, the correctness of which, it is safe to say, has never been tested.

So far as the topographical survey of the State has extended, these areas could be calculated with a good degree of accuracy, but beyond the area covered by the topographical survey, which is a very small part of the State, these areas will not be claimed by anybody to be anything more than an approximation, and in many cases not very close at that.

Immediately when the new Commission began a study of the situation, it concluded, inasmuch as our water powers are located on our large rivers, that it would be better to extend the topographical survey up these rivers, so that it might cover as far as possible all of that great northern part of the State, largely covered with various kinds of timber growth, and within which area the reservoirs must be established, if anywhere, to conserve the flood waters of the rivers for the benefit of the water powers located below, by whomsoever owned.

Working in conjunction with the United States Geological Survey and with the full co-operation and approval of the Survey, the Commission has now undertaken to extend the quadrangles to be surveyed as fast as possible into these wooded sections, which form the sources of all of our great rivers.

The report of the Commission's Chief Engineer covers this matter in detail and shows the work accomplished in connection with the Survey. The public will be interested to know that the stream and river measurements have been continued and the number of discharge measurements increased from 52 in 1914 to 112 in 1916. Prior to 1916 the Commission depended largely on the gauge readings and records kept by private corporations. This has now been changed in part, and stations are now established and the records taken by the employees of the Commission, and during the season of 1917 these records taken by our employees will be extended to cover practically all the stream and river work, leaving the engineering department independent of private records.

The Commission considers it its duty to call the attention of the public at this time to the small amount, as compared with the whole amount, of the area of the State, that is being covered by this Survey annually, in order that the public may realize that no complete, comprehensive plan for the conservation of the storage of the flood waters can be made until this topographical survey, or some survey to replace it, has been much further advanced than it now is.

Referring to the abundance of water powers that we have in the State, the Commission in its 1915 Report, Page 4, Volume 2, said: "Cheap electric lighting in the farm houses of the State would do more for the comfort, convenience and happiness of the people on the farms, than many times the same amount of money would accomplish if expended in other directions."

The Commission has been able during the last year to investigate the subject of rural lighting only to a limited extent. This was necessarily so because of the great amount of investigation work that the Commission was compelled to make, because of direct complaints against the service furnished by companies doing business in the larger cities and towns. These complaints were not confined to any particular line of utilities, but covered both electric light and power service, gas service and water for domestic use.

The Commission in its 1915 report, Volume 2, Page 5, said: "It is believed by many that the great peat deposits of Maine are some time to be of great value, and the Commission has already taken up the investigation of this material, but as yet the results of our research are not sufficiently complete for publication."

In 1914 Governor Haines and his Council approved of and started the beginning of an investigation looking towards a full study of this subject on a broader and more comprehensive plan, and this Commission has been able to continue the service of Mr. Freeman F. Burr at that time employed, whose report we are able to give to the public in this volume. We feel sure that the report of Mr. Burr will be found of particular interest to the people of Maine at this time, when the price of coal is so high as to be almost prohibitive. And when we realize that a very large percentage of all of the farm lots of the State, to say nothing of the wild and waste areas, embrace some peat deposits, would it not be well at this time to follow the subject further by investigation?

Mr. Burr comes to us well recommended, and these recommendations are on file with the Commission, but in order that the public may realize that Mr. Burr is not a novice, we quote from a letter from A. W. Grabau, Professor of Paleontology, at Columbia University.

"Mr. Burr is better equipped to work on the investigation of swamp peat deposits than almost any other man with whom I am acquainted, and this is because he has carried on extensive studies in Geology, Botany and Zoölogy, both at Harvard University and here at Columbia University. He has worked under some of the most eminent men on these lines, and of his ability to carry on the work I can speak with confidence. * * * And I recommend Mr. Burr most strongly as a man qualified to carry on this work. * * *"

When Mr. Burr was employed by this Commission to continue his work on peat investigation and complete his report on the same, he was also requested by the Commission to study, as far as he was able to study, in his journeyings over the State, and to report to the Commission in as concise a form as possible, on the geology of the State so far as it came under his observation.

It seems to be the general idea that in many localities in the State we have large deposits of rock carrying potash in extent, varying from a very small amount up to 14 per cent.

Mr. Burr has given these matters much study, and his services should be continued and his present work amplified. More mineral specimens should be gathered, and because the specimens that he has this year gathered are practically all from the surface, his further collection of specimens should be taken from modest depths below the surface.

Anyone who will read Mr. Burr's report will realize that a very large percent of all the known minerals of the world have already been found within the boundaries of the State of Maine, but inasmuch as no completed geological survey, which will mean research, has ever been made of the State, the Commission is firmly convinced that a small amount of the State's money used annually in this direction is likely to bring wonderful results as to the real mineral wealth of the State.

The Commission submits this second report to the public well satisfied that it has been able to continue the work carried on by its predecessors, the State Survey and the Water Storage Commissions, and to extend the investigation of our resources beyond that undertaken by either of these Commissions.

REPORT OF CHIEF ENGINEER ON TOPOGRAPHY, GEOLOGY AND WATER RESOURCES.

Public Utilities Commission,
State of Maine,
Hon. B. F. Cleaves, Chairman,
Augusta, Maine.

Dear Sir:—

I herewith submit for your consideration a report of the work of the Engineering Department on the topographic, geologic and hydrographic work done in this State.

The work accomplished by the geologist of the commission, Mr. Freeman F. Burr, is giving in his report which follows.

Report is made of the work done under the special appropriation of $5,000 in making a topographic map of the State, also a statement is given of the geologic work performed by the United States Geological Survey in investigating the geological resources in Maine during 1916.

The report of Mr. G. C. Danforth, Assistant Engineer, in charge of the hydrographic work, gives the daily and monthly estimates of river discharge from October 1, 1915, to October 1, 1916, at the regular gaging stations in thie State arranged on the climatic year basis. A list of discharge measurements obtained during this period are also shown.

Respectfully submitted,

P. L. BEAN,

Chief Engineer.

PART 1.

TOPOGRAPHY

Five Thousand Dollars was appropriated for the year 1916, to continue the topographic mapping in this State. The law requires that this money be expended in co-operation with the United States Geological Survey.

In prosecuting this work during the past year the Commission has co-operated with the United States Geological Survey under the same agreement as for 1915, the details of which were published in the report for that year.

The following table gives the results of the field work completed during the past year under that agreement.

QUADRANGLE.	Counties.	Area mapped—square miles.	PRIMARY LEVELS.		Secondary traverse miles.	TRIANGULATION.	
			Miles.	Permanent marks.		Stations occupied.	Stations marked.
Winn...........	Penobscot	224	66	15	333	-	-
Seboeis..........	Penobscot	-	24	6	86	8	-
Millinocket......	Penobscot	-	-	-	-	6	2
Mattawamkeag...	Aroostook Penobscot	-	-	-	-	6	-
Brooks..........	Waldo... Penobscot	-	-	-	-	5	4
Burnham........	Waldo...	-	-	-	-	6	5
Totals.......	....	224	90	21	419	31	11

Results of the office work were as follows:

The office drafting of the topographic maps of the Belfast and Passadumkeag quadrangles was completed and the maps transmitted for engraving.

Adjustment of levels for the Seboies and Winn quadrangles were completed and the field notes typewritten and prepared for publication.

Manuscript for Bulletin No. 644-7, Triangulation and Primary Traverse in Maine and Vermont was prepared and printed for distribution.

Final computations of geologic positions for the Brooks and Burnham quadrangles were 80% completed.

The following sheets have been received in this office as completed and ready for use: Liberty, Portland and Casco Bay. The two latter sheets are resurveys without cost to the State.

The cost of the topographic work has been as follows:

Item	1915	1916
Appropriation	$5,000 00	$5,000 00
Expended	4,999 19	4,988 92
Balance	81	11 08

The unit of publication for these maps 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 United States Geological Survey at the rate of ten cents a sheet. When fifty or more are ordered, the rate is $6.00 per hundred. Sheets should be ordered from The Director, United States Geological Survey, Washington, D. C., enclosing money order for the amount due. Stamps will not be accepted. The Public Utilities Commission's office is not a distributing point for these maps.

The following sheets have been issued for the State of Maine:

Augusta
Anson
Bangor
Bar Harbor
Bath
Berwick
Bethel
Biddeford
Bingham
Blue Hill
Boothbay
Bryant Pond
Buckfield
Bucksport
Buxton
Casco Bay
Castine
Cherryfield
Deer Isle
Dover
Eastport
Ellsworth
Freeport
Fryeburg
Gardiner
Gorham, N. H.
Gray
Kennebunk
Kezar Falls
Lewiston
Liberty
Livermore
Matinicus
Monhegan
Mt. Desert
Newfield
Norridgewock
North Conway, N. H.
Norway
Orland

Orono
Penobscot Bay
Petit Manan
Poland
Portland
Rockland
Sebago
Skowhegan
Small Point
Swan Island
Tenant's Harbor
The Forks
Vassalboro
Vinalhaven
Waldoboro
Waterville
Wiscasset
York

Local Agents for Topographic Maps.

Purchasers may save delay incident to ordering through the mails by buying of the following agents, who carry in stock maps of areas in their vicinity.

Augusta:

J. F. Pierce, Bookseller and Stationer.

Bangor:

E. F. Dillingham, Bookseller and Stationer.

Bath:

Charles A. Harriman, Jeweler and Optician, 106 Front Street.

Belfast:

M. P. Woodcock & Son, Books and Stationery.

Boothbay Harbor:

R. G. Hodgdon, Clothier and Furnisher.

Bridgton:

H. A. Shorey & Son.

Brunswick:

F. W. Chandler & Son.

Castine:

W. A. Ricker, Stationery and Miscellaneous.

Gardiner:

Beane's Corner Drug Store.

Lewiston:

John G. West, Journal Building.

Portland:

Edw. G. Haggett, Bicycles, Cameras, and Sporting Goods, 9 Casco St. Loring, Short & Harmon, 474 Congress Street. William Senter & Co., Jewelers, Nautical and Optical Goods, 51 Exchange Place.

ROCKLAND:

E. R. Spear & Co., 408 Main Street.

WATERVILLE:

John H. Burleigh, 93 Main Street. Green & Wilson, 132 Main Street.

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 river maps generally on a scale of 1 inch to 2,000 feet, show the plan of the rivers with five-foot contours along the banks, and the profiles. 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 rapids 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 shown. These maps in general show the high water line, the low water line, and the five-foot contour lines from 10 to 25 feet above the lake. Soundings are often shown, and occasionally several five-foot sub-contours, representing 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 when their use as storage reservoirs is contemplated.

RIVER AND LAKE SURVEYS.

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 Brassua 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, Sheet No 1.
24. Baskahegan, First and Second Grand and Allagash Lakes, Sheet No. 2.
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.

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*Edition exhausted.

34. Androscoggin River Brunswick to Umbagog Lake—plan and profile, Sheet 4.
35. Androscoggin River, Brunswick to Umbagog Lake—plan and profile, Sheet 5.
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, Sheet No. 2.
43. Mooselucmeguntic and Richardson Lakes, Outlet plans, Sheet No. 3.

Union River Basin.

44. Abraham, Scammons and Molasses Ponds and Webbs Pond Outlet, Sheet No. 1.
45. Alligator, Rocky and Spectacle Ponds, Sheet No. 2.
46. Great Pond, Green Lake Outlet and Branch Lake Outlet, Sheet No. 3.
47. Union River, Ellsworth to Great Pond, Sheet No. 1.
48. Union River, Ellsworth to Great Pond, Sheet No. 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 No. 6.
55. Dead River and South Branch; Tim Pond and outlet, Sheet No. 7.
56. Spencer Stream; Little Spencer Stream; King and Bartlett Lake and outlet; Little Bartlett Lake and outlet; Baker Pond and outlet, Sheet No. 8.
57. Dead River, Long Falls, special map, Sheet No. 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. Rangeley 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.

KENNEBEC BASIN.

79. Great Moose Pond.

PART II.

GEOLOGY.

GEOLOGY.

Exclusive of the work done by the Commission during the past year in investigating the geologic resources of the State, the United States Geological Survey, has, at its own expense, made certain investigations in the South and Western part of Maine.

The bulk of this work has been performed by Mr. F. J. Katz, who has made an extended reconnaisance of Southern and Western Maine, in order to secure information on the larger problems involved in the Portland-Casco Bay district and the Dover-York district. Similar work carried on in Massachusetts, has enabled the reaching of many new conclusions as to the age and structure of the Maine Rocks.

Some new detailed mapping has been done in the York quadrangle. Short papers based on this work are about to be published.

REPORT OF FREEMAN F. BURR, GEOLOGIST.

Augusta, Maine,

December 31, 1916.

Hon. Benj. F. Cleaves,

Chairman, Public Utilities Commission,

Augusta, Maine.

Dear Sir:

I herewith transmit my report for the year 1916, on certain economic phases of the geology of Maine.

Very truly yours,

FREEMAN F. BURR,

Geologist

INTRODUCTION.

That part of the work described in this report which relates to peat deposits in the Livermore Quadrangle was carried out in the summer of 1914, by approval of Governor Haines and his Council and under the direction of the Maine State Water Storage Commission. Severe illness prevented the completion of the work at that time, and for this reason the results are made a part of the present report.

Early in July, 1916, the Public Utilities Commission directed the Geologist to begin an extended investigation into the mineral resources of the State; particular attention to be given to the sources of potash feldspar and associated minerals, and to the materials found in peat bogs.

In pursuance of the directions so given, the writer of the following report has personally visited as many localities in the State as the limited time available would permit; covering, in the course of the work, approximately 2,000 miles by train, 600 miles by automobile, and 250 miles on foot.

Because of the size of the territory to be covered, and the physical nature of much of it, a good deal of work has necessarily been in the nature of rapid observation trips over long distances. The greater part of the bed rock is more or less deeply buried under a blanket of glacial drift; so that in some instances it is necessary to travel many miles to find outcrops of sufficient extent to afford the information sought. Continuous outcrops are, as a rule, found only along the sea-coast, on the borders of some of the lakes, in rock cuts along the railroads and some of the newer highways, among the mountains and on the upper courses of some of the streams.

It has been found possible to do more intensive work in regions where outcrops are more numerous, where mines and quarries have been or are now in operation, or where the surface has been more or less extensively prospected by persons interested in exploiting mineral deposits of various kinds.

The present purpose has been very materially furthered by application to the writings of many previous investigators, who have from time to time studied special phases of the Geology and Mineralogy of the State. Particularly useful in this connection have been the publications of the United States Geological Survey: Bulletins, Mineral Resource reports and special papers; Topographical maps, covering a considerable area in the Southern part of the State; and the three complete Geological Folios of the Eastport, Penobscot Bay and Rockland Quadrangles. The writer wishes to make general acknowledgment of his indebtedness to these and to other published sources of information in the preparation of the present report.

During the summer a large number of rock and mineral specimens have been procured, and a selected lot of these, a list of which is given at the end of the report, will be added to the collection already on the shelves of the museum in the State House at Augusta. Such a public exhibition as this should be one of the best means for informing the people of the State as to its mineral resources; and to this end it should be made as completely representative as possible.

General Discussion.

In the course of the present work at least four things have become convincingly clear:— (1) that this State has mineral resources in remarkable variety, and in amounts sufficient to make their careful consideration a matter of plain duty; (2) that the people of the State in general have little knowledge of these resources, and consequently are able to take little intelligent interest in their development; (3) that, except in a few instances, those who make a business of exploiting resources fail, or are unable, to take full advantage of their opportunities; (4) that, particularly as concerns metal mining, a bad beginning was made years ago, in that mines which might have been worked profitably in a small way were swamped by overcapitalization, too expensive equipment and an exaggerated idea as to the extent and value of the deposits.

(1) It may be stated as a plain matter of fact that Maine contains within its borders as great a variety of minerals as any equal area in the United States; and that it has its full proportionate share, in matter of variety at least, of those which may at present be classed as useful.

Of something over 200 mineral species named by Dana (J. D. Dana, A System of Mineralogy, 5th edition, 1875) as occurring in the United States, at least 86, or over 40 percent., have been found to exist in Maine. Thirty-seven of these are commercially important when found in sufficient amount and great enough purity to make mining profitable; 13 may be classed as affording, when of good quality, material for cut gems or ornamental stones. More than 20 are being, or have been, mined at more or less profit; and of at least one, feldspar, Maine furnishes a more valuable supply than any other state.

The preceding statement omits to take account of the vast amount of building stone and road materials furnished every year by the rocks of the State.

Of the metals, Maine is known to possess gold, silver, tin, copper, lead, zinc, iron, antimony, bismuth, manganese, arsenic and molybdenum. Some or all of these may be in small amounts; perhaps too small to encourage expectations of immediate profits in mining them. There has, however, been so little systematic prospecting that no definite statement as to the probable amount of any of them is warranted. There seems no really good reason why any or all of them should not be found in amounts that would satisfy moderate expectations.

ROCKS AND MINERALS.

In order to make the matter clear to the unscientific reader, or to one having little or no familiarity with rocks and minerals, it may not be out of place here to enter as briefly as possible into some general questions concerning their character and distribution. Such a reader is strongly advised, as a preliminary to taking active interest in any mineral industry, to consult some good reference book in Geology or Mineralogy, or both. Several such are listed in the bibliography which is appended to this report.

It is a matter of everyday observation that rocks, as we see them on the surface of the earth, appear as ledge, as boulders scattered about over the fields, as pebbles, or as the smaller particles which make up such materials as gravel, sand, clay and soil. The ledge may be referred to as solid rock or bedrock; the gravel, sand, etc., as loose, unconsolidated or fragmental rock material, or as mantle rock. Everywhere, as is shown by clearing away the loose material, or by drilling or sinking wells and shafts through it, solid rock underlies the blanket, and thus forms a continuous surface, or bed, the world over. The thickness of the blanket varies much in different localities, sometimes increasing a good many feet within a few rods. In places it is hundreds, or even thousands of feet thick. An area of solid rock exposed at the surface, and unencumbered by a covering of loose material is known to the geologist or the miner as an outcrop. In regions where the solid rock is exposed for many square miles the term loses much of its force, and may fall into disuse; but throughout our State, where on the whole the mantle of loose rock constitutes by far the greater part of the surface, and one may frequently travel many miles without encountering so much as a square foot of actual ledge, the word "outcrop" holds a striking significance. Along the coast, except for stretches of sandy or shingly beach, or muddy marsh land at the heads of coves, the outcrop may be nearly continuous. Many of our mountains and hills show large areas of bare rock upon their summits and down their steeper slopes. The streams along their upper courses, may run between rocky walls. But in the low lands the solid rock is for the most part hidden under a loose mantle, varying in thickness from a few inches to many feet, and in character from the finest kind of silt and clay to coarse boulder-filled gravel.

The loose material has all been derived from the disintegration of solid rock. Much of it has simply rolled and slid down the slopes from the heights, where frost and other agencies are constantly at work, tearing the rock apart. A great deal has been deposited here and there by streams, or by waves and currents of the ocean; these always show layering, or stratification, and sorting into deposits of various kinds, as clay, sand, gravel, etc. The winds have also had some share in spreading out the loose materials; the most striking manifestation of their action being seen in the sand-dunes, or wind-formed hillocks, sometimes of considerable size. A very large part of the mantle is considered to owe its present position to mighty glaciers, which spread over this part of the world from the northward, plowing up the loose rock material in their paths into irregular ridges, or morains, and dropping, as they melted, a great load of unsorted materials of all sizes and kinds over the whole surface. The interested reader will find the story of the great glaciers one of the most fascinating chapters in earth history; a chapter that must be read if one is to arrive at anything like a satisfactory understanding of the surface conditions of our northern country as they exist today. The materials left by the glaciers, have, of course, in the thousands of years that have elapsed been in part worked over, and redistributed and sorted by streams and waves. Much remains, however, as the ice left it, and this forms the ground morain, or "drift."

The solid rock has been described as continuous beneath the unconsolidated mantle. That it is not continuous in character is, however, a matter of everyday observation. The rock of two neighboring outcrops may differ so much as to attract the attention of the most casual observer; or the rock in one small outcrop may show differences that the merest child can detect. These differences may be matters of color, or of grain, or of mode of "weathering"; or they may be variations difficult to define at a glance, but none the less apparent. These superficial differences are fundamental, taking their true significance from the nature and origin of the rocks themselves.

Broadly, the rocks may be divided into two distinct classes: (1) those which consist of angular particles or grains, closely interlocked; and (2) those which are made up of more or less rounded grains, resembling sand grains, pebbles, etc., or of fragments of shells or other hard parts of animals. The first are the crystalline rocks, so called, because the particles or grains are considered to be more or less perfect crystals. The second are the fragmental or sedimentary rocks, or, as they are sometimes called, clastic, which has essentially the same meaning as fragmental.

Of the crystalline rocks, some, by their position, relation to other rocks, and certain chemical and physical peculiarities, appear to have solidified (crystallized) from a liquid, or molten, condition. These are called igneous rocks, and the liquid masses from which they are considered to have formed are termed magmas. When a magma flows out upon the surface, through a volcanic vent, it is known as a lava; and this term is also applied, somewhat loosely, to solid rocks which are known to have resulted from the crystallization of such magmas.

Igneous rocks may be clear and glassy, (obsidian or volcanic glass); opaque, but so fine in grain that the crystalline structure cannot be detected without a microscope (felsite, "jasper," and the ground-mass of porphyr); too fine-grained to appear distinctly granular, and yet visibly crystalline (trap-rock); or distinctly granular, and plainly seen to be made up of two or more minerals (granite, and a long series of related rocks).

The above must be understood to be the briefest kind of introductory sketch. To obtain a good general working knowledge of the rocks, the reader is advised to visit a museum which possesses a good series of carefully labeled rock specimens.

The igneous rocks, as seen in the field, may form large masses of more or less irregular form; or they may occur as sheets which have the appearance of having been forced in a liquid, or plastic, condition between layers of the surrounding rock, or along cracks or planes of weakness. When such a sheet appears to have risen from below, in a direction approximately vertical, it is called a dike; if it seems to have spread out in a generally horizontal position it is called a sill. The terms "flow" and "sheet" are applied to masses of rock that have formed from surface lavas.

Dikes and sills may appear on the surface as more or less sharply defined ribbons, or bands, usually differing in color and texture from the rock which confines them. With respect to the dike, or sill, the confining rock is known as the wall-rock; the term "country rock" is frequently used when the confining rock forms the general bed over a considerable area. The accompanying photograph and diagram will serve to show some of these relationships.

A third group, not so clearly defined as the other two, consists of rocks that are considered as having been derived from either igneous or clastic rocks by the action of pressure, heat or water, or by their combined action. Space will not permit an adequate treatment of these rocks, and the reader is referred to any good reference Geology. It will suffice here to say that they are called metamorphic rocks, and they include mica and other schists, gneisses, slate, quartzite, marble (crystalline limestone), and some others.

MINERALS.

If a piece of fairly coarse granite is examined closely, it will be seen to be composed of two or more substances, rather uniformly distributed through the mass in distinct grains. These are the minerals of the rock. Some of these grains are rather glassy, too hard to be scratched with a knife-blade, and rough on the surface (quartz); some are of much the same sheen or lustre, but may be scratched with the knife-blade if sufficient care is used, and show smooth surfaces which reflect flashes of light when the specimen is turned about (feldspar); a third kind will usually be found which is soft enough to be scratched easily, can be picked off in little scales, and shines with a pearly, almost metallic, lustre (mica). These three are the usual minerals of granite, and they may be seen to good advantage in coarse specimens of the rock from Hallowell, North Jay, Fryeburg and many other places in the State. Granite, using the term in its strict sense, always contains quartz and feldspar, chiefly the potash variety (orthoclase); it usually has mica, and a number of other minerals may be present. Other combinations, in which appear a number of varieties of feldspar and many other minerals, give rise to a long list of rocks with which it is impossible to deal at any length in the present paper. In all, many hundreds of minerals are recognized, (Dana describes 837); but only a comparatively small number of these enter largely into the makeup of the rocks, or have any important bearing in a question such as is discussed in this report.

A mineral may be defined, for purposes of clearness, as one of the definite chemical compounds in the rocks; although it should be remarked that a few minerals are elements, and most minerals as they are actually encountered are mixtures of two or more, rather than single compounds. The above definition has enough truth to be of fundamental value. (For a clear definition of the terms "element" and "compound," consult any standard reference book in Chemistry.)

The compounds which form the minerals of the average rock contain in abundance only 8 elements which, with their chemical symbols and percentages of occurrence, are as follows:—Oxygen (O), 47; Silicon (Si), 28; Aluminum (Al), 7.9; Iron (Fe), 4.4; Calcium (Ca), 3.4; Magnesium (Mg), 2.4; Sodium (Na), 2.4; Potassium (K), 2.4. Next important, in the order of their abundance, are Titanium (Ti), Hydrogen (H), Carbon (C), Sulphur (S), Phosphorus (P), and Chlorine (Cl). All other elements combined enter into the rocks of the earth's surface to an amount of about 0.7 of one per cent. These are, with the possible exception of the first three, very unevenly distributed; and any one of them, even the rarest, may become important through the local abundance of some mineral which bears them. A case in point is the uncommon element Fluorine (F), which occurs in the tourmalines; and another is the still rarer element, Beryllium (Be), which becomes a fairly important constituent of such of our rocks as contain large amounts of the mineral beryl.

The chemical composition of a mineral is, of course, a matter for laboratory determination. For the purpose of ready identification, certain easily determined physical characters are much more important. These are hardness, lustre, color, streak, cleavage, specific gravity and crystal form. For convenience in determining hardness a scale of ten degrees is ordinarily used, a fairly common mineral representing each degree, as follows:—(1) talc, (2) gypsum, (3) calcite, (4) fluorite, (5) apatite, (6) feldspar, (7) quartz, (8) topaz, (9) corundum, (10) diamond. For everyday practice the finger nail and an ordinary knife blade make very serviceable rough and ready instruments for testing this quality of a mineral; the nail will scratch a mineral of the hardness of talc, but will make no impression on harder minerals; the knife blade is about as hard as quartz, will make no impression on the few harder minerals, can with difficulty be made to scratch feldspar, readily scratches apatite and fluorite, and will cut calcite and gypsum.

In describing lustre and color, descriptive terms are used, which define themselves.

The streak is the color of the powdered mineral, and is determined by rubbing the specimen on the surface of some white material harder than itself. For this purpose it is the custom to use a piece of unglazed porcelain; but in the field it is usually possible to obtain a fragment of quartz or light colored feldspar, and either will answer well enough.

Most minerals will, upon being sharply struck, break with more or less regularity, so as to show flat, smooth surfaces in one or more directions. This character is known as cleavage, and is often of great importance in identifying a mineral, conclusions being based on the perfection of the cleavage, the angles between two or more cleavage directions and the positions of the cleavages with respect to the crystal form. For example, mica cleaves perfectly into extremely thin leaves or sheets in a direction parallel to the base of the crystal. Absence of cleavage may aid in determining a mineral, as in the case of quartz, which shows no cleavage at all except under extraordinary conditions.

Specific gravity is determined accurately by the use of some method which compares the weight of the mineral with the weight of an equal volume of water. This is not often practicable in the field; but fortunately enough other characters are usually available to obviate the necessity of anything but a rough estimate. It is well to bear in mind that quartz, feldspar and the ordinary granites are all about 2.5 times as heavy as water; a rough estimate of the specific gravity of other materials may be made after a little practice by a comparison of specimens of nearly equal size in the hand.

Most minerals, if allowed to form freely, in cavities and crevices, and in some cases also in the mass of the solid rock, take regular forms (crystals) which are highly characteristic. The subject is too long and too difficult to be dealt with here; it is, however, intensely interesting, and will well repay the effort and time spent in acquiring a general knowledge of it.

FELDSPAR.

1. Description of the Mineral.

The term "feldspar" applies to a group of very common minerals which are all essentially alike in being about as hard as ordinary glass, in having a glassy sheen or lustre, and in breaking (or "cleaving") in two directions nearly at right angles. The fact that feldspar may be scratched, although with difficulty, by a knife blade gives an easy method of testing the hardness; the lustre may readily be shown by turning the specimen back and forth in the light; and the cleavage may be determined by striking the specimen sharply with a hammer, when it will break readily in such a way that each fragment will show two flat, smooth shiny surfaces practically at right angles to each other. The lustre is much greater on fresh cleavage surfaces; for this reason it is comparatively easy to detect the feldspars in a fine grained rock, because if a freshly broken surface of the rock is turned in the light, there will be a reflected flash from each particle of feldspar. Under the circumstances, quartz particles are usually dull, and mica, the other common mineral of the granites, is not only much softer but scales off readily into thin flakes. However, a little experience with the thing itself is worth more than any amount of description; and anyone interested in finding out what feldspar, (or any other mineral), is like, is advised to visit a mine, or a good collection, and get some competent person to show him.

There are three fundamental members of the feldspar group, all compounds of silica, alumina, and either potash, soda or lime. Mineralogically, the potash feldspar is known as Orthoclase, the soda feldspar as Albite, and the lime feldspar as Anorthite. As feldspars are ordinarily found in the rocks they consist of varying mixtures of Orthoclase and Albite, or of Albite and Anorthite. This gives rise to another division, more convenient than the above for practical purposes, into two groups: The Alkalic group, containing potash and potash-soda feldspars; and the Plagioclase group, containing soda, soda-lime and lime-soda feldspars.

The Plagioclase group is widely represented in the State, and frequently affords fine mineral specimens,—for example, the gray albite and pure white cleavelandite of the gem mines. Since, however, it offers little or nothing of commercial importance, it may be ignored so far as present purposes are concerned.

The "spar" of the miners and of commerce belongs entirely to the Alkalic group, and is essentially potash feldspar; although a certain amount of soda is frequently, perhaps usually, present. A spar may carry more than twice as much soda as potash; but so far as concerns the commercial spars of this State it is far more frequently the case that the potash is greatly in excess, the soda sometimes showing scarcely a trace.

Pure soda spar is occasionally mined for commercial purposes; but since it has not so far, in Maine, occurred in sufficient amounts to be mined separately, it may be left out of consideration.

In color, the spar of the mines may vary from white to gray, buff or pink. Some of the best Canadian spar is rather deep red, but most of the Maine material is of a decidedly lighter color. The colors, other than white, are doubtless due to extremely small amounts of various impurities, perhaps chiefly compounds of iron. If the latter occurs in large enough amount to produce rust stains upon exposure to the air, it may render the spar unfit for some purposes. For the most part, however, the color disappears upon grinding, and has no effect on the final product. Such impurities usually total less than 1 percent. of the mineral, and are ignored in reckoning the composition.

Pure potash feldspar, or Orthoclase, consists chemically of 64.7% silica (SiO_2); 18.4% alumina (Al_2O_3); 16.9% potash (K_2O). However, so far as concerns natural spar, as it is found in the rocks, this must be considered as an ideal composition, seldom any more than closely approximated. Since, as it stands above, it is likely to be misleading, particularly as to the amount of potash to be expected, the question of the usual composition of commercial spar will be discussed at some length in the next section.

Uses.

Spar, as defined in the preceding section, is used for a variety of purposes, in amounts sufficient to make it an important article of commerce.

The most important of its uses is in the manufacture of various kinds and grades of pottery, table porcelain and enameled sanitary ware. The greater part of such wares are manufactured in Trenton, N. J., and Liverpool, Ohio; and these two centers draw their raw material, in a crude or in a powdered condition, almost entirely from the states of the Atlantic sea-board. Maine has long been one of the most important states in this trade; and owing to the fact that its entire output is shipped in the form of a high grade, finely powdered product, it stands ahead of any other state in the value of its feldspar shipments.

Spar is also used to form a binder for emery and other hard substances in the manufacture of cutting, grinding and polishing wheels and stones; for making opalescent glass; as an abrasive in scouring soaps and window washes; for poultry grit; for roofing material and for the surfacing of concrete work; as an ingredient of fertilizers. Small amounts of very high grade spar are used in the manufacture of false teeth.

Three grades of spar are recognized by the trade, as follows:—

No. 1.—Carefully selected, free from iron bearing minerals, largely free from Muscovite (white mica), and containing less than 5% free quartz;

No. 2.—Largely free from iron-bearing minerals and Muscovite, but containing from 15% to 20% free quartz;

No. 3.—Not carefully selected, may contain some iron-bearing minerals and more or less Muscovite, and up to 35% free quartz.

The question of impurities, associated minerals, methods of separating, etc., will be discussed in later sections.

The relative amount of potash and soda in the feldspar does not appear to be an important matter in connection with most uses. It is, however, essential that for pottery purposes the feldspar should be purely alkalic, for the reason that lime-bearing feldspars crystallize upon cooling from a melted condition, and therefore cannot be used for products such as porcelain, glazes and glass, in which a glassy consistency is the chief requirement.

Although there exist in Maine considerable amounts of practically pure spar that could, at little additional cost, be separated as grade No. 1 of the scale given, it has not been considered profitable to so separate it. It is the general mill practice here to mix the pure spar with the less pure run of the ledge, and grind them all together; thus producing a powdered spar that contains somewhat less than 20% free quartz, care being taken to discard all deleterious minerals. The resulting product is a high No. 2 grade according to the scale, or first grade according to the classification employed by the Maine millers. This might at first sight seem to be a mistaken policy. It is, however, the result of long experience; and when all the factors that enter into the question are considered, it becomes fairly apparent that it is at present the best practice. The supply of the purer grade is at best comparatively small, and in areas within convenient hauling distance would doubtless be soon exhausted. The existing mills are not of great capacity, and any attempt at grading the output would add materially to the cost of operation, without sufficiently increasing the value of the output. All of the sorting of the raw material must be done by hand, and any additional sorting would require a larger force, and slightly greater skill on the part of the laborers. Finally, when it is considered that products as fine as those in Limoges, in France, and in the best English potteries are manufactured from spar of a grade that would not be considered by the potters in this country, it seems fairly evident that the product of the Maine mills is of as high a grade as is necessary for most purposes.

As a matter of fact, the writer is informed that orders are occasionally filled for special high grades of powdered spar; but these are not large enough or frequent enough to affect materially the output of the mills. At present there are, so far as can be discovered, no mills in the State that give any consideration whatever to lower grades.

By far the greater part of the better grades, which includes practically all of the product of this State, is used in making both body and glaze of table porcelain and china, and for vitrified sanitary ware (bath-room equipment, sinks, etc.), for which a pure white product is required. The color of the crude spar has little bearing upon this, unless it is badly stained by iron rust, since buff and pink spars all produce a powder that is practically white, and that becomes pure white when it is melted.

For the manufacture of opalescent glass, and for binding material in abrasive wheels and stones, low grade spar containing up to 35% free quartz and some other impurities is used. The mines and mills of Maine at present make no effort to supply these trades; and it is doubtful if they will in the future, unless, under circumstances as yet unforeseen, factories are established in the State.

Large amounts of crushed spar are used in other states for the manufacture of asphalt and other roofing materials, for the surfacing of concrete work, for sidewalk pavements and for poultry grit.

So far as is known, no attempt has ever been made in this State to supply the demand for crushed spar to be used for any of the above named purposes. The writer has been unable, in the limited time at his disposal, to obtain figures which would in any way indicate the extent of such a demand, or the profits which might reasonably be expected from catering to it. It would seem, however, to be a matter well worth further consideration, for the following reasons if for no others:—(1) There are immense amounts of feldspar rock favorably situated with respect to mill sites and shipping facilities; (2) the low requirement as to purity would do away with careful sorting, and would at the same time obviate the uncertainty of the continuous operation of reasonably large plants; (3) because the materials need only to be crushed, not ground, comparatively inexpensive machinery could be used; (4) much of the output would be in the nature of a finished product, and might be marketed directly from the mills; (5) because of its making use of a much higher percentage of the total rock of a given area, it might make available comparatively small, scattered deposits of high grade spar that cannot, under present conditions, be handled at a profit. It may be that further investigation would prove all of these arguments to be fallacious. It seems, however, worth while to present them, at least in a tentative way, in the hope that some one will give them further thought.

Feldspar as a Source of Fertilizer Potash.

This question has, particularly since the beginning of the European War, received so much attention that it deserves careful enough consideration to warrant giving it a section by itself.

It is, of course, commonly known that potash is an important plant food, and is for this reason a large ingredient in all commercial fertilizers; or rather was until the conditions brought about by the war made the price in large measure prohibitive.

The present stringency in the potash market is due to the fact that all but an extremely small percentage of the potash used in this country for stimulating crops and for other purposes has been in the past imported from Germany. The latter country has practically inexhaustible stores of natural potash salts, the easy availability of which has made it possible to market them at a low price. So great is this German supply, and so easily is it worked, that little serious consideration had been given to the question of possible sources of supply nearer home, until it was suddenly cut off, and we were left practically without this important material.

The magnitude of this sudden deprivation may be appreciated when attention is called to the fact that during the year ending June 30, 1914, potash salts to the value of $15,000,000 were imported from Germany. Of this, more than half was in the form of the chloride, 85% of which was used in fertilizers. The remainder was used in the manufacture of soap, glass and paper, in the preparation of colors, in printing and photography, and in the chemical industries. A considerable amount, in the form of the chlorate, goes into the manufacture of safety matches.

About three-fourths of the fertilizer potash goes to states east of the Alleghenies, most of it to be used on the fields of cotton, tobacco and potatoes, and on the orchards.

It may be authoritatively stated that as yet no means has been devised to render available in this country a supply of potash sufficient to supply our needs. Much attention has naturally been given to the question, and many sources of supply have been suggested and carefully examined. Enough has been accomplished to give more or less definite promise of future success; but it is only fair to say that so far no process has been perfected for producing potash on a commercial scale at anything but prohibitive prices.

Our present interest in the matter lies in the fact that in our feldspar there exists a supply of potash which, if it could be unlocked, would undoubtedly relieve us from all worry in regard to this country's supply for many years to come.

Pure potash feldspar carries theoretically 16.9% potash in the form of the oxide (K_2O). Even the best commercial spar, however, seldom runs more than a trifle over 12%; and on the whole it would seem unwise to count on a maximum yield of better than 6% from run-of-ledge spar even under very promising conditions, without hand sorting to such an extent as materially to cut down the profits. This is because of the presence of free quartz, which cannot be wholly removed by any practical process. To be sure, there are considerable deposits of feldspar in this State that carry less than 4% quartz; and such might be made to yield, after deducting a practically unavoidable loss of at least 15% in any commercial process, somewhere in the neighborhood of 200 lbs. of potash (K_2O) to a ton of rock. It is hardly fair, however, to base calculations of possible yields of potash on such feldspar, until it is shown that it exists in sufficient quantities, in sufficiently available form, to warrant the expectation of obtaining potash on a profitable scale from this alone.

As a matter of fact, it is an easy matter to obtain from a score of widely separated localities, masses of practically pure feldspar from a few inches to several feet in diameter, that would doubtless yield in the laboratory better than 10% potash. It must, however, be borne in mind that these are accompanied by, and intimately associated with, equally large masses of pure quartz, mixed feldspar and quartz, and perhaps other minerals in large variety. The crude material would not need to be iron free, and a considerable percentage of soda, while not adding to the value of the product, would not be detrimental.

It has been suggested that the comparatively low purity requirement would make it possible to utilize feldspar bearing rocks other than those from which feldspar is at present obtained. With us this does not broaden the scope of the question, since the only probable source other than the pegmatites would be the granites, and these seldom carry more than 5% potash, usually much less.

The writer does not wish to appear pessimistic in regard to this question. In fact, it seems on the whole highly probable that means will be found to utilize a part of our immense supply of feldspar as a source of potash; and those interested in feldspar mining are urged to keep closely in touch with developments in this direction. However, nothing could be more detrimental to the mineral interests of the State than ill considered ventures, doomed to failure because of too great expectations at the outset. It is, therefore, considered wiser to run the risk of overestimating the difficulties, than to accept, with too great readiness, the figures offered at present by those who have in hand the problem of working out in the laboratory the methods which must later be applied to the commercial processes.

Suggested Methods.

In an interesting article in a recent number of Industrial and Engineering Chemistry (Vol. 7, No. 2, P. 145, Feb., 1915) the authors describe a process by which potash may be extracted commercially from feldspar in the form of chloride (KCl) by the use of 20 parts each (by weight) of burned lime and calcium chloride to 100 parts of ground feldspar.

The calculations are based on a plant capable of handling 300 tons of feldspar in a day of 24 hours. Using what appear to be fairly conservative figures, a manufacturing cost of $32 per ton of KCl is worked out, giving a profit, at the mill, of $5.50 per ton at the normal selling price of $37.50. At war prices of $100 upward, the profit would of course increase proportionately, but such prices would cease to hold upon the opening up of large supplies in this country, or upon cessation of the war.

Some of the figures given are far too sanguine. For example, it is calculated that 1,000,000 cubic feet of feldspar rock (an estimate not excessive for any one of a great many localities), will contain 17,000,000 pounds of K_2O. From careful observations in the field, information furnished by miners, mill operators and others, and from careful examination of analyses of run-of-ledge feldspar, we are forced to conclude than 10,000,000 pounds would be a liberal estimate. Assuming, as the authors do, that 75% of this would yield to the commercial process, this would leave 7,500,000 pounds as the total probable yield. This, of course, materially reduces the possible profits. It may be, however, that a careful reconsideration of the calculations on the basis of some such figures as the above would still show promising results; particularly if, as suggested, the by-products of the process could be put to some profitable commercial use.

One method of utilizing the by-products of potash extraction is being somewhat seriously considered by parties interested in feldspar prospects in the town of Peru. Large amounts of good spar are undoubtedly available in this district, in deposits as yet practically unworked. Across the Androscoggin River, in Dixfield and Carthage, there are extensive beds of somewhat impure limestone. If some such process as the above is in the minds of the prospectors, the limestone can be burned to lime, and the latter used in the reduction of the feldspar. The further intention, if it was rightly understood, is to manufacture a form of Portland cement by roasting together the refuse from the feldspar mill with a desirable amount of the limestone. No definite opinion can be expressed as to the feasibility of this undertaking; any progress, however, will be watched with great interest.

Electrolitic methods have been applied to the exratcion of potash from feldspar, it is claimed with some success.

Occurrence.

Potash feldspar, or Orthoclase, is found in all the granites, and in a large number of related igneous rocks. In some of these it may amount to over a third of the rock by weight, and in some of the fine-grained rocks of similar composition it may constitute nearly a half. It is found also in gravels, sands, clays and soils, and in rocks which have been formed by the cementing of these materials, as well as to a certain extent in the metamorphic rocks. In fact, next to quartz, potash feldspar is probably the most widely distributed of all the minerals.

Should the extraction of potash from feldspar become commercially established, it is conceivable that any of the above named rocks that contain large percentages of feldspar might be utilized. At present, however, it is only in those peculiar masses known as pegmatites that "spar" occurs in sufficiently available form to encourage mining. In all other types of rock in which this mineral occurs, it is so intimately involved with other minerals as to defy any economic means of separation.

The pegmatites are coarse-grained rocks of the same general makeup as the granites and other similar rocks. It is the granite pegmatites that are of interest in the present discussion, and it is to these that the term will be understood to apply throughout the remainder of the report.

As in ordinary granite, the chief minerals of pegmatite are quartz, potash feldspar and mica, but whereas in a single mass of granite these minerals are in general evenly distributed and of uniform grain, in a typical pegmatite there is no uniformity whatever, either in size of grain or in distribution. It is common, for example, to find feldspar crystals varying from a few inches up to several feet in diameter within an area of a few square yards of surface. It is this peculiarity that gives pegmatite its importance as a source of spar; since quarries of considerable size may be located in masses of rock that contain little else.

Pegmatite also differs from fine-grained granite in containing here and there bodies of the rarer minerals, such as beryl, tourmaline, lithia mica, etc.

The pegmatites occur in irregular bodies, sometimes of considerable extent, and in more or less definite dikes or veins. These latter may sometimes be traced across country for long distances, but are found to vary greatly in width, coarseness of grain and mineral composition. It is for this reason entirely uncertain that a dike which yields good returns in spar at one point will show the same character in any other part of its course.

The pegmatite dikes and more irregular masses seem to be associated definitely with larger masses of granite; they are, in fact, frequently found in such positions as to connect them unmistakably with these bodies, and it is highly probable that all of the pegmatites could be traced back to granite sources. They are found to cut rock of all sorts, sometimes, so far as appears at the surface, at considerable distance from any granite. At one locality, a small granite quarry in Fryeburg, pegmatite dikes of two distinct types were noted, one rather uniform in grain, of the same general appearance as the granite, and plainly representing a coarse phase of the general mass, from which it was differentiated merely by a gradual increase in coarseness, the other of entirely different appearance, cutting sharply across the granite, very uneven in texture, and carrying large pink feldspars, many of them showing good crystal form. The latter plainly bears to the enclosing granite merely the relation of dike to wall rock, and owes its origin to some other mass.

In the majority of cases, in the western pegmatite area of the State, the wall rock is some form of mica schist; although in some cases the wall rock is gneiss, and in at least one case it is a dark green hornblendic rock. There seems to be no particular significance in this, so far as the general composition of the pegmatite is concerned. Field experience seems to indicate, however, that pegmatites which cut such rocks are more likely to contain minable bodies of spar and large concentrations of the rarer minerals. This is doubtless in part due to the fact that schists and similar rocks are much more variable in strength than rocks of the granite type. This is in a measure borne out by the fact that pegmatite dikes, as has been suggested, vary greatly in width, and that they frequently follow the planes of schistosity, (that is to say, they lie between "layers" of the schist more often than they cross them). The wider parts of the dikes indicate greater freedom to form large, and in some cases more or less perfect crystallizations.

The feldspar occurs in the pegmatite in the form of large, usually imperfectly formed, crystals, either of the pure mineral or of what is known as graphic granite. The latter is an intimate mixture of quartz and feldspar, in which there is about three times as much of the latter as of the former. Graphic granite varies much in coarseness, but this does not seem to affect the relative amounts of the two minerals, and although the coarser grades are sometimes given preference by the miners, it is probable that the finer material is just as valuable as a source of spar. Single crystals, either of pure spar or of graphic granite, may vary in size from a few inches up to several feet. Quarries have been visited in which there were scores of crystals which exceeded 4 feet in diameter, and there is at least one record of a crystal that measured twenty feet. Mines are usually located in those parts of pegmatite bodies which contain feldspar, or graphic granite, in very large crystallizations. Quartz and mica are likely to occur in abundance in these same portions, but the former, up to a certain point, is not detrimental for most uses, both are easily separable from the spar, the labor, and therefore the expense, of separaion decreasing with the size of the crystals, and either may, if in proper condition, be of some value. It is a matter of general experience that the more coarsely crystalline pegmatite, in which potash spar forms the bulk of the rock, is likely to be free from tourmaline and other minerals that might injure the spar for commercial purposes.

The pegmatite in this State is frequently crossed by dikes of trap-rock, from a few inches to several feet across. This is a dark colored, fine grained rock showing strong iron stains on weathered surfaces and along joint cracks. The dikes of it are more sharply defined than those of pegmatite, and much more uniform in width and texture. Some of the gem miners claim that the rarer minerals, particularly those affording gem material, are more likely to be found in the neighborhood of these dikes. This does not however, gain much credence among geologists, and it is doubtful if it is very definitely borne out by experince. It is not intended to imply that there is certainly nothing in the idea, it is merely that much more investigation is needed to make it of any particular value as a guide.

Distribution of the Sources of Feldspar.

Broadly speaking, rocks which may be considered as possible commercial sources of feldspar occur in more or less close association with granite, wherever the latter is found. Such localities are too numerous, and too widely distributed throughout the United States, to receive particular mention here. Several of the Eastern States, however, contain considerable deposits of workable spar in amounts sufficient to compete with the Maine supply, and these should receive mention before proceeding to deal in detail with the distribution of the feldspar sources of this State.

Feldspar mines that are at present, or have been, actively productive, are located in Connecticut, New York, Pennsylvania, Maryland, Virginia and North Carolina. New Hampshire, Massachusetts and Georgia are known to have feldspar-rich pegmatites of some extent, but these states have not, so far, been important producers.

In Maine.

As has already been suggested, it is probably true that all of the granites of the State have associated with them some pegmatite, or at least coarser phases that might conceivably, at some future time, yield feldspathic materials of commercial importance. Many of the porphyritic granites (those containing large feldspar crystals evenly disseminated in a ground-mass of typical fine-grained granite), carry orthoclase crystals over two inches long and three quarters of an inch wide. Most such granite has iron-bearing minerals (chiefly biotite or black mica) too thoroughly mixed with the feldspar to permit of its use in pottery, but it might be of some interest as a source of crushed material for some purposes in which alkalic feldspar, not necessarily in a high condition of purity, is the chief desideratum, or as a source of fertilizer potash.

Such granites are notably present in the region between Penobscot and Union Rivers from Brooksville and Bluehill northward through North Ellsworth, Dedham and Holden. The large crystals are inclined to be rather pure orthoclase and large masses of the granite, as some of that in the neighborhood of Bluehill, may consist in greater part of this feldspar. Field observation seems to indicate that the coarser granites, inclining to porphyritic texture, are less likely to show pegmatitic phases than the finer and more even-grained granites. It is certainly true that pegmatite dykes are very uncommon in the schists and other rocks surrounding the main granite masses. Much of the granite of the region is of medium grade, and non-porphyritic, but the statement in regard to the comparative absence of pegmatite applies. The dikes are apt to be rather finer grained than the main mass, and quite as uniform in texture and mineral composition. The better granites of this district, including some that are distinctly porphyritie, are quarried in a good many localities, both on the mainland and on the islands, and produce a large amount of excellent building stone. For this purpose freedom from pegmatite (the "salt horse" of the quarrymen) is a desirable characteristic.

Great areas of granite occur in the mountainous parts of the State, in the central and northwestern areas, and careful prospecting in the neighborhood of these might reveal promising sources of feldspar in considerable amounts. They are for the most part, however, difficult of access and remote from railroads, and are interesting only as regards possibilities in the not very immediate future.

Scattered small masses of potash feldspar are found here and there in the quartz veins that are abundant in the slate areas, but the mineral is probably nowhere present in sufficient amount to make it even remotely interesting.

It has not been thought necessary or advisable to enter in any greater detail into the distribution of the above-mentioned possible sources of potash feldspar, since it will doubtless be true for some years to come, as it has been in the past, that the only source to be considered will be the extraordinarily coarse-grained and variable pegmatites of a limited area in the western part of the State.

With the exception of one abandoned quarry at New Castle, and two at Edgecomb, all of the pegmatite that has been worked, or even prospected, for commercial spar lies in an area bounded by a line that follows the most easterly boundary of Sagadahoc County from the islands north to the 44th degree of latitude, hence due west to the Androscoggin River, thence up-stream to the northern boundary of Androscoggin County, thence westward across Oxford County to the New Hampshire line.

Within this boundary are some thirty or more quarries, mines and small prospects, twenty of which produce, or could produce, marketable spar in some quantity. Of these, perhaps twelve are worked more or less steadily for spar, all of which is hauled to three grinding mills, one belonging to the Trenton Company of New Jersey, located at Cathance, and two belonging to the Maine Feldspar Company, No. 1 at Littlefield Station on the Grand Trunk R. R., No. 2 at Topsham. Seven or eight localities are worked, either as mines or as mere surface prospects, primarily for gems or rare minerals. In at least four of these such maketable spar as is broken out in the course of operations is piled up beside the openings and allowed to accumulate until there is enough to make shipping it worth while. Besides the above there are known to be as many as eight old workings that have been abandoned for one or more of the following reasons:—Exhaustion of good material, insufficient means for carrying on extensive operations, disappointment in regard to the amount or quality of the pegmatite, or various difficulties in the way of profitable quarrying. One or two small quarries have been opened in localities so remote from shipping points as to make the cost of hauling prohibitive.

Several of the quarries, or mines, were opened originally for the purpose of obtaining muscovite mica; this mineral will be treated briefly in a later paragraph.

DISTRIBUTION OF PEGMATITE BY COUNTIES.

ANDROSCOGGIN.

Many small dikes of rather fine-grained pegmatite, largely an intimate mixture of quartz, feldspar and muscovite mica, occur in the eastern part of the county, from East Livermore, through Leeds, Greene and Lewiston to Lisbon Falls. Dikes of this rock may be seen in the Androscoggin at Lewiston and at Lisbon Falls, up to 30 feet in width. At the latter place the larger dikes strike a little west of north, are somewhat coarse, and might be worth further prospecting. The smaller ones are finer, strike about 20 degrees east of north, and show little promise. Most of the smaller dikes of this whole region strike in nearly this same direction, and show similar characteristics. Numerous granite boulders carry pegmatite of no value as to the feldspar content.

At Auburn the pegmatites have been extensively quarried both for feldspar and for gems, principally tourmaline. The principal spar quarries are those of the Maine Feldspar Company (2) on Mt. Apatite, and the Berry and Havey quarries across the Little Androscoggin River. The Towne and Pulsifer quarries are operated for gems, but considerable amounts of spar are saved. All of these deposits deliver to the mill at Littlefield Station. Several irregular dikes at South Auburn would permit separation of spar in considerable amounts, but have not been worked. A large dike on the Henry Irish farm, striking north and south, and about 100 feet wide, might yield marketable spar. This forms a low ridge, and can be traced for several hundred yards. It is in places very quartzy with much black tourmaline and some beryl. It appears to carry amounts of spar that could be readily separated.

Aroostook County.

Occasional large crystals of fine spar occur in quartz veins in the slate, at Fort Kent and other places. No promise of large occurrences is indicated anywhere in the county.

Cumberland County.

The most promising opportunity for spar in this county is at South Freeport. Here the pegmatite occurs in at least three dikes which have the variation in width, grain, and mineral makeup which is characteristic of good prospects. Operations have been started in two of these dikes on the Grove property, and some little prospecting has been done on the Taylor and Strout properties. The main system of dikes strikes approximately northeast-southwest, with a steep dip to the southeast. Other dikes strike nearly east and west, with a steep dip to the south. The country rock here is a rather coarse metamaphoric rock, containing much hornblend, dark colored soda-lime (?) feldspars and some brown mica. The deposits here are near sea-level, and close enough to a harbor so that the spar could easily be loaded on small vessels. It seems hardly likely that workings will go far below the surface, as water will constitute a serious obstacle. The quality of the spar is undoubtedly good, and if advantage is taken of all the deposits in the immediate neighborhood, the yield ought to be promising. Good specimen beryls have been taken from the more quartzy parts, and there seems a possibility that some of these will prove to be of gem quality. So far as could be learned, there is little promise of other gems in this locality.

Some miles to the northeast, there occurs on the Davis property a dike containing a considerable amount of good spar, which seems to offer easy separation from injurious impurities. This appears to belong to the system already described; this is borne out by the fact that this dike is paralleled by at least two others. The principal deposit here had not been worked commercially at the time it was visited, but had been somewhat extensively prospected and uncovered. Mr. Davis expresses the intention of working this for potash and results will be awaited with interest. The dike cuts a hill of some altitude, and the product of a quarry located here could be brought to sea-level by gravity.

HANCOCK COUNTY.

Some promise of spar is indicated at East Orland, where several narrow dikes, in part consisting of fairly pure potash feldspar, occur. These are too far from transportation facilities to be of commercial importance at present. So far as has been seen, such dikes are rare in other parts of this county, but more thorough prospecting might show something of interest. Granite boulders near Ellsworth and other places show some pegmatite, not of promising quality.

KENNEBEC COUNTY.

Granite boulders everywhere carry some pegmatite, but not of a quality to warrant considering it a source of feldspar. Wherever mica schist occurs as the country rock, small pegmatite dikes are occasionally found, and these sometimes contain interesting minerals. More often these are replaced by quartz veins up to several feet in thickness. This county is hardly to be considered as a feldspar district.

KNOX COUNTY.

On the shore near Thomaston there are small pegmatite dikes, striking nearly northwest-southeast, and nearly vertical. None of these are promising. The islands south and east of Port Clyde, and the shores of the neighboring mainland show similar dikes, which offer interesting geological and mineralogical problems but do not indicate commercial possibilities in feldspar.

Oxford County.

This county probably contains a larger amount of coarse pegmatite, more widely distributed, than any other county in the State. Feldspar of possible commercial quality is known to occur in Albany, Bethel, Buckfield, Fryeburg, Hebron, Minot, Norway, Paris, Peru, Rumford, Stoneham, Sumner and Waterford and prospecting is to be encouraged in favorable localities anywhere in the territory included within these towns.

In this county are also located the oldest and most famous tourmaline mine, that of Mt. Mica in Paris, some of the best deposits of other gem minerals, as topaz and beryl in the country north of Fryeburg; and sources of rare minerals in great variety.

The largest pegmatite mass seen was on Streaked Mountain, about 3 miles west of Buckfield. This covers the entire top and part of the slopes of the mountain. The exact form of the deposit is hard to determine, but it does not appear to form part of a definite dike. The feldspar is in large imperfect crystals, and should yield readily, in large amounts, to quarrying operations. Quarrying has recently been carried on near the road from Buckfield to South Paris, but operations have not gone very far. The writer was informed that results were promising. This pegmatite varies greatly in mineral makeup, some portions showing a good deal of black tourmaline, others very quartzy and carrying fairly numerous crystals of beryl, some of them promising gem quality. Small dikes occur in the rocks surrounding the main mass, and these have yielded specimens of a large number of fine and rare minerals. Those in the neighborhood of Owl's Head have been extensively prospected by Mr. Perrein Dudley and others, and have yielded, besides promising beryl and green tourmaline of good color, considerable amounts of the extremely rare caesium mineral pollucite. These dikes all indicate spar possibilities, but will doubtless continue for some time to be more interesting for their other minerals.

A large district has recently been rather thoroughly prospected on Pinacle, Tumbledown-Dick and Black Mts., in Peru. Through the courtesy of Mr. Cyrus S. Stackpole, the writer was enabled to examine the deposits in this district in some detail. These include, so far as indications at present show, a large flat-lying mass of very coarse pegmatite, somewhat similar to that on Streaked Mountain. Large imperfect crystals of pure spar occur, quite free from impurities, mingled with masses of white quartz which usually carries beryl crystals more or less promising in quality. There are also smaller dikes of pegmatite on the Farrar farm, on the slopes of Black Mountain, and in some other places. These are on the whole less promising than what appears to be the main deposit, but are worth further prospecting. The district includes an old mica mine, from which little marketable material has been obtained. The pegmatite on Black Mountain, and also some in other places, contains good-sized crystals of green apatite. The purposes for which these properties are being prospected were mentioned in an earlier part of this report.

At Mt. Mica, the mines are worked mostly for the gem tourmalines which they have long afforded; a considerable amount of good spar appears, however, and this is occasionally marketed.

At Waterford, on the farm of Mr. George Kimball, there are at least two large pegmatite dikes, in one of which a mica mine was opened some years ago. Attempts have been made, with little success, to market this product; it occurs in fairly large plates of promising appearance, but appears not to be suited to electrical purposes, probably because of a certain percentage of iron. As the mica occurs in large amounts, it is thought that some profit might be realized by grinding it. The dikes contain considerable amounts of excellent spar, sometimes in very perfect crystals; one such was seen which measured over a foot in diameter. Aside from the fact that this deposit is located in a very hilly region, somewhat remote from transportation facilities, it should be a promising one for further prospecting.

In Hebron small quarries have been tentatively opened at No. 4 Hill, and on the property of Alton Hibbs, a mile north of the town. In the former deposit, black tourmaline forms an impurity difficult to remove. On the Hibbs property, a 20 foot dike occurs, striking approximately north and south, and standing nearly vertical. This dike apparently contains a good amount of nearly pure spar, and should be more thoroughly prospected. There is also some mica of good appearance, and green tourmaline occurs in places. Pegmatite of promising appearance also occurs on the slope of the hill south of Hebron Sanatorium, and along the road from Hebron to South Paris.

Pegmatite dikes that might yield some spar occur about 2 miles northeast of Norway (Stevens Ledge). The best of these strike north and south and are nearly vertical; other dikes strike at right angles to these, and are very quartzy. Muscovite and biotite are rather thoroughly disseminated, and these with considerable garnet might prove difficult to separate.

The dikes at Fryeburg have already been briefly described. The coarser dike here looks promising, and it is suggested that it might be worth while to prospect it somewhat thoroughly. Occurrences of pegmatite are fairly abundant to the north and east, and some of them have been to some extent exploited for gems. Most of them, however, are too remote from the railroads to be at present interesting as sources of commercial spar.

Sagadahoc County.

There are some 17 quarries and prospects in this county, some of which are active, and produce feldspar of considerable value. These are located at Topsham, Cathance, Georgetown, Riggsville and Phippsburg. Those at Topsham and Cathance are the most important, and produce material ranging from pure spar to graphic granite, all of which goes to two mills, that of the Maine Feldspar Co. at Topsham, and that of the Trenton Co. at Cathance, to be ground.

Among those which have been actively worked in recent years are:—In Cathance, the Alfred Graves, Maine Feldspar, Maine Graphic Granite, Trenton, New W. G. Wills, Fisher; at Topsham the Maine Feldspar Co. deposit; in Georgetown, the Golding quarry. Besides these are several abandoned quarries, as the Mt. Ararat, old Golding and old W. G. Wills quarries; and a large number of more or less promising pegmatite dikes. Few of the above deposits have produced gems, although opaque beryls are not of infrequent occurrence. Fine pink and green tourmalines have recently been reported from near Georgetown.

In Lincoln County, some prospecting has been done at New Castle and at Edgecomb, but it is believed that little commercial spar has been obtained at either place. Further prospecting seems warranted, however, and might yield some good results. A large number of pegmatite dikes appear along the railroad east from Wiscassett. Some of these were examined but did not appear promising as the minerals were comparatively fine and too intimately mixed to be readily separated.

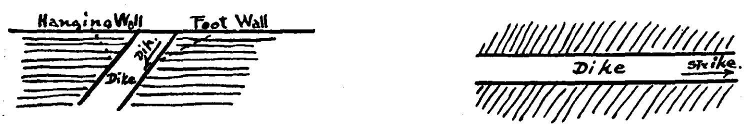
It is obviously impossible to offer anything like an accurate estimate of the amount of marketable feldspar in Maine. If the known deposits were of uniform composition in a broad way, either areally or in depth, a fairly approximate figure might be arrived at. Ordinary pegmatite weighs about 150 pounds to the cubic foot. Supposing this to be half feldspar, a mass of rock 100 feet by 20 feet by twenty feet would contain 1,600 tons of pure spar. Since the commercial material contains about 20% quartz, this would actually mean 2,000 tons of pottery spar. Such a mass would be comparatively small; there are localities in the State that contain deposits perhaps a hundred times as great. It is not, therefore, an exaggeration to reckon several million tons as a possible yield. The demand being steady, and constantly increasing, and crude run-of-ledge spar being worth around $4 a ton at the shipping point, it is plain that Maine has a valuable resource in this mineral, supposing its use to be confined merely to the pottery industry. It is felt that its value will increase greatly as new uses are found for it, and that a decided increase would follow the establishment of industries that would demand it within the State.

That the above figures are well within bounds is shown by the fact that one mill, during 1915, ground 7,560 tons of commercial spar, 5,548 tons from one quarry, 1,902 tons from another. This represents but a small part of the possible yield from either source.

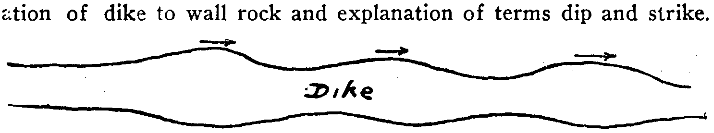
The cost of mining spar depends so largely upon local conditions, current prices of labor, etc., that it is difficult to give even approximate figures. This cost must, of course, be such that the above price will yield a profit when the cost of hauling is taken into account. This latter also varies locally, and must be determined for each case. One company pays 75 cents per ton for a haul of two and a half miles, and 50 cents a ton for a haul of two miles over an easier road. The higher price, which amounts to 30 cents per ton mile, is probably a good average basis upon which to reckon. In many cases the marketing of by-products, such as gems and other minerals, serves to reduce the cost of operation, and it is suggested that more serious attention might be given to this side of the mining industry throughout the district.

PROSPECTING.

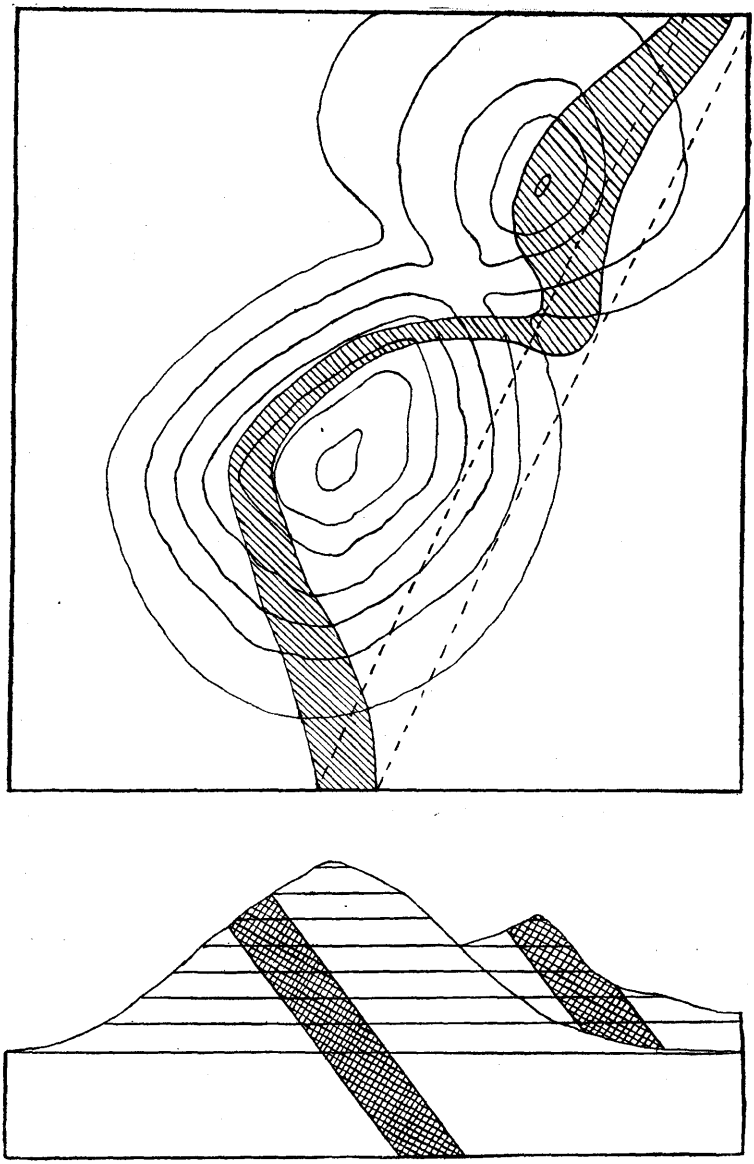
If the bed-rock of these regions were bare over large areas, or even if that which is bare should remain un-weathered, the prevailing light color and coarse grain of the pegmatites would make every deposit easily seen from a considerable distance. Unfortunately, there is in reality an extremely small amount of rock surface that is absolutely bare, for even if no thick covering of soil exists, there are a great many plants, such as lichens, mosses and ferns, that can get along with little or no soil, and these form a tangled mat which must be removed before the rock can be examined, and where this mat does not exist pegmatites frequently assume, under the action of the air and surface water, the same dull gray color as that borne by the schists and other rocks which surround them. So that it is necessary, in order that no promising possibility may escape attention, to go carefully over a suspected rocks area, almost foot by foot, tearing off frequent masses of the matted plant covering, and breaking into exposed surfaces with a hammer. In a new region this may be at first a more or less haphazard proceeding, but in an area where masses of pegmatite are already known, particularly if these are in the form of distinct dikes, some little guidance at least is afforded the prospector. Having located a dike, it is of first importance to obtain its strike and dip, that is, its horizontal direction and the angle at which it passes downward. Both of these must be taken at the contact between the dike and the wall rock. The strike by sighting, preferably with a good compass, along this contact, and the dip with some instrument that will give the angle between the contact surface and a level or horizontal plane.



Relation of dike to wall rock and explanation of terms dip and strike.



Common form of pegmatic dike.



1. Map and 2 Profile to illustrate the possible course of a dike. The outcrop will occur along the shaded band.

If the dike is vertical, to trace it across country, unless it is badly broken by faults, is a comparatively simple matter. If, however, as is often the case, it dips at an angle less than 90 degrees, the problem, especially in a region of abrupt hills, may become somewhat difficult. The accompanying diagram may help to make this clear. The lower figure shows two hills in profile, the same dike, appearing as a dark band cutting across both of them at a steep dip. The upper figure shows a map of the same two hills, with the dike cutting diagonally across. If the dip were vertical, or the surface level, the dark band would lie straight across between the dotted lines. The region being hilly, and the dike dipping steeply, the outcrops would actually appear along the sinuous course shown. This may serve to indicate some of the difficulties to be met in prospecting and to indicate the necessity of exercising care.

Metallic Ores.

The term metallic ore is somewhat difficult to define any more than approximately, since the great majority of our minerals contain one or more metals in some amounts, and therefore practically all rocks are potential ores. In its more common use, the term is restricted in its application to those minerals and rocks which are at present mined for the purpose of obtaining metals in commercial or useful amounts. Necessarily the application broadens as new metals find a use, and as metals already used are required in larger amounts. For our present purpose the term may be taken, with reservations, to apply in its narrower sense.

In a report on Some Ore Deposits in Maine (U. S. G. S. Bul. 432, 1910) W. H. Emmons says:—"Metal mining does not rank as an important industry in Maine, for, aside from iron ore, the deposits of which were once worked with some vigor, the metallic production of the State has been small. It contains, however, deposits of nearly all the common metals, and owing to the complex relations of the rocks and the eventful geologic history of the region, the number of types is not surpassed in many regions of greater mineralization and larger ore deposits."

This is as true today as it was six years ago, and a more apt description of Maine in respect to the present status of its metallic minerals could hardly be formulated. It is, on the whole, encouraging rather than otherwise, and above all it offers a hint as to the proper attitude to be assumed toward the whole question, one of expectant open-mindedness, and at the same time of deliberate caution. Prospecting for metallic ores of many kinds should be encouraged and the people of the State should be warned against the expectation of large immediate financial returns. In other words, useful minerals should be regarded in the same light as other products of the land, as crops which may, under proper circumstances, add to the general income, if only in a small way. Many, perhaps most, of the metal mining enterprises of the State have been ruined at the outset by too glowing promises, and consequent over capitalization and extravagantly elaborate equipment.

The metals of Maine include gold, silver, tin, copper, lead, zinc, iron, manganese, bismuth, antimony, aluminum, molybdenum, tungsten and arsenic, also a number of rarer metals, for which some use exists, such as columbium, caesium, rubidinum and probably uranium and radium.

Metal mining began in this State very early in the nineteenth century, apparently with an attempt to obtain copper near the northern boundary. One of the first enterprises was a small pyrite mine on Jewell Island in Casco Bay, the product of which was used in the manufacture of iron sulphate (copperas or green vitriol) and alum. Some time later the iron ore of Katahdin Iron Works was opened up, and mining carried on intermittently until 1890, the ore having been smelted near at hand, and the iron shipped as pig. Lead was mined at Lubec in the early sixties, and more actively between 1878 and 1882. Copper mines were opened at Bluehill and Sullivan at about the same time, and worked until 1883, when a sudden drop in the price of copper caused them to shut down. Silver mines at Sullivan also ceased operations at this time.

Since then mining has been carried on in a more or less desultory way at these and a few other localities. No accurate calculation of the value of metals that have been mined in Maine can be made. Emmons gives $400,000 as a conservative estimate for all except iron, but this is undoubtedly somewhat too small. Probably, judging from the character of the developments in most cases only a small percentage of this amount can be charged to profit.

A brief consideration of some of the metallic resources of the State follows.

GOLD.

Gold occurs principally in the form of the pure metal, and may be recognized by its color and metallic lustre (in some cases apparent only upon scratching or rubbing), and by its softness. It has frequently been confused with pyrite and other metallic sulphides, with which it is frequently associated, and even at times with yellow mica. The former is much harder, and of a more brassy color, besides showing a strong tendency to decompose and show iron stains; also upon heating the sulphides give off the odor of burning sulphur. The latter is not truly metallic in appearance, and need not be mistaken for gold by anyone. The writer knows, however, of at least one "gold mining" enterprise in the State that was based on the discovery of a quantity of this material, and a man who does some business in the identification of minerals states that he is not infrequently asked to determine the amount of gold in absolutely worthless yellow mica. The prospective seeker is advised, in order to avoid chagrin, to become familiar with the appearance of native gold, both as it occurs in gravels, and in vein quartz, and warned not to expect anything more than days' wages as a reward for his efforts. He can, however, be certain of a ready market, at a standard price, for all the gold he can find.

Gold has been found in Maine, in very small amounts, in association with the copper ores at Bluehill and elsewhere, in some of the granites, and in the river gravels at Madrid, Albion, Carrabassett and a few other places. The best places to prospect for this metal would undoubtedly be in the sands and gravels of mountain streams; it is possible that it will also be found in some of the many quartz veins that cut rocks of all sorts in localities too numerous to receive particular mention.

It should be said that gold in pay quantities may exist in a rock without being visible. Specimens suspected of containing gold in very small amounts have been collected during the past season from several localities. It is not desirable to report more definitely on these until assays have been made.

Silver.

Silver, in small amounts, has been found in practically all of the lead, zinc and copper ores of the State, and probably somewhat more than 5,000 ounces of the pure metal have in the course of time been obtained from these sources, chiefly from the mines at Sullivan and Byard Point. The name "silver mine" has been applied popularly, as at Cherryfield, to several shafts sunk in bodies of lead and zinc ores, but it does not appear that much silver has actually been obtained in any of these cases. The ores of the Somerset Mining Company, at Concord, yielded, on analysis, four percent of silver.

This metal occurs as the sulphide, argentite, at Cherryfield and Sullivan, and as the chloride, cerargyrite, at Sullivan, from which place is also reported a sulphide of silver with antimony. Free, or native silver, has been reported from Sullivan and Eggemoggin.

Tin.

No large commercial source of this metal has yet been found in the United States, although its ores, in small amounts, are known to be comparatively wide spread. A workable deposit of tin ore would be a most welcome addition to the mineral resources of the country.

In Maine, tin has been found in the form of the oxide, cassiterite, in crystals an inch or more in diameter, scattered sparingly through the gem pegmatites at Mt. Mica in Paris, at Hebron, and in the vicinity of Streaked Mountain. Specimens of this mineral may be seen in the State collection. Tin is also reported from Catherine Hill in a natural alloy with bismuth. Tin ores at Winslow were at one time considered promising.

Copper.

Most of the copper found in Maine is combined with sulphur in the minerals chalcocite, bornite and chalcopyrite (containing iron), and tetrahedrite (containing antimony). Such sulphides have been mined as ores of copper at Lubec, Dexter, Concord, Sullivan, Bluehill, Sargentville, Brooksville, Harborside, Eggemoggin, Deer Isle, Castine, Gouldsborough, Franklin, Pembroke, and at Milton Plantation and Grafton (?) in Oxford County. Small amounts of native copper have been found at

Bluehill. The blue and green basic carbonates, azurite and malachite, occur as surface stains on the rocks about the copper workings, and the latter is frequently the best surface indication of the presence of copper. Fine specimens of azurite have been reported from Harborside, but none could be found there at the time of a recent visit.

Small quantities of the sulphide ores of copper were collected at Ellsworth and one or two other localities, but these were not such as to warrant expectations.

It should be said that rocks containing less than seven percent of copper can be worked at a profit, provided the body is of considerable extent. Prospecting for ores of this metal is to be encouraged; and it is suggested that some profit in a very moderate way might be expected from hand working in many of the localities mentioned, particularly if present market conditions continue to hold. In this, as in other metal mining in the State, the sinking of deep shafts and installation of expensive equipment should not at present be considered.

Some idea of the possibilities of our copper mines may be derived from the statement that the Douglas mine at Bluehill produced, between 1878 and 1883, about 2,000,000 pounds of copper, valued at $300,000.

Lead.

The sulphide of lead, galena, has been mined from time to time at Lubec, Cherryfield, Bluehill, Bingham, Parsonsfield and Milton Plantation, and is found at least sparingly at nearly all the metal mines. Some good specimens of this ore were seen at East Dixfield, in small quartz boulders. As the ledge was not found, no definite locality can be given. It is likely that the actual vein is somewhere to the northward; but no opinion can be given as to the distance the boulders may have traveled to reach their present location.

Zinc.

The sulphide of zinc, sphalerite or blende, is usually closely associated with galena, and is found in this State in practically all the localities that have produced lead. Specimens from Cherryfield, showing the sulphides of both metals, may be seen in the State Collection. It does not appear that this metal has ever been an important product of Maine mines, but the possibility of larger occurrences is suggested.

IRON.

Iron bearing minerals are among the commonest, in this State as elsewhere. They are disseminated through all the rocks; sometimes in amounts, or in a form, too minute to be detected without microscopic or chemical examination; but very frequently in visible form. It requires but very little to produce a strong rust stain on a weathered rock surface, and exceedingly minute amounts are sufficient to give deep colors to certain clear minerals.

The list of minerals containing iron is too long to be given here; most of them cannot be considered as ores, and are therefore of little importance to the present discussion.

The sulphide of iron, pyrite or iron pyrites, is of very wide distribution; but it is to be considered rather as a source of sulphur than of iron, and will therefore be discussed later. Iron is also found in other sulphides, with copper (chalcopyrite) and with arsenic (arsenopyrite or mispickel): Considerable amounts of the latter mineral are found at Corinna, Newfield, Thomaston (Owl's Head) and in the Mt. Mica mine at Paris. These minerals are also considered more for the other elements than for iron.

The true ores of iron are chiefly the oxides, hematite and magnetite, the hydrous oxides, limonite and turgite; and the carbonate, siderite. All are present in some amount practically everywhere in Maine, though it is probable that only the hydrous oxides are in available quantities under present conditions. It should, however, be borne in mind that some of the heavy dark rocks, such as trap, may carry as much as seven or eight percent iron, contained in the dark silicate minerals and also in oxides, chiefly magnetite. A shortage in the high grade iron ores of the country may in the future, conceivably give these rocks value as iron ores. Many lake and river sands which have resulted from the disintegration of these rocks, contain large percentages of iron bearing minerals, and may well be kept in mind as possible future sources of iron.

The whole question of the value of iron ores in Maine is one for future detailed investigation. At present it seems probable that the most promising deposits are those of the bog ores, which consist chiefly of limonite and the closely related turgite, with a possible percentage of bog manganese. These underlie all of our peat and other bogs to some extent, since the process of dissolving (leaching) iron out of the rocks and concentrating it in the low places is one that has been going on everywhere for ages. Such deposits are difficult to get at, and at present it is not possible to specify many definite localities; any of the bogs described in the chapter on peat may reasonably be expected to contain some bog iron, particularly where these receive drainage from the surfaces of rocks containing considerable amounts of iron minerals.

The most considerable deposit of minable iron so far known in Maine is that at Katahdin Iron Works. Here the ore, bog iron, has resulted from the decomposition of a dark rock rich in sulphide minerals. The water draining over this rock is so strongly mineralized as to be almost undrinkable and it has deposited the hydrous oxide of iron down the slope of a hill, coating sticks, leaves, pebbles and other small objects, and forming a thick bed of high grade ore. The mines were surface workings; the highly decomposed rock itself, with the bog ore, having been dug out and hauled about a mile to smelting furnaces. This produced excellent cast iron, in amounts varying from 2,000 to 15,000 tons per year, for some time prior to 1890. This deposit is by no means exhausted, and it is highly probable that it has not been prospected throughout its full extent. The better facilities now existing for obtaining supplies, including lime for flux, and for shipping the product, would seemingly make the reopening of this enterprise highly probable.

Deposits of the earthy form of limonite known as ochre are found between Lagrange and Howland. It is understood that this has been exploited to some extent for use in paint; further investigation might show it to be of more value as a source of iron.

MANGANESE.

Manganese occurs in Maine in at least three minerals: The carbonate, rhodochrosite, at Deer Isle; the silicate, rhodonite, at Bluehill; and the oxide, pyrolusite, at Bluehill and Lubec, and in very small amounts at many other places. Bog manganese is a fairly common associate of bog iron, and it may be expected that it will be found with the latter in this State. Minute amounts of manganese compounds occur as coloring matter in other minerals, as in amethyst.

Manganese is used somewhat extensively in the manufacture of that form of steel known as ferromanganese, and is at present in considerable demand for that purpose. The oxide has a large use in chemical laboratories; and it is also used to remove certain colors from glass, and in the manufacture of some paints. None of the compounds have yet been found in minable quantities in Maine, but manganese should be kept in mind as a possibility.

ANTIMONY.

This metal has a wide use in alloys with lead, tin and other metals: with lead in type metal; with lead, tin, copper and zinc in brittania used as a base for silver plating; and with tin and copper in babbitt used extensively in the bearings of machines. It is also used in medicine, tartar emetic being a compound of antimony.

In Maine antimony has been found as the sulphide, stibnite, at Bluehill, Sullivan and Carmel; in a sulphide with copper, tetrahedrite, and with silver, stephanite, at Sullivan.

It has not been produced in important amounts here, but offers possibilities.

ALUMINUM.

This is today one of the most important metals, and has found thousands of uses where lightness is desired as well as strength, although it has come into common use only in the last thirty years. Its consumption increased, between 1883 and 1910, from 83 pounds to 47,734,000 pounds per year. Its uses are so varied, extensive and important that almost any amount would undoubtedly find a ready market.

Curiously enough, although its compounds are almost universally present in very large amounts, so far it has been commercially obtained from practically only one, bauxite, found, so far as this country is concerned, only in some of the southern states. It occurs in the most abundant of the silicate minerals, feldspar, of which its oxide may form more than twenty percent; and in many other similar minerals. The pure oxide occurs in nature as corundum, or emery, and in the gems ruby and sapphire.

To us, however, its most interesting occurrence is in clay: a material which, in one form or another, is found in Maine to the amount of many millions of tons. Immense beds of clay border the lower courses of all our rivers; fire-clays, sometimes to a thickness of many feet, underlie the peat beds; great deposits of clayey silts lie at the bottoms of our lakes; and there exist large amounts of hardened clay in regions where water formerly stood. Shales and slates are but clays altered in their physical character by pressure, heat and the cementing action of water; and of these we have incalculable amounts.

Clays in general consist of the mineral kaolin, a hydrous silicate of aluminum, mixed in varying proportions with iron oxide, silica and other substances. Aluminum oxide, alumina, forms in ordinary clays from about 10 to over 30 percent. Counting, at a conservative estimate, 120 pounds of metallic aluminum to the average ton of clay, one square mile of clay two feet thick would produce over 150,000 tons of the metal.

This is, of course, all in the future; for the present our truly inexhaustible supplies of this valuable metal are securely locked up. It is, however, true that several patents have recently been issued for methods to obtain aluminum from clay, and experiments are under way which give promise of success. It seems, therefore, not wholly chimerical to hope that sometime in the near future our great deposits of clay, now practically unused, will turn out to be among our most valuable assets.

Molybdenum.

One of the most interesting mineral problems in Maine today is that connected with the production of the metal Molybdenum.

This substance is used in small amounts, with Chromium, in making steel for purposes that require particular hardness and resistance; for the manufacture of lathe tools for metal turning; and in general for the same uses as those to which vanadium steel and tungsten steel are put. For such purposes 5 parts of molybdenum, by weight, can be made to take the place of 18 parts of tungsten. Molybdenum steel is of special value in making permanent magnets, such for example as are used in magnetos. There is also some demand for compounds of molybdenum in making certain blue pigments for dyeing silks and woolens, and in the manufacture of porcelain. It can be made into ribbons for electric lighting purposes, and on account of its superior ductility it is sometimes used to support the tungsten filaments in incandescent electric lamps. Compounds of molybdenum are always in some demand for chemical laboratory purposes.

The demand for this metal has never been very great; it has, however, increased as new uses have been found, particularly since the beginning of the European war. It seems now practically certain that the whole of any good available domestic supply would find a ready market at a good price.

Molybdenum is found in nature chiefly in the form of the sulphide, molybdenite, a flaky, gray, brightly metallic mineral, so soft as to be easily scratched with the finger nail and to leave a gray mark on the paper, much like that made by a soft lead pencil. This occurs in flat crystals which, when of sufficient size, can be picked readily from the including rock ("gangue") by hand. Molybdenum also occurs sometimes in the oxide, molybdite, usually in the form of a soft, bright yellow powder.

The market has so far received its chief supplies of molybdenite from Australia and Ceylon; more recently from Canada, where it is found in large enough pieces to admit of hand picking.

Molybdenite has been found at a number of localities in the United States, and has long been known to occur in Maine. Dana, 1875, records its occurrence at Bluehill Bay and Candage farm, in large crystallizations; and at Brunswick, Bowdoinham and Sanford, in less available form. Later, a deposit was found about fifteen miles north of Machias, and worked for a short time in a tentative way. Most of the American molybdenite is described as occurring in the form of fine particles, disseminated through the rock in such a way as to render separation very difficult. Two recently devised methods, one by flotation, one electrostatic, make it highly probable that our deposits will be available for use in the near future. Good hand sorted molybdenite, in small lots, has sold for as much as $700 a ton. This may be too much to expect as a steady thing; but it will serve to indicate that even one or two fairly productive molybdenite mines would form a valuable addition to the mineral resources of the State.

What is probably the largest molybdenite development in Maine at the present time is at Catherine Hill, about half way between Cherryfield and Franklin, just south of the main highway, and on the northwest shore of Tunk Pond. This is being extensively prospected by Mr. C. Vey Holman, to whom the writer is indebted for several interesting hours and much valuable information. The deposit was visited, and examined as thoroughly as the time would permit, on August 5 of the present year, and a number of specimens brought away, some of the best of which may be seen in the collection at the State House.

The rock is a medium grained biotite granite, buff to pink in general color, and rather high in silica. In places where molybdenite is plentiful, the granite is likely to be deeply iron-stained, due to the decomposition of pyrite.

At first glance, the molybdenite grains appear to be disseminated with considerable regularity among the other minerals; but a closer examination of the specimens on hand indicates that the mineral has been deposited in vugs, or crevices which become very numerous in certain parts of the rock, and contain, besides the molybdenite, small well-formed crystals of feldspar, and occasionally of pyrite. There is a close association apparent between the latter mineral and the molybdenite as is shown by the fact that the great majority of the molybdenite grains are surrounded by rusty blotches. These frequently take the form of small brown or reddish rings which are highly characteristic. At depths to which prospecting has so far been carried most of the pyrite has decomposed. One specimen was found however which shows a considerable amount of fresh pyrite, with several good-sized crystals of molybdenite and the small feldspar crystals mentioned above. Another specimen has so many small cavities as to appear cellular: These contain grains of molybdenite, and one surface of the same piece, (probably a joint plane), is thinly powdered with bright yellow molybdite. The latter mineral is on the whole fairly abundant; but owing to its dust-like character, much of it is scattered in blasting, and it quickly disappears from surfaces that are exposed to the weather. Mr. Holman states that the rock assays a small amount of gold, (probably not enough to be of practical importance); and that one excavation has yielded a few grains of a new mineral, a natural alloy of tin and bismuth, to which the name holmanite has been given.

The molybdenite is mostly in the form of small, brightly metallic grains from an eighth (or less) to a quarter of an inch in diameter. Occasionally considerable amounts appear in tabular, roughly hexagonal crystals an inch or more across; one collected measuring one and a half inches long, an inch wide, and a quarter of an inch thick. These latter separate easily from the gangue, and if much is found in this form hand picking should be possible. Most of the material will probably have to be separated by one of the methods mentioned above.

The presence of molybdenite is indicated entirely across the hill in a band approximately 300 feet across, and to a depth of perhaps 60 feet, as shown in the face of a cliff on the east side of the hill. If the rock is all of about the same richness as that seen, a very conservative estimate would place the amount of molybdenite at 1,000 tons. It seems entirely unsafe to express any opinion as to whether the mineral will fail in depth: There is no valid reason to expect an increase in richness, but the whole question, outside of what the prospecting has actually shown, is problematic. The prospecting, at the time the visit was made, had been done at various intervals covering a period of some years, and had consisted of surface skinning of considerable areas, blasting to the extent of "pop-shots" in the most promising localities, and one small open cut. The work is being carried on in a conservative way by the owner assisted by two or three men. The property is favorably located, as it would be possible to convey the rough rock by gravity to the shore of Tunk Pond, separate the molybdenite there in a small mill, and ship the concentrates by boat to the Washington County division of the Maine Central R. R.

This deposit has been described at some length, both because it is the only one at present actively worked, and because it serves to indicate the form in which the mineral will be most likely to be found in other localities in this part of the State. The occurrence north of Machias, judging from small specimens, is of the same general character. It should, however, be pointed out that molybdenite is not confined to rocks of the kind described, but may occur in any crystalline rock, including limestone. Small amounts have been found, near the Mt. Mica gem mine, in Paris, in a dark colored mica schist.

The writer has been told of a deposit of molybdenite, "somewhere in Penobscot County," in which the crystals are said to be of much larger size than those described. Since the informant declined to be more specific in regard to location, and did not present any specimens, this is to be regarded merely as a suggestion of possibility.

TUNGSTEN.

The uses of this metal have been suggested in the preceding section. Its most familiar use is in the manufacture of filaments for incandescent electric lamps.

It is recorded as occurring in Maine, in the mineral wolframite on Camdage farm near Bluehill. Other localities doubtless exist, and the possibility of commercial deposits should be kept in mind.

ARSENIC.

Arsenic finds its chief use in the manufacture of insecticides and other poisons although it also finds extensive use in medicine.

The minerals in which it occurs in Maine have already been mentioned in connection with other metals. Its chief ores, realgar and orpiment, are not reported from this State; but the native metal is mentioned by Dana as occurring on the east flank of Furlong Mountain in Greenwood.

RARER METALS.

A number of minerals occurring in some quantity in Maine are sought occasionally, or in small amounts, for the rare metals they contain. The pegmatites of the western part of the State in particular contain such minerals. Among them are beryl, chrysoberyl, berylonite and herderite, all compounds of the metal beryllium; columbite, a compound of iron and columbium; lepidolite, a violet mica which contains, besides lithium, the rare metals caesium and rubidinum; and pollucite, essentially a silicate of caesium and aluminum. The latter offers a good illustration of the fact that miners, particularly those working for gems, should keep in mind the possibility of a market for their unusual finds. A number of large crystals of this extremely rare mineral were found recently in the neighborhood of Streaked Mountain. The finder, a man deeply and intelligently interested in minerals, recognized this as something with which he was not at all familiar, and after careful examination determined it to be pollucite. Learning of a limited demand for this metal, he communicated with interested parties and immediately found a market for all he could produce at a very good profit. Such materials occasionally bring large returns at very little expense to the producer.

The mineral autunite, containing exceedingly minute amounts of radium and uranium, is known to occur in occasional small amounts in the pegmatites, but is of value as a mineral curiosity rather than as a source of these very rare and interesting metals.

NON-METALLIC ELEMENTS.

Carbon.

This element occurs in nature within this State in the form of graphite, or plumbago, which is of use in the manufacture of lead pencils, crucibles for melting metals, and for various purposes in which a substance is needed that will resist a high degree of heat. Several localities exist, but probably in none of them is it in amounts, or of a quality, that would warrant its commercial exploitation. This material is manufactured in large amounts in the electric furnaces at Niagara Falls. The product, however is said not to be suitable for crucible purposes, and there is still an active demand for the natural mineral.

Sulphur.

Sulphur occurs in Maine in the form of sulphides of several metals, chiefly iron. The sulphide of iron, pyrite, is very widely distributed over the State, and occasionally is found in minable quantities.

PEAT BOGS.

Definition.

A peat bog may be defined as a more or less wet, or "boggy," area varying from a few feet to several miles in diameter, and containing, in place of ordinary soils or other similar loose rock materials, a deposit of a soft, dark colored, partly decayed vegetable substance called peat. The surface of such a deposit is nearly always partly, sometimes wholly covered with long-stemmed, matted "peat mosses" (either Sphagnum or Hydnum), always supports a more or less luxuriant growth of shrubby plants of the heath family, including lambkill, Labrador tea, rhodora, azalea, blueberry, cranberry and many others; and is the usual habitat of other plants, many of them elsewhere very rare, such as pitcher plant, cotton grass, cattail and other rushes, sedges, dwarf willows, and several species of orchids. The bogs may be partially or wholly forested; heavy growths of spruce and hackmatack being highly characteristic in some localities; cedar (Arbor vitae) and hackmatack in others. Other trees, such as white pine, gray birch, red maple, alder and willow may be, and frequently are sparingly present, but they are not peculiar to such situations.

Peat bogs are frequently very wet, although not necessarily so, and may be traversed by sluggish streams occasionally broadening into small ponds. These ponds are usually the home of white and yellow pond-lilies and a large variety of aquatic plants, and a favorite feeding ground for ducks and other water fowl. Such bogs are usually of the "quaking" kind; that is, the surface bends up and down under foot, sending waves out across the open water. This is due to the fact that the plant matter forms a mere crust over water-filled spaces. Quaking bogs may be dangerous to traverse, and doubtless animals are sometimes engulfed in them; but considerable experience in this State and elsewhere indicates that there is little risk in walking on them, since the crust will bend in a sufficiently alarming manner long before it gives way entirely.

Peat bogs are formed by the accumulation, either in wet swampy places or in open water, of large amounts of vegetable matter, which may include aquatic plants, mosses, and the roots, stems, leaves, seeds, pollen and spores of all sorts of plants. It is probable that the great bulk of the material in any peat deposit has accumulated on the spot; that is, it has resulted from the death and partial decay of plants that have grown within the area of the deposit; although some small amounts must necessarily have been brought in by winds and surface water from the surrounding country.

In order that an accumulation of vegetable matter may be preserved long enough to form a true peat bed it is necessary that decay be arrested. A very little examination of the surface of a dry forest area will serve to show that the falling twigs and leaves, undergrowth, and even the trunks and roots of great trees disappear completely in a very short time, leaving not so much as a bit of color in the soil to indicate their former existence. It is an experience common to everybody that the soil of a field that has produced grass and crops for many years shows no accumulation of dead plant matter even in its surface portion. This is because of the destructive action of the air, aided by the growth of fungi and myriads of microscopic plants such as bacteria. The entire accumulation of a year, even if it lies where it will not wash or blow away, soon passes into the atmosphere in the form of carbonic acid gas, ammonia and water, and the mineral portion (ash) is returned to the soil from which it came. If the soil is continuously moist the destruction is retarded, through protection from the direct action of the air, and we may find a small accumulation of dark soil, or forest mold. When plant debris falls in such a position that it is covered by water its decay is still further retarded by the formation, through the action of water upon the vegetable tissues, of substances which in a measure prevent the growth of fungi and bacteria, so that the decomposition is halted short of complete destruction, or at least so that destruction falls behind accumulation, and a bed may form up to, or even above the surface of the water. It is probable, however, that in any such bed a certain amount of destructive bacterial action continues indefinitely; and owing chiefly to this the plant fragments gradually fall to pieces until there results a more or less uniform mass of fine, mud-like or fibrous material, dark brown or black in color, which if practically free from mineral matter is called peat. This substance is popularly called muck, but the word is more usefully applied to this material when it contains so large an amount of mineral matter (clay, mud and sand) as to render it valueless for the purposes to which pure peat may be applied.

Such accumulations form in temperate climates, as that of the area studied, only in places where water stands continuously, or nearly so, through a long term of years, so that it has been possible for a considerable amount of plant material to collect and be protected from immediate decay. The water may be fresh or salt, the product varying in respect to the kinds of plant remains and the mineral contents accordingly. The salt water peats form in general in quiet lagoons back of barrier beaches, consist largely of the root-stocks of marsh grasses, and ordinarily have a higher mineral content than those formed in fresh water. They are the soils upon which grow the salt marsh grasses extensively used for cattle bedding, etc., in the coast regions: aside from this, except for the fact that their use as fertilizer has been somewhat seriously considered, the question of their economic importance has received little attention. They will not be further considered here.

Fresh water peat is formed in ponds and swamps, and to a certain extent on level or gently sloping surfaces that are pretty continuously wet. In such situations the conditions necessary for the formation of beds of relatively pure peat are as follows:— (1) Accumulation must be more rapid than decay; (2) the water must be still enough so that plant matter will settle and remain in place; (3) drainage into the area must be too gentle to permit the introduction, in considerable amounts, of mineral matter in the form of sand, silt, clay, etc. This latter condition need not be inherent; it may be brought about by the growth of plants about the margin, as is plainly indicated in some of the cases later described.

Our present interest in the bogs centers around the fact that they afford a number of materials which are, or may become in the immediate future, of large commercial importance. These may be divided into (1) surface materials; (2) peat or muck; (3) underlying materials.

I.

Surface Materials.

Forest Trees. The bogs frequently carry dense stands of spruce, cedar (arbor vitae) and hackmatack (larch or tamarack); The first furnishes the wood most largely used in the manufacture of pulp paper, and is also of value for its timber; the second is used extensively for posts, telephone and telegraph poles, and railroad ties; the last is an occasional demand for boat knees. Other trees grow on the bogs, often to considerable size, but are either of little value or of too infrequent occurrence to be considered as a valuable product.

BERRIES. The cranberry in particular, and the blueberry to a less extent, thrive on peat bogs so as frequently to become of commercial importance.

GRASSES. These are sometimes found in sufficient abundance to afford hay of a kind usually valuable only as litter or bedding.

PEAT MOSS. This plant frequently covers the entire surface of the bog sometimes in a practically undecayed condition to a depth of several feet. Bogs so covered are called mosses or muskeags (tundra in the far north). The moss is in somewhat extensive demand as a packing material particularly for small live plants and the roots of trees, the satisfactory transportation of which demands that they shall be kept moist. It also affords an excellent stable litter, and subsequently a valuable mulch for orchards and berry patches. This material should be given careful attention by farmers, and effort should be made in this State to develop a market for it. A recent number of the Literary Digest, quoting from the Medical journals, mentions an important use of dried peat moss that has grown out of the present war in Europe. The material has been found very valuable for dressing and plugging wounds, its use in this connection depending largely upon its great absorbent powers.

2.

PEAT. This material forms the bulk of the deposits in the bogs; and in the light of present knowledge it bids fair to become, under careful and economic exploitation, one of the most important resources of this and some other states. One group of uses depends upon the fact that this material is essentially a low grade coal, and as such can profitably be applied to most of the uses to which the latter is now put. The other group of uses depends largely the ability of peat to absorb liquids and certain gases.

Peat has been used for fuel, at least in some of the more northern European countries, from very early times, probably far earlier than those recorded in written history. Many of these countries have suffered periods of deforestation which in some cases, as in parts of Ireland, have apparently become permanent. The inhabitants, in searching about for something to take the place of the vanishing wood in their fires, found that the black earth of their bogs and heaths made a very fair substitute: The scarcity of wood continuing, the use of peat has in some cases become a habit that even the discovery of the fuel value of coal has not been able to alter.

Methods of getting peat from the bogs and preparing it for fuel have been much further developed in Europe than in this country, and there is a large amount of excellent literature on the subject, available to anyone wishing to become familiar with the details of these methods.

The chief reasons why peat has not been extensively used as a coal in this country are,—(1) the existence of large amounts of superior coal at present available at comparatively low prices; (2) certain difficulties in the way of obtaining peat in a condition of immediate availability, (3) hesitancy of the public to make use of an unfamiliar material, the same difficulty that retarded the use of coal in the years immediately following the discovery of its valuable properties.

In regard to the first it should be clearly pointed out that the supply of good coal is far from endless, that a slight shortage quickly raises the price to an almost prohibitive level and that prices now fluctuate to such an extent as to make it difficult to reckon the expense of using it for only a few months ahead. Also, the utilization of a comparatively inferior fuel like peat in certain processes for which it is perfectly well fitted, would undoubtedly work a very great saving of the best grades of coal for purposes to which they alone are adapted.

The chief difficulty in the way of the ready availability of peat lies in the fact that in the bog it contains a large amount of water, sometimes as high as 85% or 90% by weight, much of which must be eliminated before the peat can be economically utilized. Fortunately this elimination can be in large measure satisfactorily accomplished merely by piling the wet material on a dry surface and allowing it to drain as thoroughly as possible before attempting to haul it away. Another drawback, of minor consequence, is that work on the peat bogs, here in the north, can be conveniently carried on only during a limited part of the year.

As has been suggested, there have been developed many methods for extracting and preparing the material, varying from simple processes requiring practically no more elaborate equipment than is to be found on any farm, to complicated processes that require the outlay of many thousands of dollars in the erection of large plants.

For household purposes, peat can be put into very satisfactory form merely by pressing it, when partially dry, into cakes of convenient size for handling, and allowing them to dry for some days in the sun. The dry cakes should be fed, just as is usual for coal, to a fire started with kindlings, and a result is to be expected much like that obtained by burning soft coal. It is highly desirable that this should be tried, at least in an experimental way, by people living in the neighborhood of bogs, and the results reported. Such an experiment, the only one of its kind in the history of the State so far as can be learned, was tried years ago by a Mr. James Allen, who used peat from the Hermon Bog. Complaint was made that this fuel brought considerable dirt into the house; but this could be avoided by careful handling. The persistent burning of this fuel under low draft, and the comparative freedom from ash are qualities that ought to encourage a tryout in many localities.

More elaborate preparation requires the use of some form of pug mill for the thorough mixing of the raw peat. After mixing, it is usually forced out in cylindrical form, and then dried, either by exposure to the sun for two weeks or longer, or by artificial heat. In some cases it has been mixed with some resinous or oily substance, pressed into briquettes, and kiln-dried.

Peat in all of the above forms is at the present time being used as fuel in Europe at the rate of about 10,000,000 tons a year. We have, therefore, the distinct advantage of having had the experimental stages in its utilization all carried out for us. In spite of this, however, and although our peat is of practically the same composition and has the same qualities as to heating value and percentage of ash, the use of it with us has scarcely begun.

C. A. Davis, writing in 1909 (U. S. G. S., Bul. 394), estimates the total peat area of the United States which will average 9 feet deep, as about 11,188 square miles: and taking the possible average production of dry fuel per acre, one foot deep, as 200 tons, he finds a total of 12,888,500,000 tons of dry peat for the whole country. These figures are admittedly conservative, and it is probable that the actual total is several times as great.

Taking the above figure as a basis, and reckoning a value of $3.00 per ton for air-dried blocks near the bog, the total value, if used directly for fuel, amounts to $38,665,700,000. This again is doubtless a very conservative estimate.

In Maine, Davis estimated that he had examined 25 square miles of peat beds, with an average depth of 10 feet; which would give 34,000,000 short tons of air dried machine peat, valued at $102,000,000. He considers that this is perhaps one-tenth to one-fifth of the total peat resources of the State: It is the opinion of the writer that it actually represents a much smaller fraction of the total, and a very approximate estimate will be given at the close of the section dealing with distribution.

That the best value is not obtained from the use of peat directly as a fuel seems evident. Much greater returns may be expected by applying it to the operation of producer gas power plants, and the incidental saving of very large quantities of useful by-products. The question of so applying peat is too large a one to be discussed in detail in this paper: there is, however, considerable literature on the subject, and the interested reader is referred to several publications of the United States Bureau of Mines as the most convenient sources of definite information.

The use of this fuel as above has passed the experimental stage, as there are a good many plants for this purpose already in Europe, actively at work producing power for large plants. Two in Italy use 140 and 90 tons of peat per day respectively. It is regarded as an excellent material in this country, and it is only a question of a short time when it will be very widely utilized.

This method not only increases the fuel value of the peat: it may be made to yield by-products which are themselves of great value. Chief among these is ammonium sulphate, to the manufacture of which peat is considered to be peculiarly adapted. Again using Davis's figures, if all the estimated commercial peat of the country were used in producer plants, it would yield 644,400,000 tons of ammonium sulphate valued at $36,732,400,000, which it will be noticed is very close to the total value of the peat if it were all used directly as a fuel. On this same basis, the value of this material that could be obtained from Maine Peat may be conservatively stated as $100,000,000. The net profit to be expected would of course depend upon the cost of digging and preparing the peat, the convenience of the location of the plant with respect to both the source of supply of the fuel and to shipping facilities, the economy of operation of the plant, the value of the product manufactured, and several other factors. It is obvious that no very definite figures can be given: and considering the variety of purposes to which such plants may be applied, it is thought wise to avoid any statement in this connection.

Other by-products are a form of coke, and a large number of volatile substances similar to those obtained from the distillation of wood, including petroleum, lubricating oil, paraffin wax, asphalt, creosote, wood alcohol, acetic acid and some other materials.

A ton of good air-dried peat has been made to yield 35 pounds of light petroleum, 51 pounds of heavy petroleum, 35 pounds of lubricating oil, 6 pounds of paraffin wax, 31 pounds of asphalt, 21 pounds of creosote, 32 pounds of ammonium sulphate, 16 pounds of wood alcohol, 12 pounds of acetic acid, over 700 pounds of charcoal (peat coke), and about 300 pounds of fuel gas. (For an excellent treatment of this whole subject see C. A. Davis, U. S. Bur. Mines Bul. 16, 1911). It might be that plants operated for the by-products alone, exclusive of fuel gas, could be made profitable in this State: This, however, would depend upon special, largely local, conditions, and no general statement is warranted. On the whole it is expected that plants will be run primarily for the purpose of developing power on the basis of the fuel gas, and that the by-products will be applied to reducing the cost of operation.

The location of plants will be governed largely by the following factors (it is assumed that economy will dictate that plants shall be located in the close neighborhood of the source of supply, and transportation of the raw material thus avoided):—abundance and availability of sufficiently high grade peat: demand for the power developed; availability and price of labor, both skilled and unskilled; and convenience of transportation facilities.

The Peat Deposits of Maine.

A discussion of the general distribution of peat in the United States will hardly be necessary here. It will suffice to say that Maine has its proportionate supply and that its peat is of fully as high quality as that found elsewhere. So far as is known, little attempt has been made to utilize the supply, and therefore, practically nothing is known by direct experiment within the State in regard to the profit to be expected from its exploitation.

The great majority of the deposits that are large enough to warrant expectations of commercial use are in the less elevated portions of the State, and it is probable that practically all of the peat that will be considered for commercial purpose in the immediate future lies between the coast and a line drawn across the State from Houlton to the Rangeley Lakes. Large peaty areas exist north of this line, but most of those seen were heavily wooded and very wet. The great northwestern area of the State, northward from Moosehead Lake and Mt. Katahdin, is well supplied with lakes and swamps, and should afford peat in considerable beds. It is, however, practically without transportation facilities, and it was considered too inaccessible for practical exploration in the limited time allowed for the present work. In regard to this region, Davis says,—"Peat resources as great as or greater than those of southern Maine undoubtedly are to be found in the forested lake districts of the northern part of the State." The writer is inclined to agree with this statement, but at present no data are at hand upon which to base a more definite estimate. The country close to the St. John River shows little that is promising.

The most valuable peat beds at present available lie in Androscoggin, Aroostook (southern part), Cumberland, Kennebec, Knox, Lincoln, Penobscot and Washington Counties, with subordinate supplies in Oxford, Piscataquis, Waldo and York.

The total peat area examined is estimated at about 50 square miles, with an average depth of 8 feet. This gives approximately 48,000,000 short tons as the possible yield of air dried peat. It may be noted that the figures in the last column of the table will not produce this total. This is because a number of large areas were left out of consideration; uncertainty as to average depth, extent or uniformity of the material making it inadvisable to set a definite figure. It is probable that all of the areas examined would produce some usable peat, and on the whole the total given is not considered too large. Attention should also be called to the fact that except in those areas that have been accurately mapped in detail, it is nearly impossible to locate all of the bogs, and it is doubtless true that many have been missed, even in the near neighborhood of those investigated. The United States topographical maps indicate all but the smaller swampy areas very clearly, and it is probable that very few peat deposits important enough to warrant consideration have been neglected in the area covered by these. Practically all of the deposits mentioned are within feasible hauling distance of railroads or salt water shipping points, a consideration of great importance in estimating their value.

In the following table it is intended to present the facts which are most pertinent to the present discussion.

Location and Brief Description of the Bogs.

Location.	Distance f'm R.R. miles.	Condition.	Area acres.	Average depth feet.	Yield air dried peat in short tons.
Androscoggin County.					
East Livermore	3	Forested	300	10	600,000
Greene	1	open heath	160	6	250,000
Lewiston:					
Farwell bog	2	open heath	130	15	400,000
No Name bog	3	open heath	125	15	400,000
Leeds:					
West of Center	2	open heath	100	4	80,000
South of Center	2	open heath	200	15	600,000
North of Center	1	open heath	2	20	8,000
Aroostook County.					
Bancroft	2	cedar swamp	200	2 (?)	little.
Crystal	2	partly wooded.	100	5	100,000
Crystal	1	partly wooded.	60	9	25,000
Squa Pan	1	densely wooded	200	2	little. (?)
Bancroft, East	near	open heath	100	10	200,000
Bancroft, East	near	cedar swamp	100	2	not promising.
Wytopitlock	near	wet wooded bog	150	(?)	not promising.
Houlton, S. W	near	open heath	30	4	25,000
Sherman	near	partly wooded.	50	7	70,000
Cumberland County.					
Brunswick:					
College bog	2	shrubby heath.	160	3-	little, local use.
Cape Elizabeth	....	part wooded	100	10	225,000
Falmouth	5	part wooded	85	15	250,000
Sebago:					
Northwest River	8	swamp	600	(?)	(?)
Hancock County.					
Bucksport:					
Mud Pond	5	open heath	20	10	40,000
Nicolin	1	open heath	12	10	25,000
Franklin County.					
Chesterville	5	open heath	300	6	300,000
Kennebec County.					
Augusta	2	....	small	shallow	impure, clayey.
Belgrade:					
Messalonskee Lake	1-	cat-tail swamp.	500	2	poor quality.
Great Pond	6	mostly wooded.	300	4	very wet, unavailable.
Chelsea	near	open heath	5	14	14,000

Location and Brief Description of the Bogs.—Continued.

Location.	Distance f'm R.R. miles.	Condition.	Area acres.	Average depth feet.	Yield air dried peat in short tons.
Fayette	4	open heath	100	6	120,000
Oakland, S. W	near	part wooded	10	15	30,000
Oakland, North	1	open center	300	15	900,000
Sidney:					
Great Sidney bog	5	open heath	640	20	2,500,000 fibrous.
Vassalboro	2	partly open	30	7	40,000
Wayne:					
Muddy Pond	3	open heath	10	10	20,000
Pickerel Pond	5	open bog	60	15	180,000 (available ?)
Southeast	5	open heath	5	10	10,000
Winslow	5-	open heath	100	20	400,000
Knox County.					
Rockland	3	open heath	150	8	240,000
Oxford County.					
Buckfield, East	2	open, grassy	100	8	160,000 (quality ?)
Hartford	near	open	80	10	160,000
Hebron, Southeast	....	wet and grassy	200	(?)	doubtful.
Norway, North	near	open	small	2-	(?)
C. Fogg place	4-	open	3	8	4,800
Fryeburg:					
Kezar Pond	5	2 shallow bogs	600	(?)	not promising.
Penobscot County.					
Alton	2	open heath	640	9	1,150,000
Drew	near	largely wooded	1,000	8	1,600,000
Etna	near	wooded	200	12 (?)	480,000 (?)
Hermon	near	partly wooded	300	8	480,000
Hermon bog	1	partly wooded	600	10	1,200,000
Hudson	near	largely open	400	10	800,000
Kingman, West	near	open heath	200	6	240,000
Newport	near	open heath	30	5	30,000
Oldtown:					
Pushaw Pond	3	variable	5,760	5 (?)	5,700,000 probably more.
Orrington	3	open	300	8	400,000
Piscataquis County.					
Brownville	near	two open heaths	300	6	360,000
Brownville Junction	near	partly wooded	small	(?)	mig't yield some

LOCATION AND BRIEF DESCRIPTION OF THE BOGS.—Concluded.

LOCATION.	Distance f'm R.R. miles.	Condition.	Area acres.	Average depth feet.	Yield air dried peat in short tons.
SOMERSET COUNTY.					
Bingham, N'w'd	near	heavily wooded	2,000	(?)	yield uncertain.
Fairfield	near	partly wooded.	(?)	(?)	(?)
Oakland, North	2	largely wooded	400	6	480,000
Pittsfield, Southeast	1	open moss	500	10	1,500,000
Smithfield, Northwest:					
East Pond	5	open moss	300	15	1,000,000 best in the state
WASHINGTON COUNTY.					
Alexander	10	partly wooded.	large	(?)	uncertain.
Charlotte, Northeast	1	open moss	5	3	3,000
Cherryfield, North	2	open heath	40	6	48,000
Cherryfield, North	7	open heath	3,000	5 (?)	3,000,000
Schoodic Lake	7	open heath	1	15	3,000
East Machias, North	7	open moss	50	10	100,000
Southern Inlet	near	open moss	60	10	120,000
Ellsworth Falls:					
Union River	2	grassy marsh	6,000	little	doubtful.
Forest, Northwest	near	open moss	30	10	60,000
Jonesboro:					
Whitneyville	near	open moss	20	8	30,000
Pond Cove		open moss	40	5	40,000
Roque's Bluff		open heath	15	5	15,000
Black Head		open heath	10	10	20,000
Jonesport, East	8	open heath	40	10	80,000
Jonesport, North	7	open heath	20	6	24,000
Lubec:					
Quoddy Head		open, wave-cut	20	5	20,000
Pembroke:					
Ayers Junction	near	open moss	160	15	280,000
Ayers Junction	near	op'n moss, sedgy	50	5	50,000
Falls Point		open heath	35	10	70,000
Perry			10	3	6,000
Trescott, South		open moss	160	8	250,000
Vanceboro, West	near	partly open	500	10	1,000,000
Danforth, West	near	largely wooded.	300	6 (?)	300,000 (?)

THE OCCURRENCE OF PEAT IN THE LIVERMORE QUADRANGLE, MAINE.

INTRODUCTION.

The following report is the result of field work carried out in the summer of 1914, under the direction of Mr. Cyrus C. Babb, Chief Engineer of the Maine State Water Storage Commission. For encouragement and many suggstions as to the mode of conducting the work, the writer wishes to acknowledge indebtedness to Mr. C. A. Davis of the United States Bureau of Mines.

The field work was based on the United States Survey topographical map of the Quadrangle, and embraced the accurate locating of the more promising beds, the sounding and sampling of these to determine the amount and quality of the peat, and the collection and preservation of samples for further more detailed study. These samples have been studied microscopically in the laboratories of Columbia University, but it has been found impossible, up to the present time, to carry the investigation so far as might be desired.

METHODS OF INVESTIGATION.

On the topographic map of the quadrangle numerous areas are marked as swampy. Most of these were visited, the use of an automobile making it easy to reach them with little loss of time. It was found that a rapid traverse of each area was sufficient to determine the presence of peat, and also, with careful attention to the immediate surrounding topography, to give a fairly good notion as to its amount and quality. This reconnaissance showed that all the large peat deposits are included in the areas marked swampy, and that practically all that are worth investigating in a detailed way are in the areas hereinafter shown; namely, those numbered from 1 to 9 on the accompanying maps. The portions known to contain good workable peat to a considerable depth have been indicated by cross-hatching; areas not carefully investigated, but believed to contain more or less peat are indicated by parallel ruling. Black figures indicate where soundings have been made.

Sounding and Sampling.

The areas worth careful investigation having been determined, these were visited with equipment for sounding, sampling and collecting.

It was found that the depth of peat could be determined with fair accuracy by the use of a stiff rod of any sort, even a wooden pole cut on the spot and well trimmed giving very satisfactory results. This because of the fact that the peat may be penetrated readily, whereas any bottom material, other than clay or fine wet slit, offers effectual resistance. Even the change from peat to soft clay can be detected with comparative ease after a few trials; also, enough material adheres to the sounding rod so that frequent withdrawal and examination will give much useful information.

For more accurate work, particularly where samples were desired, a sounding and sampling rod devised by C. A. Davis was found very useful, and most of the definite data in this respect were obtained through its use. This consists essentially of a jointed steel rod, in suitable lengths for convenient transportation, provided with a brass sleeve and plunger, by means of which it is easy to sound to depths down to 21 feet and pick up samples at any intervening depth desired. These samples are in the form of cylinders six inches long and about an inch in diameter. This form of apparatus would not work well at much greater depths and it is not satisfactory for sounding deposits that are full of coarse obstructions, such as stumps and logs. As, however, it was found that practically all of the deposits were of uniformly soft material, and that little of the area contained beds over 20 feet deep, no better instrument could have been desired.

Soundings were made, and samples collected, over a considerable part of each of the areas selected for investigation. It would have been desirable to do this in a somewhat more systematic way; various difficulties presented themselves, however, and it was found impossible, without assistance, to make a more thorough survey. It seemed best, under the circumstances, to follow lines of least resistance, in other words, to sound and collect samples wherever, and at whatever depths, turned out to be most expedient.

Difficulties.

The bogs, even where they are open, are at best difficult to traverse, as the footing is usually soft and wet, and a stiff growth of heath plants, sometimes waist-high, impedes progress very effectually. The wooded portions are exceedingly dense, and at times practically impassable except with the aid of an axe. With one assistant, an investigator might well spend an entire day in a bog, working it over in a complete and satisfactory way. Alone, it was found that to work more than half a day at a time was too fatiguing to be worth while. In this district, peat-bogs are apt to be very wet and cold before the middle of June and after the first of September, and work in them except during the summer months is extremely disagreeable and also somewhat risky.

The bogs are seldom really dangerous, popular testimony to the contrary notwithstanding. Except in cases where a considerable body of open water still exists, the deposits are so nearly continuous and firm as to render engulfment practically impossible; in fact, it was found easy in every case to approach within a few feet of the edges of the quaking bogs without breaking through or even seriously displacing the crusts. Accidents are of course possible, and probably some care is necessary in many cases to avoid them; but after a somewhat extensive and uneventful experience, it seems probable that most of the tales of mishaps to cattle, and even to men, are wild exaggerations.

General Description.

In all essential particulars the bogs of the region are of the same type, that known as acid, or sour. They differ, on the whole, only in the stage reached in the process of development. This is indicated by the presence or absence of open water, and by the nature of the living vegetation on the surface. In general, a treeless bog may be considered younger than one that is forested, not necessarily in actual lapse of time, but as regards stage of development. By the same reasoning, the treeless part of any given bog should be the part most recently filled in, and this is usually borne out by other evidence. This should not be taken to imply that the wooded portions contain the deepest peat. As a matter of fact, the forest encroaches upon the bog from the margin and works progressively inward, so that the part remaining open may be, and usually is, the deepest. Almost uniform absence of stumps and logs indicates that there has been very little deforestation of the bog areas.

In this quadrangle the bogs are all relatively small, the largest being a little more than two miles long and less than a mile wide, and each lies in a rather narrow, well defined valley, the peat-filled portion being marked by an almost perfectly level surface, shown on the map by the fact that contour lines do not cross the actual peat areas, even when these are more than a mile long. As a matter of field experience in this quadrangle, it is found that when any decided change of level does occur, as indicated by the crossing of a contour line, it is accompanied by changes in the character of the deposits, including failure of the workable peat.

It is uniformly true that at least one small stream takes its rise in every bog; always sluggish and ditch-like within the peat area, and becoming a rapid brook soon after leaving it. In cases where open ponds exist, such usually have definite inlet and outlet.

Origin of Deposits.

A glance at the topographic map will at once suggest the origin of the peat bogs, and careful investigation bears out this impression. They all occupy positions exactly similar to those held by the various lakes and ponds of the district; and if in each case, the peat were replaced by water, the resulting lakes and ponds would in shape and general appearance differ not at all from the existing water bodies. They all occupy parts of valleys that have obviously been normal stream valleys at a former time; and they all present the same feature of a dam of loose material, (sand, gravel, etc.), across which a small stream has just succeeded in making its way.

The probable history of any one of the bogs may be briefly reviewed as follows. Just previous to the glacial period this entire region, in common with the neighboring country, had assumed a condition of mature erosion, with the larger streams flowing through rather broad, well defined valleys, in a northwest-southeast direction, toward the Atlantic. Branch streams had carved valleys nearly at right angles to these, in a direction controlled by a prevalent rock structure which is doubtless to be correlated with that existing predominantly throughout the Appalachian region. Smaller branches joined the main streams and the larger tributaries in a more or less irregular manner. All of these streams had become established in continuous valleys interrupted neither by falls nor by lakes: between them were well rounded hills of low relief, arranged in the form of very much broken ridges running approximately from northeast to southwest.

Over the surface thus briefly described was thrust the great ice sheet carrying before it, and within its mass, everything in the shape of loose rock material that lay in its path. This process is considered to have been repeated at least twice, but for our purpose it will be sufficient to think only of one great advance. During the subsequent melting back of the great mass of ice there was left, spread over almost the entire surface, a blanket of clay, sand and gravel, in part sorted by water from the melting ice, in part remaining mixed (till or boulder clay). These materials in part filled up the valleys, not smoothly, but more or less unevenly, and the irregularities in the surface were increased by temporary advances, which ploughed up the till in uneven heaps (moraines). Some of the chief effects of all this were the obliteration of some of the valleys and the partial damming of others, so that the streams, in re-forming on the altered surface, in part sought new channels, in part found their waters temporarily impounded in lakes, ponds, and swamps.

A further study of the topographic map, coupled with observation in the field, will show that between the time of the recession and the present, there have been much greater bodies of water than those now existing. In the depths of these greater lakes fine silt, clay and sand were deposited, sometimes containing great numbers of the tiny siliceous shells of the minute plants known as diatoms. As the water diminished, and the lakes in consequence gradually shrank to their present area, the silt, etc., was left as the surface cover over a considerable part of the region, reaching a thickness of many feet in the hollows. This material, because of its fineness, was soon in large part carried away by wind and surface water. In protected places, however, it remained long enough to become covered with vegetation and has thus become the surface soil in certain areas throughout the quadrangle. The same material, doubtless continuously augmented up to the present time, covers the bottoms of the lakes and forms the underclay in most of the peat deposits. A low cliff cut in such silty material, essentially a diatomaceous earth, exists on the southeast shore of Lake Androscoggin. This particular deposit extends, as the surface soil, up the slope from the shore to about 30 feet above the summer level of the lake. It is over four feet thick near the beach, and may reach a much greater thickness. Wherever this occurs it seems to form a fertile soil, well adapted to the rapid growth of plants.

It is believed that the material described above has been a very important factor in the development of the peat bogs. It is in those places where, in the general reduction of the surface water area, small ponds have been left in sheltered places, in basins underlain and margined by the fine silty material that the bogs are found. The gently sloping surface of fine soil has afforded an excellent opportunity for the rapid growth of plants along the shore, and also for the growth of marginal and aquatic plants. This bordering growth has at once checked the carrying of coarser mineral matters into the water, and shortly the washing in of mineral matter of any sort. Thus, as plant growth increased, creeping outward into the pond and over its surface, an accumulation of nearly pure peat, the result of the death and partial decay of such plants, has been possible.

These deposits are included in the general table, but some additional facts are given in the following paragraphs.

PEAT, LIVERMORE QUADRANGLE.

AREA 1; SECTION 2, E.

On July 13 a traverse was made just north of Burgess Pond. The bog was found to be heavily wooded, with a mixed stand of fairly large trees of balsam fir, red maple, black spruce, etc., the latter reaching a height of 40 feet; the undergrowth is thick and consists chiefly of cinnamon fern four feet high, and various small shrubs; moss is not important, but occurs in occasional patches. The peat here seems to be of good quality, is fine in texture, and for the most part rests on a gently sloping bottom of hard sand and gravel. On the west side the bottom slopes more abruptly, giving about 3 feet of good clear peat only ten feet from the edge of the bog; on this side the plant deposit rests on 6 inches or more of clayey material like that which underlies the greater part of the peat in the quadrangle.

Between the west shore of Burgess Pond and high land there is a quaking bog, (the same may be said of the three smaller ponds lying to the south), consisting of a fairly thick crust of peaty material shelving out over open water: it is evident that the process of pond filling is well under way here, but not enough peat has so far been deposited to be of any consequence.

No samples were taken in any part of this area; the results of such examination as could be made in the field are given in the table.

LIVERMORE QUADRANGLE, MAINE.

Area No. 1.

Section No. 2, e.

Description of Material.

Station.	Depth.	MEGASCOPIC.	MICROSCOPIC.
1.	4.5′	Good quality woody peat, with little or no moss.	
2.	6′	Clear woody peat.	
3.	6′	Good peat, very wet near bottom.	
4.	6′	Good peat.	
5.	7′	Good peat.	
6.	10′	Clear woody peat.	
7.	3′	2½ feet good peat, remainder with underclay.	

Peat, Livermore Quadrangle.

Area 2: Section 2, d, e & h.

This is a long, narrow area, with a total length of over 2 miles and a width of about a quarter of a mile. The part that contains workable peat is essentially that above the 380 feet contour, which crosses the bog at either end; this comprises about 160 acres, and contains good clear peat down to a maximum depth of 15 feet, (the average depth would appear to be not far from 8 feet). Most of the soundings were made, and all of the samples taken, along a logging road that runs the entire length of the area; some soundings were made along a cross-road at the widest part. These roads cut through a nearly impenetrable growth of spruce, in which it was impossible to work.

The northwestern end of the area, (that below 380 feet) is occupied almost entirely by a grassy meadow underlain by a shallow peat deposit; this is comparatively well drained by a large brook that leaves the area over a drift dam farther to the northwest, and should make excellent agricultural land for some crop that needs only a short season.

The area contains a large deposit of excellent peat; the heavy timber growth, however, makes it unlikely that this will be available for a long time, and also inadvisable that it should be, since a further growth of some years will make this stand of considerable value for lumber.

Some definite data concerning this area will be found in the table:—

Livermore Quadrangle, Maine.

Area No. 2.

Section No. 2, d, e & h.

Description of Material.

Station.	Depth.	Megascopic.	Microscopic.
1.	3′	Fine, slightly gritty, gray matter, mostly mineral, including clay, Si02 and mica. A few roots, rhizomes, etc. Dries fairly hard. Asorbs water readily.	Many small quartz grains; scattered flakes of greenish mica; occasional diatoms.
1.	1′	Fibrous, peat, with many rhizomes, etc., mixed with above. Very hard on drying. Wets with difficulty.	Plant tissues; root, stem and leaf; quartz grains; numerous diatoms.

LIVERMORE QUADRANGLE, MAINE.

Area No. 2.

Section No. 2, d, e & h.

Description of Material.

Station.	Depth.	MEGASCOPIC.	
2.	2′	Gray-brown-yellow, fine-course, gritty, somewhat peaty. Si02 grains up to 1 mm. diam. Rhizomes, etc. Absorbs water.	Considerable plant matter. Mostly grains of *quartz* and mica of varying sizes. Many diatoms.
3.	8′	Dark brown, fine, some fibre. Very hard and tough on drying. Wets with difficulty.	Few mineral grains. Mostly very minute plant matter (spores or pollen); some distinct plant fibre. No diatoms.
	4′	Brown, fibrous, soft and friable. Wets with difficulty.	Much fibre with other plant matter; some spores and sporangia. Very little mineral matter. No diatoms.
4.	8′	Dark brown, fibrous. Very hard on drying. Does not wet readily.	Mostly very fine, largely indeterminate plant matter, with spores and some fibres. Few mineral grains and no diatoms.
	4′	Dark brown, dense, hard and brittle when dry. Wets with comparative ease.	Much comparatively coarse plant matter, with considerable woody tissue. Little mineral matter; no diatoms.
	Surface.	Mat of stems and leaves of heaths, sphagnum, spruce needles, etc. Parts of insects found.	
5.	8′ total 12′	Dark brown. Shrunk. $\frac{3}{4}$ and hardened much in drying. Very fibrous.	Some fibre, mostly very fine plant matter, including spores, etc. Very little mineral matter and no diatoms.
6.	4′ total 12′	Light brown. Has shrunken very much on drying and is very hard. Fibrous. Wets slowly.	Much like preceding, with more root and rhizome tissue.
7.	8′		
8.	12′ total 15′	Brown, compact, in part woody. Dries to medium hardness. Does not wet readily.	Very fine plant matter, including spores (?) Little mineral matter. No diatoms.
9.	3′	Considerable fibre. Dries to compact, rather hard mass; does not wet readily.	Very fine plant matter. Practically no mineral matter. No diatoms.
10.	surface.	A dark-brown, peaty loam in appearance. Not much shrinkage. Friable. Wets rather readily.	Considerable mineral matter, very fine; finely divided plant matter in excess. No diatoms.
11.	surface.	Gray-brown peat with visible mineral grains. Not much shrinkage. Rather soft and friable. Insect elytra. Absorbs readily.	Much fine plant matter; considerable mineral abundant diatoms.

PEAT, LIVERMORE QUADRANGLE.

Area 3, Section 5, c.

This bog has an open area at the northern end and about half a mile square. Southward, an almost impenetrable growth of spruce and tall heaths makes it almost impossible to work. Near the North Wayne road is a considerable open area, usually too wet for successful investigation. From a superficial examination, the conditions here seem promising; soundings, however, show a probable maximum depth of peat of only about 5 feet. The area is chiefly remarkable for the extraordinary development of sphagnum (peat moss), which forms hummocks into which one may sink to depths of two or three feet. Although what peat there is here is of good quality, the moss would undoubtedly turn out to be the most valuable product.

LIVERMORE QUADRANGLE, MAINE.

Area No. 3
Section 5. c.
Description of Material.

Station.	Depth.	MEGASCOPIC.
1.	2′	Good peat.
	5′	Peat, underlain with fine, sandy silt.
2.	2′	Clear peat, mossy.
	5′	Silt.
3.	6″	Mostly moss.
4.	2′	Largely dead peat moss.
	4′	Good, fine peat.
	5′	Sandy peat.
5.	2′	Good peat.
	4′	Sandy silt.
6.	1′	Dead moss.
	3′	Good peat.
7.	1′	Moss.
	2′	Good peat.
	3′	Good peat.

PEAT, LIVERMORE QUADRANGLE.

Area 4; Section 6, d.

Muddy Pond bog is very small, no more than 16 acres of it being underlain by peat in sufficient amount to be of any value; it is, however, of interest, first because it is easy of access, and could easily be made a source of supply for a considerable center of population, and second because it illustrates in a very perfect way the processes of peat formation.

The center of the area is occupied by a small pond, the area of which has noticeably decreased in the course of the 20 years during which I have been able to observe it. It is to be regretted that during that time nobody has taken sufficient interest to make definite measurements; but as to the fact of visible shrinkage there can be no doubt. The pond itself is nearly choked with a growth of yellow and white pond lily, pickerel weed, cattail and a variety of aquatic plants from those of the pond-lily family down to algae. The water in the summer is not more than seven feet deep anywhere; therefore, as soundings show about twelve feet of peat close to the edge, it is safe to assume a filling of at least five feet. Around the edge of the open water is a shelf of quaking bog, interrupted at one point to the westward where a slightly steeper rocky shore seems to have made it difficult for peat-forming plants to gain a foothold. Although this crust of bog is thin enough so that occasional masses of it have broken off and floated away, it is thick enough to hold a man practically out to the very edge, and considerable clumps of alder grow upon it. Farther inshore the deposit becomes continuous, attaining a depth of 5 feet within a short distance of the solid land. The largest part of the peat deposit is north of the pond, where the quaking bog changes gradually into a solid deposit covered with heath plants, and finally into a boggy wood of larch.

Southward the pond has contracted to a mere ditch, with four to six feet of peat on either side. This finally finds outlet over a low dam of drift by means of a rapid brook which empties after a short course into Lake Androscoggin. On the west side of the ditch, the peat is underlain by a deposit of clayey material exactly similar to that which forms the bottom of the majority of the bogs. Here it is found to be in places more than 12 feet thick, and is plainly continuous with a cover of the same material that extends up the sill-slopes to some distance beyond the limits of the bogs. The significance of this occurrence is gone into in the general discussion.

The table gives the data collected in connection with this area:

LIVERMORE QUADRANGLE, MAINE.
Area No. 4
Section No. 6, d.
Description of Material.

Station.	Depth.	MEGASCOPIC.
1.	1′	Clear peat, mostly fibrous, sun dries well; burns freely.
	5′	Clear peat, mostly fibrous, sun dries well; burns freely.
	9′	Clear peat, mostly fibrous, sun dries well; burns freely.
	13′	Clear peat, mostly fibrous, sun dries well; burns freely.
2.	1′	Clear peat, mostly fibrous, sun dries well; burns freely.
	5′	Clear peat, mostly fibrous, sun dries well; burns freely.
	9′	Clear peat, mostly fibrous, sun dries well; burns freely.
	13′	Clear peat, mostly fibrous, sun dries well; burns freely.
3.	9′	Clear peat, mostly fibrous, sun dries well; burns freely.
4.	9′	Clear peat, mostly fibrous, sun dries well; burns freely.
5.	5′	Clear peat, mostly fibrous, sun dries well; burns freely.
6.	3′	Clear peat, mostly fibrous, sun dries well; burns freely.

PEAT, LIVERMORE QUADRANGLE.
Area 5, Section 6, e and h.

At the south end of Pickerel Pond there is a bog extending southward for about a mile, and undoubtedly containing a large amount of peat. It is practically impossible, however, to explore it in a satisfactory way because of the numerous embedded trunks and stumps of trees, and also because those parts of the surface that cannot be reached by boat or canoe are so wet and soft that one cannot find sufficiently secure footing to make use of the sampler. Such investigation as it was possible to carry out convinced me that large masses of wood are so prevalent as to render the material unfit for any of the ordinary uses to which peat is put. Draining of this area is rendered impossible by the fact that the use of water power at the foot of Pocasset Lake makes it necessary to hold the water level up to a point just about even with the surface of the bog. The place is of interest, in that a colony of beaver has established itself here, and seems to be thriving under careful protection.

PEAT, LIVERMORE QUADRANGLE.

Area 6, Section 8, d & a.

This is a long, narrow area bordering the steep western slope of Boothby Hill, in Leeds. It extends something over 2 miles nearly north from the road running westerly from Leeds Center, but only that portion lying within the 320 foot contour is of any importance to this discussion, the slight rise to the north of this contour allowing sufficiently good drainage to give this part of the area the character of wet woods rather than that of bog. A heavy stand of small spruce at the foot of Fairview Hill indicates some depth of peat, but this did not seem important enough to warrant examination.

The principal deposit of peat here underlies an open bog measuring approximately 1000 yards by 200 yards, and traversed throughout its length by a sluggish stream which becomes a rather rapid brook at a point a little north of the 200 foot contour, this point also marking the southern limit of the bog.

The deposit is plainly the result of the slow filling of a small pond, formed by the damming of the valley of a small stream; in fact there has been open water here within the memory of people still living in the neighborhood. By these same people it is stated that a considerable quantity of "muck" was in early times taken from the bog for fertilizer; and that this use of the material was considered of considerable importance is shown by the fact that rough roads were built out into the bog at several places, obviously at the cost of much labor. At the present time, so far as could be learned by observation and inquiry, neither this nor any other use is made of the peat.

This area was examined superficially in June; and again, more carefully, on September 6, when soundings were made and samples taken in what appeared to be the most promising parts. On the whole, it was found that the vegetation was of low growth, scarcely ankle-deep, and not nearly so rank as on the majority of the bogs; in some spots, in fact, it fails entirely. Sphagnum is fairly prevalent, varying considerably in amount; cranberry is very abundant at the south end; clumps of cotton-grass, Labrador tea, royal fern, etc., are scattered pretty regularly over the surface; the larger heath plants, which form such a prominent feature of most peat bogs, are conspicuously absent here.

The deposit is a comparatively shallow one, its maximum depth being not over 5 feet, its average depth something less than 3 feet. There is, however, a considerable amount of peat of what appears to be very good quality; at a conservative estimate, 360,000 cubic yards. The peat is underlain in part by the clayey material that is found under all the bogs, in part by sand of varying coarseness.

The entire area could be partially drained with comparatively little labor and at small expense; so prepared it would make excellent agricultural land for certain purposes, and it may well be that its most economical use would be in this direction.

The following table gives the results of an examination of the samples collected in this area:—

Livermore Quadrangle, Maine.

Area No. 6.

Section No. 8, d & a.

Description of Material.

Station.	Depth.	Megascopic.	Microscopic.
1.	Surface.	Earthy, bearing live mosses, lycopods, etc.	Quartz and other mineral grains predominant. Sticks, roots, spores, diatoms, etc.
2.	2′	Brown-black; stiff and hard with loss of water.	Little fibre, mostly fine plant material with spores, sporangia. Quartz grains abundant.
	3′	Tough, fibrous, brown peat; much sphagnum.	Largely felted fibres. Some quartz grains and a few diatoms.
	4′	Smooth, soft, blackish; somewhat fibrous, with rootlets and occasional sphagnum. Wets readily.	Quartz grains fairly abundant; many diatoms. Partly matted rootlets, grass rhizomes, etc.; some sporangia.
	Surface.	Mat of sphagnum, cranberry, etc.	
3.	1′	Gray, not very fibrous, shrinks and hardens on drying. Does not wet readily.	Many spores and sporangia; comparatively little fibre; few quartz grains; few diatoms.
	2′	Brown, fibrous, hardens on drying. Seems pure peat.	Much fibre; abundant spores and sporangia; few diatoms; comparatively few quartz grains.
	3′	Brown, distinctly fibrous; tough on drying. Does not wet readily.	Considerable fibre; abundant spores and sporangia. Comparatively few quartz grains few diatoms.
	4½′ Bottom	Fine, soft, gray, earthly, gritty.	Largely quartz grains; many diatoms; some plant fibre.
4.	Surface	Mat of plant fibres.	
	1′	Dark brown, rather fibrous; wets somewhat readily.	Mostly spores and sporangia; some fibre; little quartz; no diatoms.
	2′	Black, soft, smooth; little fibre, wets readily.	Largely spores and sporangia; not much quartz; few diatoms.
	3′	Brown, very fibrous, tough. Does not wet readily.	Mostly rhizomes and roots. Some quartz; few diatoms.
	4′	Black, soft, distinctly fibrous and spongy; some sphagnum. Wets readily.	Much fibre; many sporangia; few quartz grains; rather abundant diatoms.
	5½′ bottom	Gray, sandy. Wets and softens readily.	Very abundant quartz grains; few diatoms; some fibre; some sporangia.

Livermore Quadrangle, Maine.

Area No. 6.

Section No. 8, d & a.

Description of Material.

Station.	Depth.	Megascopic.	Miscrocopic.
5.	2′	Light brown; rather fibrous; soft, wets rather readily.	Much fibre; few quartz grains no diatoms.
	1′	Dark brown-black; not very fibrous; fine, wets readily.	Mass of spores and sporangia; scattered fibres; some quartz grains; some diatoms.
	3′	Dark brown; fibrous, hardens little on drying. Does not wet readily.	Largely matted root and other fibres; scattered quartz grains; occasional algal filaments.
	4′ bottom	Light gray, clayey, hardens on drying; absorbs water eagerly.	Largely very small, angular quartz grains; no diatoms.
6.	2′	Light brown, very fibrous. Does not wet readily.	Much fibre; some spores and sporangia; many diatoms; few quartz grains.
	3′ bottom	Very fine, light gray, clayey; occasional roots. Very hard on drying. Absorbs water.	Chiefly very small, angular quartz grains.
7.	1′	Gray-brown, very fibrous; grass, little decomposed, hardens; does not wet readily.	Much filamentous algae; leaf, stem and root tissue abundant; considerable quartz; some diatoms.
	2′	Earthy peat, brown; fibrous; hard on drying; does not wet readily.	Abundant spores and sporangia; root and leaf tissues; some algal filaments; considerable quartz; many diatoms.
	2½′ bottom	Gray-brown, earthy, with a little fibrous peat. Hardens, wets readily.	Plant fibres fairly abundant. Some filamentous algae; spores and sporangia abundant; some diatoms; many quartz grains.
8.	1′	Brown, very fibrous; roots and stems abundant. Wets with great difficulty.	Abundant spores and sporangia; root and stem tissue; plentiful quartz grains and diatoms.
	2′	Brown, fibrous, earthy; very hard on drying. Does not wet readily.	Plant tissues; abundant spores and sporangia; many quartz grains; some diatoms.
	3½′ bottom	Gray, clayey, practically no plant matter. Wets readily.	Almost entirely very fine mineral grains.
9.	6″	Gray-brown, fibrous, loamy; gritty. Very hard on drying; wets readily.	Abundant quartz grains; some diatoms; many spores and sporangia.

PEAT, LIVERMORE QUADRANGLE.

Area 7; Section 8, h & j.

Two miles nearly due south of Leeds Center there is an elongated area marked as swampy on the topographical map. This entire area doubtless contains more or less peat, but it is safe to assume that only that portion that lies somewhat below the 320 foot contour is underlain by a sufficient amount to make it worth investigation. Of this, the southern part is covered with a dense spruce growth, and has not been studied; the northern part, however, includes an open bog containing about 120 acres, or nearly 600,000 square yards, which is underlain by a considerable depth of very good peat. (The estimate of the area is very conservative, and would be increased considerably by including the wooded margins to the north, east and south).

This bog is covered in a rather uniform way with a rank growth of heath plants, rooted in a thick, soft mat of sphagnum; in the more open places clumps of pitcher plant (Saraceania) are common, and here and there may be found little colonies of the round-leafed sundew, (Drosera rotundifolia). The accompanying photographs will serve to show the nature of the vegetation, and also to give some idea of the difficulty experienced in getting about over the surface of such an area.

The usual shallow, sluggish "brook" traverses a large part of the open bog, and where the peat is deepest it broadens out into small pools in which grow spatter dock and various algae; here the footing seems somewhat treacherous, and there may be some open water under the surface mat; there is no doubt, however, that most of the bog is underlain by a solid mass of peat, and that it has long since lost the character of a quaking bog. An interesting phenomenon was noted here: in one or two cases water followed the sampler up as it was withdrawn, and welled out rather forcibly at the surface, showing that this part of the mass of peat is still more or less in the condition of a surface mat even though there may be no considerable body of actually open water beneath. It is this condition that brings about the disturbances of an eruptive nature that are occasionally recorded in the literature of peat bogs.

This deposit is the deepest one, so far as my investigations have shown, (with the possible exception of the one at Pickerel

Pond, Section 6, e & h), to be found in the quadrangle. It reaches a maximum depth of over 21 feet, (the limit of the sampler), and is more than 12 feet deep over a considerable part of the area. The table shows the data collected in this connection:

LIVERMORE QUADRANGLE, MAINE.
Area No. 7.
Section No. 8, h & j.
Description of Material.

Station.	Depth.	MEGASCOPIC.
1.	1′	Sandy peat.
2.	1′	Peat.
	4′	Clayey peat.
3.	2′	Clear peat.
	6′	Underclay with peat.
4.	4′	Clear peat.
	8′	Peat mixed with silt.
5.	1′	Very good peat.
6.	21′+	Good clear peat.
7.	21′+	Clear soft peat.
8.	17′	Fine peat.
	21′	Peat with underclay.
9.	17′	Clear peat.
	17′-21′	Underclay.
10.	13′	Clear peat.
	13′-17′	Under clay.

PEAT, LIVERMORE QUADRANGLE.

Area 8; Section 8, b.

This case is introduced as an illustration of the formation of peat under conditions that seem somewhat peculiar. The deposit is practically all in the condition of a surface mat or crust, and, although it reaches in places a depth of over 21 feet, there is hardly enough of it to warrant its exploitation. Moreover, the beauty of the place, inadequately shown in the photographs, would warrant its jealous preservation.

The bog forms a border from 50 to 100 feet wide around a nearly circular pond something over 100 feet in diameter, and the whole is contained in a depression about 20 feet deep, enclosed by steep sand and gravel walls; on the south and west, the back slope of the Leeds Center sand plain, on the east and partly on the north by the esker along the top of which runs the "Ridge road" to North Leeds. A sizeable brook enters the hollow from the northwest, and an outlet cuts across the esker to the northeast and enters Lake Androscoggin; doubtless a considerable amount of water seeps in through the porous materials that form the walls.

The water of the pond is clear, and so far as can be seen, practically free from vegetation; even the usual surface plants are lacking except that a few very small clumps of yellow pond lily occur close to the western margin. The surface of the bog is covered with sphagnum and a low thick growth of heath plants, (including lambkill and Labrador tea), among which are clumps of pitcher-plant, cotton-grass, and the dainty white Habenaria. A fringe of alder, larch and gray birch merges gradually into a wood of white pine, red maple and red oak that climbs the walls to the higher levels.

In all the other bogs that I have seen, a gently sloping rim of wet land intervenes between the hill-slopes and the edge of the bog, interfering with ready drainage into the bog, and thus making it possible, (so one is led to think) for nearly pure peat to form; but in this instance a good clear vegetable deposit begins almost abruptly at the foot of a wall of very loose material. Explanation of the peculiarities of all the occurrences will be attempted in the general discussion, and therefore no further details will be noted here.

Soundings were made, and samples taken, here as elsewhere, and the facts concerning them are tabulated as follows:

LIVERMORE QUADRANGLE, MAINE.

Area No. 8.

Section No. 8, b.

Description of Material.

Station.	Depth.	MEGASCOPIC.
1.	2′	Good peat, very wet.
	3′	Good peat, very wet.
	4′	Good peat, very wet.
2.	2′	Good peat, very wet.
	3′	Good peat, very wet.
	4.5′	Peat, gritty (sand).
3.	2′	Good peat.
	3′	Good peat.
	4′	Good peat.
	5.5′	Peat with sand.
4.	2′	Clear peat.
	3′	Clear peat.
	4′	Sandy peat.
5.	2′	Clear peat.
	3′	Sandy peat.
6.	2.5′	Clear peat.
7.	3.5′	Clear peat.

7 A.

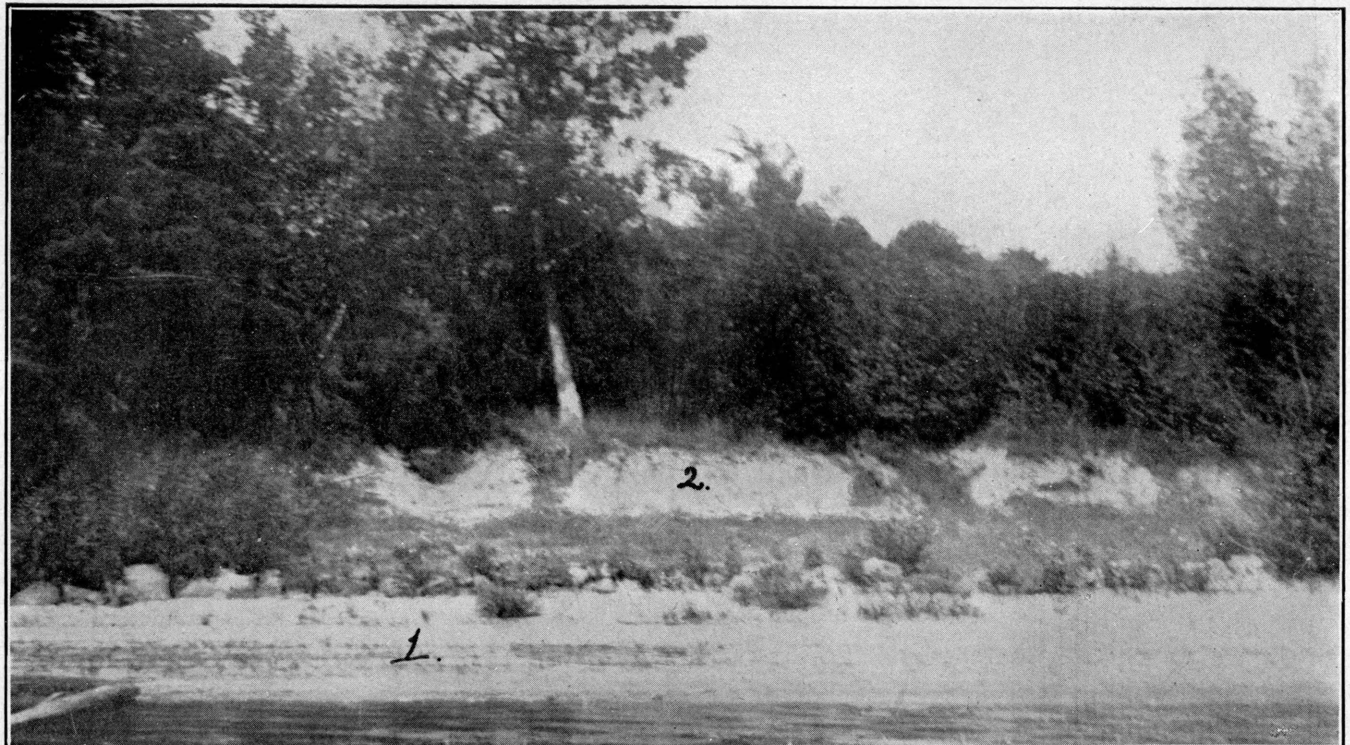
Since writing the above it has been learned that Mr. Harvey Lowell of Wayne (residence marked X on section 6h of map) and his grandson, Mr. Ray Norris, have for some years made use of peat for stable bedding. Mr. Norris readily gave me the details of their method of utilization, and afforded me an opportunity to examine such simple apparatus as they have devised in this connection.

The source of supply in this case is approximately the area marked 9 on section 6h; a small bog containing about 5 acres of excellent peat running to depths of 20 feet. It is interesting, as indicating the practical value, for local supply, of even the very small areas, to note that this has afforded an ample annual supply, during five or six years, on a farm that keeps two horses and at least ten head of cattle, and that the amount in the bog has not yet been noticeably depleted.

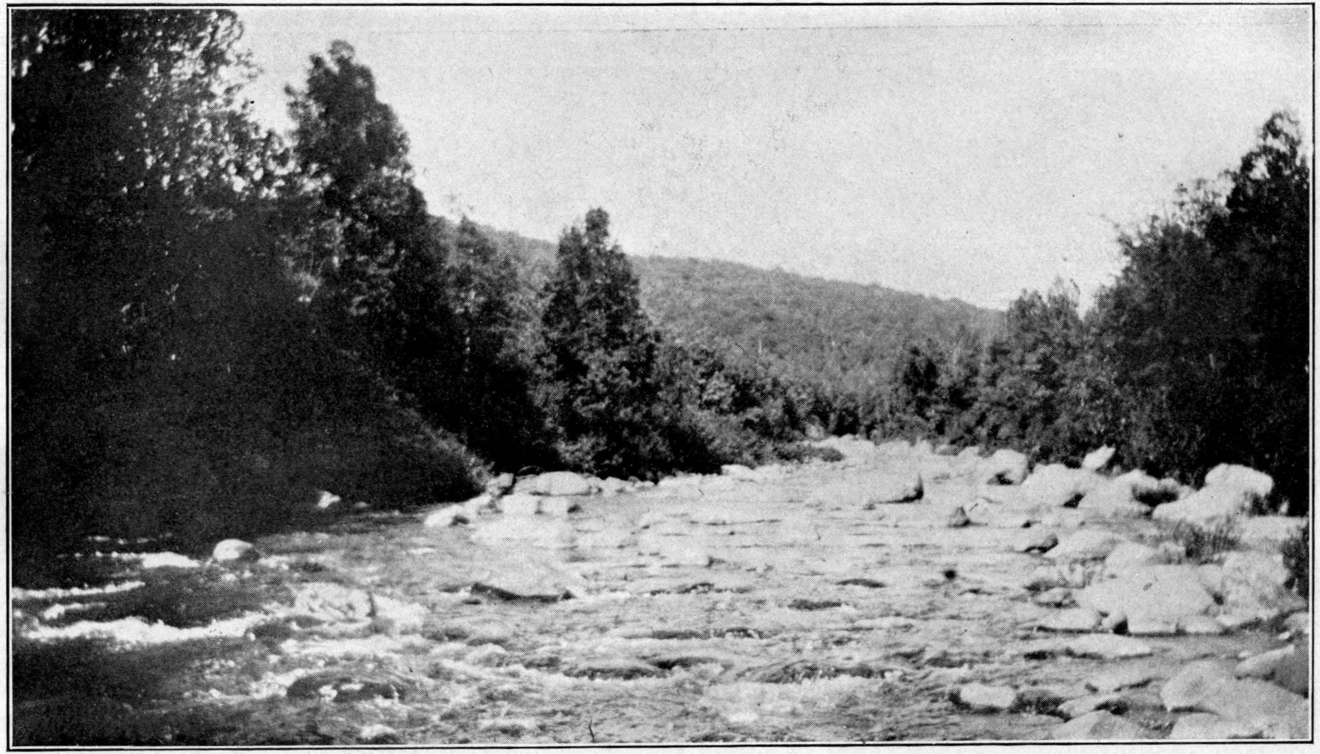
The peat is dug with an ordinary shovel, to any convenient depth, at a time when other farm work is not pressing; preferably when the surface is at its dryest. The hauling is ordinarily done immediately, and the material dumped in a convenient place near the barn, in the open air. Here a large part of the water drains out, and the dry peat is carried, by means of a small car operated by a hand windlass, into a bin in the barn; from this it is shoveled directly, as needed, into the horse stalls. Mr. Norris states that he finds it best not to use the peat in a dry powdery condition for cattle litter, as it has a tendency to fly and get into the milk pails. For this reason he allows each lot to remain in the horse stalls until it is thoroughly dampened then transfers it to the cow tie-up, and finally shovels it, well saturated with liquid manure, into the usual space under the barn.

Both Mr. Lowell and Mr. Norris assure me that their use of the "muck" is decidedly successful, that the fields certainly profit by treatment with it, and that it would be good economy to use much more if the problem of digging and hauling could be simplified.

This seems to be the only instance of the present use of peat in the quadrangle; although it is true that years ago some was hauled directly to the fields from several of the boggy areas. It is not difficult to get farmers to grant that there might be value

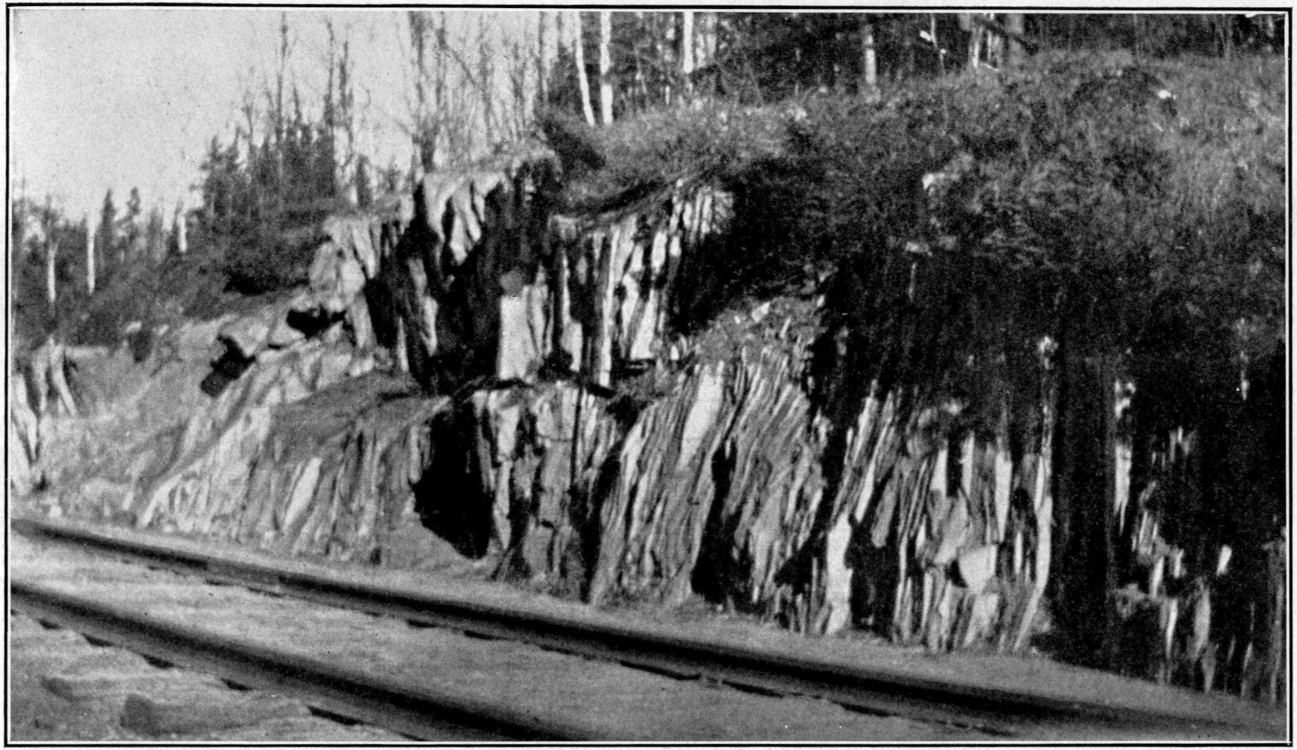


Deposit of Silt (Diatomaceous Earth), Southeast Shore of Lake Androscoggin, Wayne.
1. Present shore. 2. Old Lake bottom.

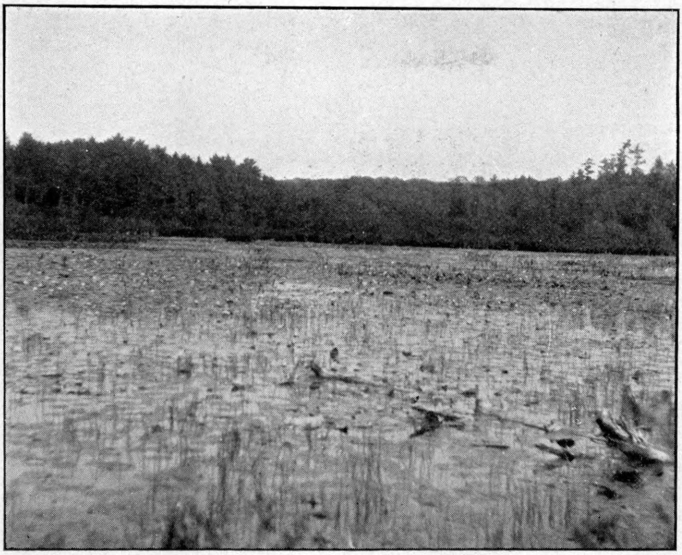


Carrabasset Stream.
Typical of the localities in which gold has been found in small amounts.

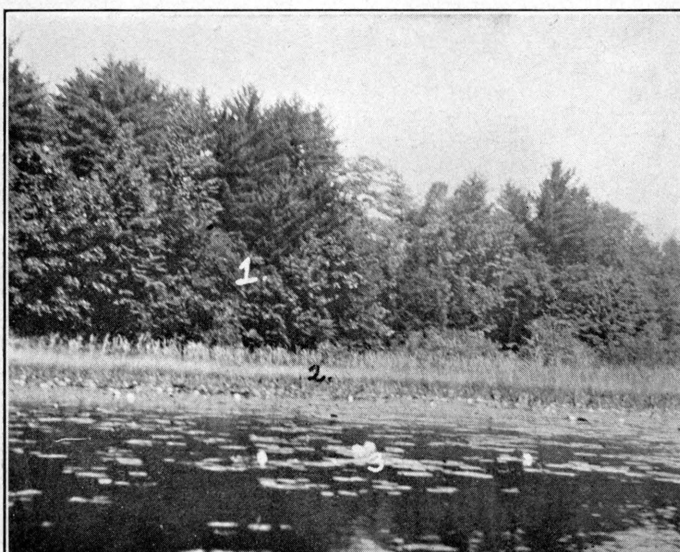
Outcrop on a mountain flank; Quartzite near Mt. Bigelow.



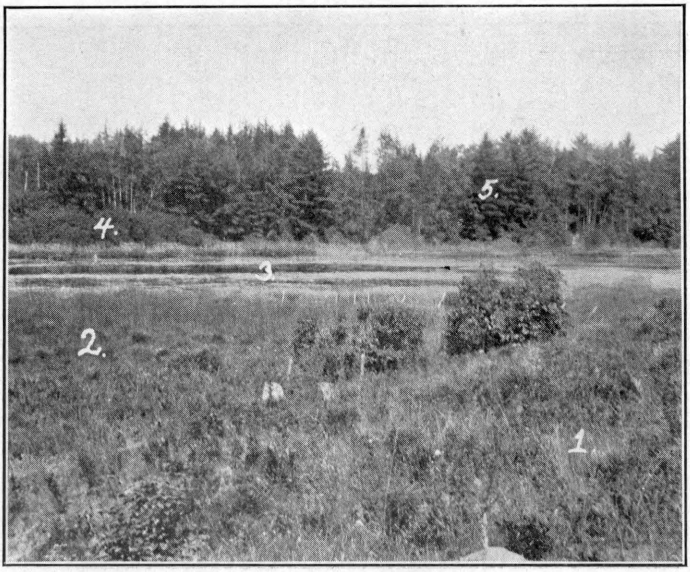
Slate exposed in a R. R. Cut near Dover.



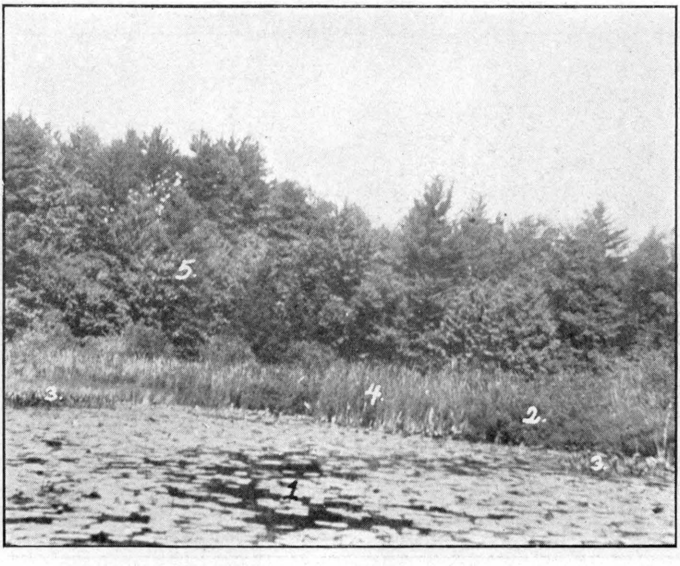
Area 4. Section 6d.
Open pond showing early stage in formation of peat.



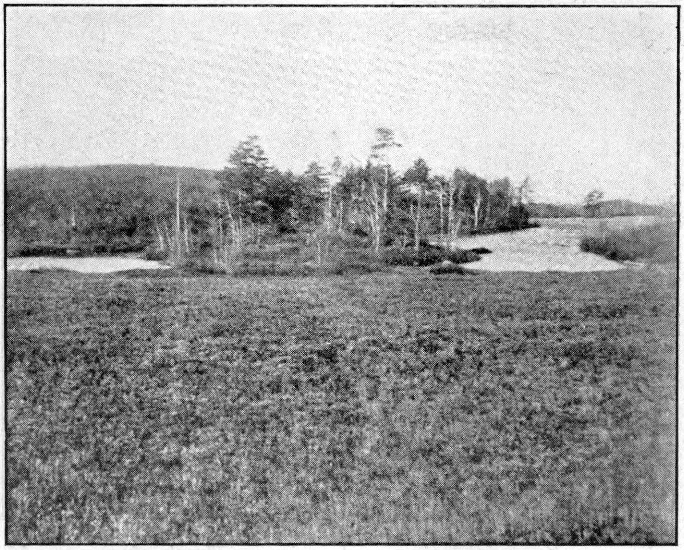
Edge of pond, showing beginning of quaking bog.
1. Upland. 2. Crust of living plants. 3. Aquatic plants in open water.



Well established bog.
1. Upland. 2. Surface of peat deposit. 3. Open water. 4. Alder thicket.
5. White pine on upland.

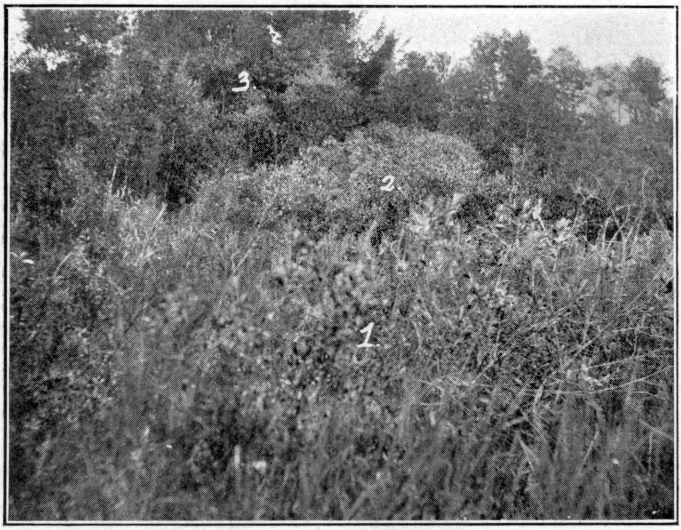


Plants concerned in early stages of peat-pog growth.
1. Pond Lilies. 2. Alder. 3. Pickerel Weed. 4. Cat-tail Rushes.
5. Upland forest.



Heath encroaching upon a small pond. Schoodic Lake, near Cherryfield.

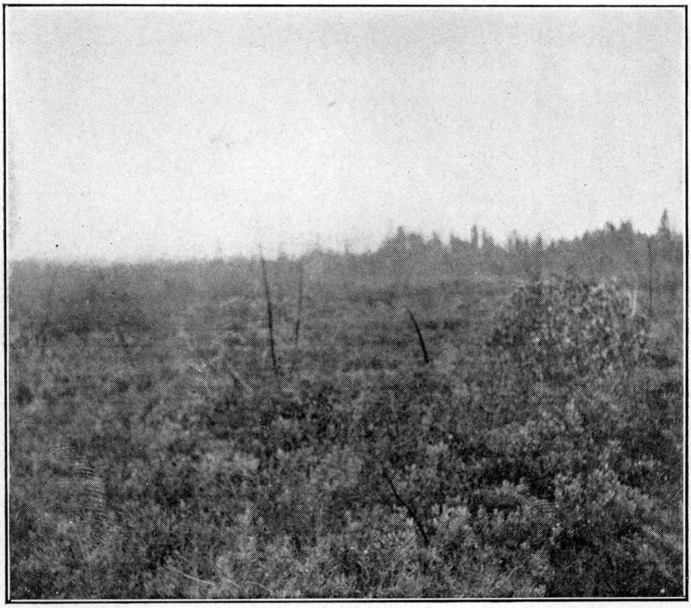
Fine example of small open heath, north of Cherryfield.



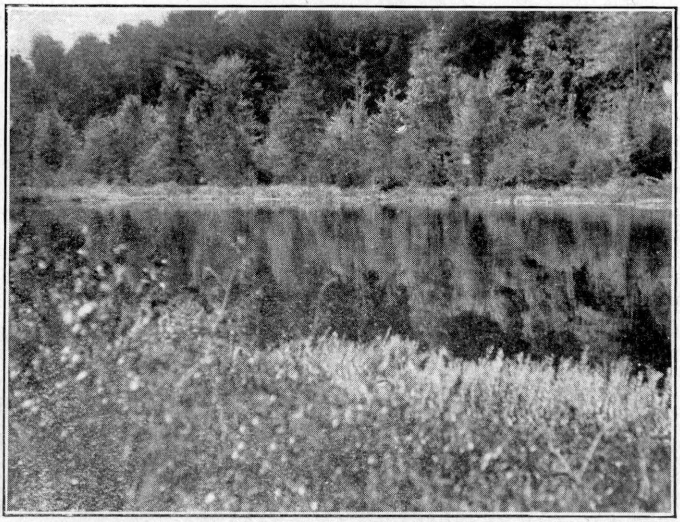
Growth on well established peat deposit. 1. Heath plants. 2. Alder. 3. Gray birch.

Heath plants and bog grasses with larch (hackmatack) in background

Great Columbia Bog. A typical open heath.

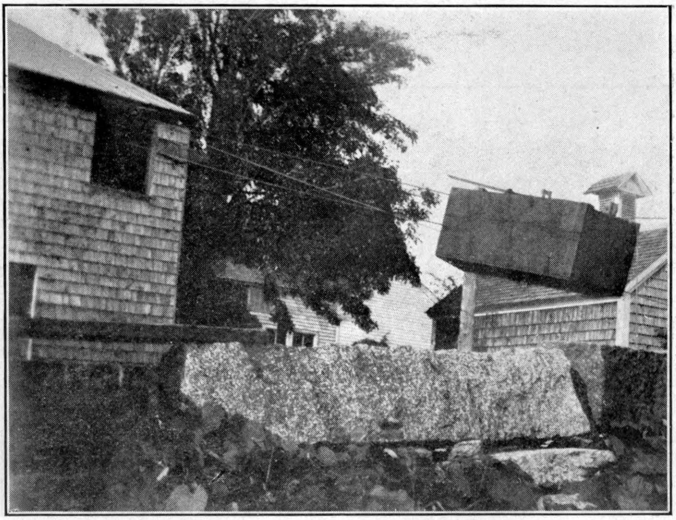


Near view of partly wooded heath, near Hermon.

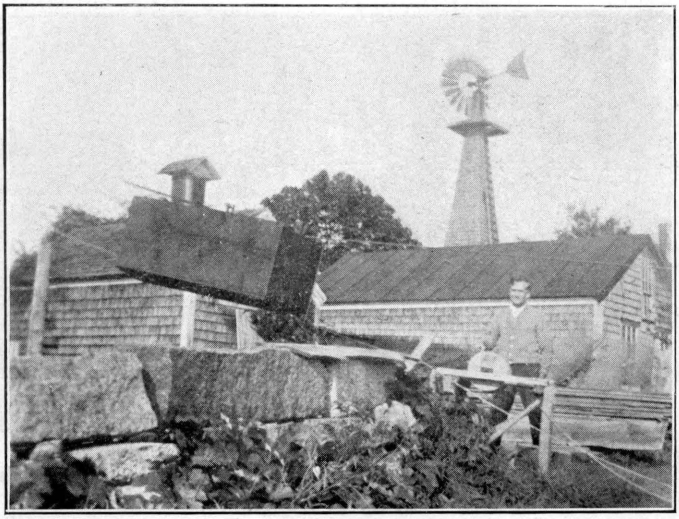


Area 8, Section 8b.
Small bog north of Leeds Center. Quaking bog gradually encroaching upon a small pond.

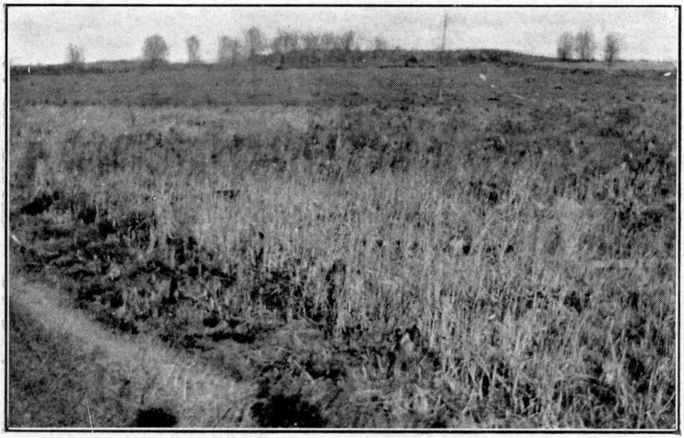
Small bog north of Leeds Center.
1. Upland forest. 2. Wooded bog with Larch and Alder. 3. Quaking Bog with heath plants and orchids. 4. Open water.



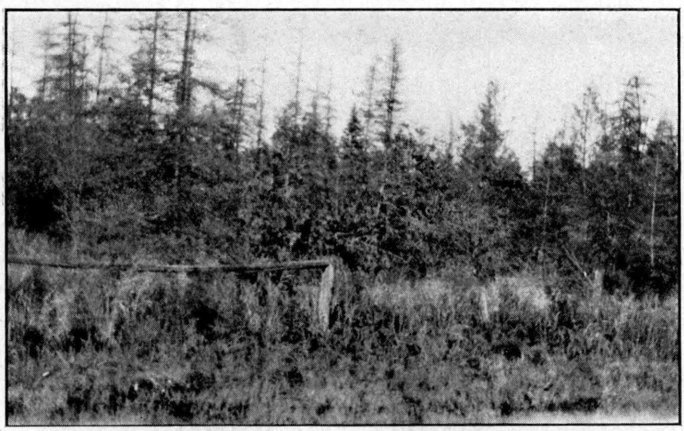
Arrangement for conveying peat into barn on farm of Mr. Harvey Lowell, Wayne. The peat is used for stable litter.



Farm of Mr. Harvey Lowell, Wayne. A load of peat on the way to bin in the barn.

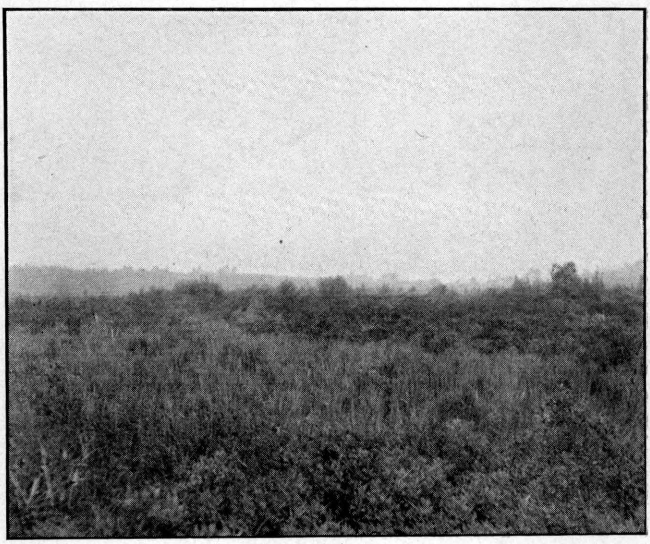


A cat-tail bog, containing little peat, near Dover.

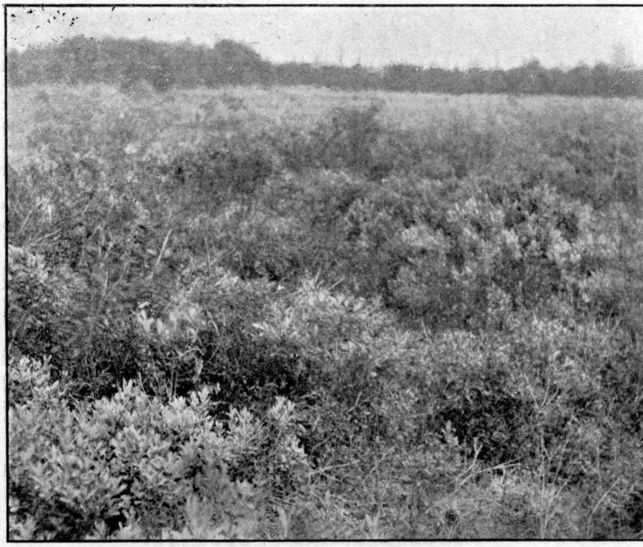


A hackmatack bog. Contains considerable peat, not readily available. South of Dover.

Monmouth Bog.
Area 7. Section 8h.
Heaths and gray birch, with spruce bog in background.

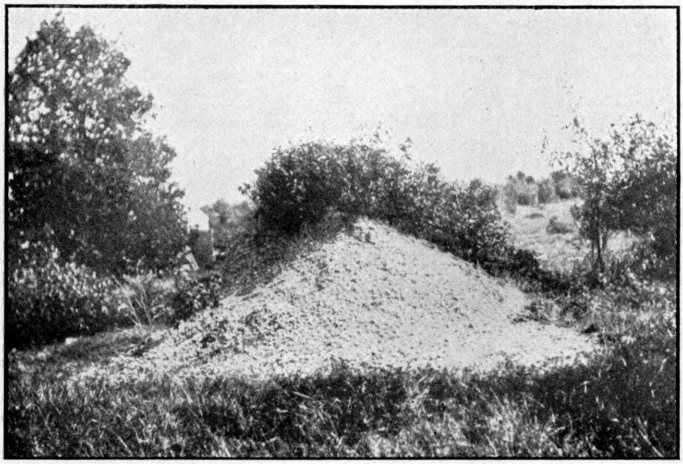


Monmouth Bog.
Heath plants and sedges.

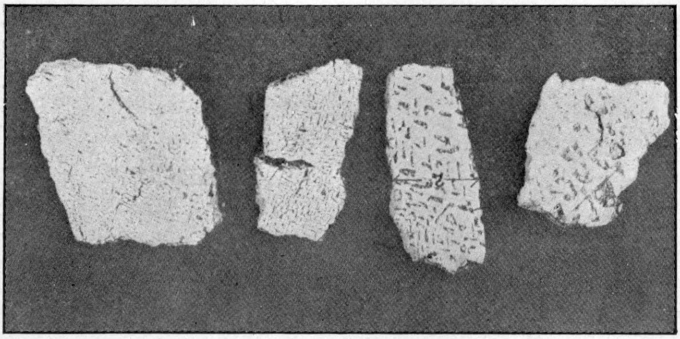


Monmouth Bog.
Near view of heath plants, including Labrador tea, Rhodora, lambkill, azalea, etc.

Monmouth Bog.
A typical heath of the central area of the state. Heath plants predominating.



U. S. Bur. Mines Bul. 92.
Weathered Pegmatite dike at East Orland.



U. S. Bur. Mines Bul. 92.
Typical graphic granites; a form in which feldspar commonly occurs.

in it; most of them, however, seem to feel that the hauling and preparing would involve too much labor and trouble. It is hoped that the above will encourage others to make a trial.

CONCLUSION.

So far as has been shown by the present investigation, the Livermore Quadrangle contains approximately 1500 acres, (a number of very small bogs would probably bring this total up to nearly 2000 acres), of bog in which there is usable peat varying from 2 feet to 20 feet in depth. These areas are fairly well scattered over the quadrangle, so as to be available to farmers in all sections.

All of the bogs may be traversed safely by foot passengers: most of them can be penetrated with teams far enough for purposes of practical exploitation. All are surrounded by high, dry land, and practically all of them are susceptible to partial drainage at no very great expense.

The peat in the bogs is of a quality warranting experiment in its use for several important farm and household purposes: and it would seem to be an undoubted matter of economy for farmers conveniently situated to carry on such experiment on a scale that would not mean serious loss in case of failure.

Hopes of large profit from the exploitation of the peat deposits are not suggested and are not to be encouraged. It is, however, felt that loss would not result from moderate expenditure of time and labor, and that some small profit would in every case be experienced.

It is urged that farmers and others favorably situated, experiment on a small scale in the use of peat for fuel, for stable litter and for mulching. Careful note of the result in each case would be of value and interest in connection with any further study of the matter.

Respectfully submitted,

FREEMAN F. BURR.

MINERAL LOCALITIES.

The following list contains all the mineral species that the writer has been able to find recorded as occurring in Maine. It is hardly likely that it is complete, even for the present moment; and it is not, of course, final, as new species may be discovered at any time. In most cases only the most important, or best known, localities have been given. It is hoped that attention will be called to any serious omissions and that new discoveries, either of minerals or localities, will be reported by those interested. The numbers are those used in J. D. Dana's System of Mineralogy.

Number.	SPECIES.	VARIETY.	LOCALITIES.
1	Gold		Albion, Madrid, Carrabassett, Bluehill, China.
2	Silver		Eggemoggin, Sullivan.
12	Copper		Sullivan, Bluehill, Sedgwick, Harborside, Castine.
17	Arsenic		Greenwood.
20	Bismuth		Catherine Hill.
25	Graphite		Bath, Bethel, Dixfield, Farmington, Greenwood, Paris, Rumford.
29	Stibnite		Carmel, Sullivan, Bluehill.
34	Molybdenite		Catherine Hill, Machias, Bluehill, Brunswick, Bowdoinham, Sanford, Paris.
40	Argentite		Sullivan.
44	Galenite		Lubec, Cherryfield, Bluehill, Bingham, Parsonfield, Dixfield.
49	Bornite		Bluehill, Lubec, Pembroke.
56	Sphalerite	Blende	Cherryfield, Lubec, Bingham, Dexter, Parsonsfield, Bluehill, Sullivan, Pembroke.
61	Chalcocite		Bluehill.
68	Pyrrhotite		Bluehill, Bingham.
75	Pyrite		Corinna, Peru, Waterville, Benton, Farmington, Rumford, Bingham, Brooksville, Jewell's Island, Wayne, Catherine Hill, Sullivan, Bluehill, Pembroke, Lubec.
78	Chalcopyrite		Lubec, Bluehill, Dexter, Harborside, Ellsworth.
91	Lollingite		Paris.
94	Arsenopyrite	Mispickel	Bluehill, Corinna, Newfield, Thomaston, Paris, Sullivan.
125	Tetrahedrite		Sullivan.
130	Stephanite		Sullivan.
140	Cerargyrite		Sullivan.
159	Fluorite		Long Island in Bluehill Bay.
160	Yttrocerite		Paris (Mount Mica).
172	Cuprite		All copper localities.
179	Corundum		Greenwood.
180	Hematite		Woodstock, Aroostook, Cherryfield.
186	Magnetite		Raymond, Marshall's Island, Wayne, Bluehill, Deer Isle.
191	Chrysoberyl		Norway.
192	Cassiterite		Paris, Streaked Mountain, Hebron, Winslow.
193	Rutile		Warren.
199	Pyrolusite		Bluehill, Lubec.
202	Turgite		With Limonite.
206	Limonite	Bog Iron	Katahdin Iron Works, New Portland, Dover, Andover, Paris, Turner, Lebanon, Rumford, Liberty.

Number.	Species.	Variety.	Localities.
218	Wad	Bog Manganese	Bluehill, Dover, Perry, Jewell's Island.
224	Molybdite		Catherine Hill.
231	Quartz		Universal in veins and as rock mineral.
		Crystal	Mt. Apatite, Stoneham, Paris, Perry, Fort Kent, Rockland, Topsham, Katahdin Iron Works, Freeport, Greenwood.
		Rose	Mt. Apatite, Mt. Mica, Albany, Norway.
		Smoky	Mt. Apatite, South Freeport, Minot, Paris, Poland, Pownal.
		Amethyst	Albany.
		Jasper	Wayne (drift pebbles.)
		Opal	Jonesport (in trap rock.)
235	Hypersthene		Wayne (in trap.)
238	Pyroxene		Raymond, Rumford, Deer Isle.
241	Rhodonite		Bluehill.
243	Spodumene		Mt. Apatite, Windham, Paris, Peru.
247	Amphibole		Thomaston, Brooksville, Moultenboro, Phippsburg, Parsonsfield, Unity, Raymond, South Freeport, Deer Isle.
254	Beryl		Albany, Norway, Bethel, Fryeburg, Hebron, Greenwood, Paris, Bowdoinham, Brunswick, Topsham, Georgetown, Auburn, South Freeport, Minot, Oxford, Peru, Monmouth, Streaked Mt., Poland, Windham, York.
256	Pollucite		Streaked Mountain, Paris.
271	Garnet	Yellow	Parsonsfield, Phippsburg, Raymond, Rumford.
		White	Harborside.
		Red	Streaked Mountain, Windham, Auburn, Greenwood, Bath, Bethel, Paris, Buckfield, Deer Isle, Poland, Portland, Norway, Orr's Island, Oxford, Brunswick, Winthrop, Wayne, Fryeburg, South Freeport.
272	Zircon		Litchfield, Mount Mica, Greenwood, Farmington.
276	Epidote		Pembroke, Gouldsboro.
289	Biotite		Hebron, Paris, Topsham.
293	Muscovite		Everywhere in granite and schists; Mount Apatite, Mount Mica, Streaked Mountain, Peru, Waterford, Fryeburg, Buckfield, Unity, South Freeport.
294	Lepidolite		Mount Apatite, Paris, Hebron.
299	Wernerite		Parsonsfield, Raymond.
304	Nephelite		Litchfield.
305	Sodalite		Litchfield.
311	Labradorite		Thomaston, Leeds.
315	Albite (incl. Cleavelandite)		Paris, Auburn.
316	Orthoclase		Paris, Poland, Hebron, Pownal, Raymond, Auburn, Buckfield, Peru, Norway, Fryeburg, Minot, Waterford, South Freeport, Brunswick, Topsham, Cathance, Georgetown, Albany, Edgecomb, New Castle, Orland.
320	Tourmaline	Black	Topsham, South Freeport, Auburn, Minot, Hebron, Buckfield, Paris, Wayne, Leeds, etc.
		Colored	Auburn, Paris, Hebron, Georgetown, Buckfield, Albany, Brunswick, Pownal, Sanford, Windham.
322	Andalusite		Mount Abraham, Bangor, Searsmont, Camden, South Berwick.
324	Cyanite		Paris (?)
325	Topaz		Fryeburg.
329	Titanite		Sanford, Thurston.
333	Staurolite		Windham, Mount Abraham, Strong, Hartwell, Winthrop, East Livermore.
343	Laumontite		Phippsburg.
363	Prehnite		Perry.
370	Apophyllite		Perry.
399	Talc		Dexter, Sullivan.

Number.	Species.	Variety.	Localities.
406	Montmorillonite		Mount Mica.
411	Serpentine		North Haven, Deer Isle.
419	Kaolinite		Impure in clay, everywhere.
420	Cookeite		Hebron, Paris.
474	Columbite		Mount Mica.
492	Apatite	Green	Long Island, Peru, Paris, North Jay.
		Purple	Mount Apatite.
503	Amblygonite		Hebron, Buckfield, Mount Mica.
504	Herderite		Mount Apatite, Hebron.
560	Childrenite		Hebron.
573	Autunite		Topsham (?), Mount Apatite (?).
610	Wolframite		Bluehill.
630	Barite		Deer Isle, Sullivan, Bethel, Brunswick, Sanford, Woodstock.
654	Gypsum		Sullivan.
715	Calcite		Thomaston, Rockport, Deer Isle, Lubec.
721	Siderite		Pembroke.
722	Rhodochrosite		Deer Isle.
751	Malachite		Harborside, Bluehill, Pembroke.
	Beryllonite		Stoneham

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Analyses of Representative Maine Feldspars.

PERCENTAGES.

	1.	2.	3.	4.	5.	6.	7.	8.
Silica ($S:O_2$)..	70.5	69.2	68.3	67.5	60.0	65.2	64.53	65.09
Alumina (Al_2O_3).	16.06	18.29	15.9	15.2	18.34	19.74	19.07	19.34
Potash (K_2O)..	10.98	10.826	9.8	9.7	12.028	10.438	12.52	11.74
Soda (Na_2O).	2.44	0.46	1.3	1.29	3.6	2.42	2.43	2.68

Localities.

Androscoggin County, 4. Auburn: Cumberland County, 5. South Freeport: Franklin County, 3. North Jay (pegmatite dike in granite): Oxford County 1. Peru, 6. Buckfield (Streaked Mountain), 7. Waterford, 8. Paris.

The above figures show the actual amount of potash, etc., contained in the samples analyzed. No commercial process can be expected to extract the entire amount shown: in fact, it is hardly probable that more than 75% of the total amount would be recovered on a large scale, and it would be safer to reckon on no more than 60%. This means that whereas, theoretically, it should be possible in the above cases to obtain 194 to 250.4 pounds of potash for every short ton of rock used, in actual commercial practice the amount obtainable would not exceed 116.4 to 150.24 pounds to the short ton of rock. The samples analyzed were picked up at random in the localities mentioned, and in each case represent considerable amounts of equally good material: nevertheless it should be stated that more or less careful selection of material would be necessary in order to obtain commercially large amounts of rock yielding as high as the smallest percentage of potash given in the table.

ANALYSIS OF REPRESENTATIVE MAINE PEATS.

	Moisture at 105 C.	Ash.	Heating value B. t. u.	
1	6.5	18.	8,100	
2	9.2	27.7	5,700	
3	10.	7.	8,500	
4	11.6	12.5	8,700	
5	16.	9.5	9,000	
6	7.	11.5	8,400	
7	8.	12.5	7,800	
8	8.	36.	5,400	
9	5.	5.5	10,000	
10	15.	12.5	8,500	
11	16.3	25.	7,000	

LOCALITIES.

Androscoggin County, 1, East Livermore, 2, East Livermore, 5, Leeds, 6, Leeds; Franklin County, 8, Chesterville; Kennebec County, 3, Wayne; Penobscot County, 4, Pushaw Bog, 10, Carmel; Piscataquis County, 11, Dover; Washington County, 7, Cherryfield, 9, Jonesport.

Under heating value, B. t. u. indicates British thermal units, based on the amount of heat required to raise the temperature of a pound of water one degree fahrenheit. An idea of the heating value of the above samples may be obtained from the fact that the heating values of bituminous coals range from 10,500 to a little over 13,000 B. t. u.. The heating value is in general greatest in those peats that have low percentages of ash; and removal of water increases heating value. Number 9 is, on the face of it, an excellent fuel peat. Number 8 would be of little value for fuel purposes, but would be of value for agricultural purposes: it is, in fact, essentially merely a peaty soil.

Attention should be called to the fact that the peat in any bog will vary considerably, according to the location and depth at which it is taken. No analysis is, therefore, to be taken as final.

(Note.—For general analyses of peats, showing amounts of Ammonium Sulphate, Tar, Gas, etc., obtainable, see body of report.)

PART III.
WATER RESOURCES

REPORT OF GEORGE C. DANFORTH, ASSISTANT ENGINEER.

WATER RESOURCES.

This work includes the collection and computation of data in connection with the stream gaging work. For each gaging station is given the following data for the year ending September 30, 1916.

1. Description of Station and list of discharge measurements.
2. Table of daily discharge.
3. Table of monthly discharge and run-off.

Descriptions, lists of discharge measurements and tables of daily and monthly discharge have been published in the Water Supply Papers of the United States Geological Survey as follows:

1898:	27				
1899:	35	1904:	124	1910:	281
1900:	47	1905:	165	1911:	301
1901:	65, 75	1906:	201	1912:	321
1902:	82	1907–8:	241	1913:	351
1903:	97	1909:	261	1914:	381
				*1915:	401

Additional data concerning work during the years 1887 to 1900 are contained in Part IV of the 19th, 20th, 21st and 22d Annual Reports of the Geological Survey. Special Reports have been issued as follows:

W. S. P. 69 Water Powers of Maine
W. S. P. 198 Water Resources of the Kennebec River Basin
W. S. P. 279 Water Resources of the Penobscot River Basin

In some sections of the State information regarding topographic features is incomplete and the computed drainage areas

*In press.

are inaccurate. As surveys are extended these computations are checked and corrected.

This is the most important branch of work in connection with the investigation of the water resources of the State and their development for power purposes. In the determination of the value of a stream for storage a continuous record of its discharge should be available in order to determine the maximum and minimum run-off and the dependable run-off from year to year. The methods used in the collection and computation of data are the standardized methods of the U. S. Geological Survey and are uniformly in use throughout the United States and Canada.

Coöperation.

Coöperation with the Water Resources Branch of the U. S. Geological Survey has been continued, the collection and computation of river discharge data is being carried on without change, and the results are published in the Water Supply Papers of the U. S. Geological Survey as well as in the annual reports of this Commission. The methods of conducting the field work are at all times subject to the approval of competent engineers of the Geological Survey, and the final computations are checked by their District Engineer, preparatory to publication by the Washington Office. The Geological Survey has also furnished the necessary instruments for carrying on the field work, and forms for use in the computation of results.

Scope of Work.

The investigations of river discharge in the State are not complete nor do they include all the streams that might advantageously be studied. They include, however, as many of the rivers as is practicable with the force available for the work. It is essential that records of stream flow be kept during a period of years sufficient to determine within reasonable limits the range of flow from maximum to minimum. Experience has shown that this period, varying with different streams, should be from five to twenty years. Certain important stations in each basin, the records of which already extend over a long period, should be maintained permanently.

River discharge records are obtained at 26 stations, 16 of which are current meter gaging stations. For the other 10 stations the computations are made from records furnished by various water power companies. Four meteorological stations and one evaporation station are also maintained.

Owing to the difficulty of computing the discharge of rivers during the frozen season on the basis of the calendar year, the so-called climatic year, October 1 to September 30, has been adopted and records from 1913 to 1916 have been computed in accordance therewith. Computations for previous years are being rearranged to conform with the new method and will be republished.

The methods of computing winter flow have recently been revised. The observed daily gage heights at all stations subject to ice cover are plotted on cross-section paper, and below this curve are drawn curves of backwater and effective gage height. Discharge measurements as plotted fix definite points on these curves and intermediate sections are filled in with the aid of the observers' notes and curves of precipitation and temperature which are plotted for different sections of the state from data obtained from our own observers and from the U. S. Weather Bureau.

During the year ending September 30, 1916, 112 discharge measurements were made, 43 of which were made under ice cover.

The gaging stations on the Sandy River at Farmington and on the St. John River at Fort Kent have been discontinued and new stations have been established on the West Branch of the Penobscot River at Medway, on the Saco River at Cornish and the Ossipee River at Cornish.

Cost of Work, 1916.

*Salaries	$3,346 00
Traveling Expenses	925 84
Supplies and Equipment	335 72
	$4,607 56

*Includes $1,008.50 paid to observers at river stations.

Field Methods of Measuring Stream Flow.

The following description of methods is compiled from various publications of the United States Geological Survey with the necessary changes and additions for its application to conditions in this state.

Base Data.

In making plans for power, irrigation, municipal water supply, and other projects involving the use of water from surface streams it is necessary to have data from which both the total flow of the stream and its distribution from day to day throughout the year can be obtained. The data necessary for obtaining such information are daily gage heights, which give the fluctuations of rise and fall of the stream, and measurements of discharge at various stages, from which a rating curve can be prepared, giving the discharge for any stage. Such a curve is possible from the fact that so long as the conditions at the controlling point in the stream remain the same there will be the same discharge for any given gage height.

The determination of the quantity of water flowing is termed a discharge measurement, and points at which discharge measurements are made, and where daily records of stage are kept for determining the flow, are termed gaging stations..

Gaging stations may be divided into two classes, known as weir stations and velocity-area stations. At weir stations the head of water on the crest of the weir is measured and the discharge computed by means of a suitable formula. The discharge at velocity-area stations is obtained by measuring the velocity of the current and the area of the cross-section, the product of the two giving the discharge.

Weir Measurements.

Unquestionably a weir properly constructed and of a type for which accurate coefficients have been determined is one of the most convenient and reliable means of measuring small quantities of water. In practice, however, weirs rarely conform to the requirements imposed by the experimenter who derived the coefficients. If the crest of the weir is sharp and clean and sufficiently high above the bottom of the leading channel and the end contractions are complete and the velocity of approach is wanting, or negligibly small, and if the head on the crest is measured at a distance of 6 or 8 feet back of the overfall, the Francis formula will give good results. On the other hand, if these essential conditions do not obtain, especially if the velocity of approach is considerable, and the contractions are imperfect, the Francis formula will not give accurate results. This is particularly true if the weir is improperly constructed and there is leakage around and under it, as is so frequently the case in practice.

The weir formulas are applied, with suitable coefficients, to dams and where the flow through the wheels can be computed with reasonable accuracy, this method is used for determining the discharge and is used at a number of the power plants in the State.

Velocity-Area Method.

The velocity-area method of measurement consists of determining the mean or average velocity of the water past a given cross-section area. The area of the cross section at right angles to the direction of flow is determined by soundings which are taken at such distances apart as will develop the contour of the stream bed. The depths are recorded and also their distances from some arbitrarily chosen initial point on one side of the stream.

The method of making the soundings depends on the size and stage of the stream. On small streams, where the depths and velocities are not large, a graduated rod may be used to advantage; on large streams, which must be measured from bridges or cables, a lead weight and sounding line must be used. The weights used are of different sizes—10 or 15 pounds—according to the swiftness of the current, and are torpedo shaped, so as to offer as little resistance as possible to the moving water.

On streams with beds which are permanent or nearly so, a standard cross section is constructed from careful soundings and referred to the zero of the gage, so that the depths for any stage can be found by adding the gage height at that stage to the depths below the zero of the gage. This method is especially useful at high stages, where it is difficult to make accurate soundings.

After the cross-section area of the stream has been measured by soundings and horizontal distances, the velocity is determined at a number of points. These measurements of velocity should be made at frequent intervals across the stream and close enough to take account of any abrupt change in the velocity. For convenience, the velocities are usually observed in the same verticals at which soundings are made. On some streams fairly good measurements of velocities may be made by means of subsurface floats. This method is applicable, however, only to channels of uniform cross-section area over a considerable distance.

The velocity of flow is best determined by the current meter. The new type of penta-recording current meter consists of six cups attached to a vertical shaft which revolves on a conical hardened-steel point. The revolutions are indicated electrically. The rating or relation between the velocity of moving water and the revolutions of the wheel is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity in feet per second for any number of revolutions in a given time interval. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds and is approximately 0.45.

Three classes of methods of measuring velocity with current meters are in general use; multiple-point, single-point, and integration.

The two principle multiple-point methods in general use are the vertical velocity-curve and 0.2 and 0.8 depth methods.

In the vertical velocity-curve method a series of velocity determinations are made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison.

In the second-multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of velocities at 0.22 and 0.79 depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives the mean velocity very closely for open-water conditions and that in a completed measurement it seldom varies as much as 1 per cent from the value given by the vertical velocity-curve method. It is extensively used in the regular practice of the United States Geological Survey.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined or must be assumed.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual cases is, however, greater than in the 0.2 and 0.8 method and the general results are not as satisfactory.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements, or for measurements when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical integration method consists in moving the meter at a slow but uniform speed from the surface to the bottom and back again to the surface, and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity determination.

In practical work on rough streams the meter should be held at 0.6 depth for depths of 2.5 or less. For greater depths the meter should be held at two points in the vertical, 0.2 and 0.8 from the surface.

When the mean velocities in the different verticals have been found, the average of two adjacent means is taken as the mean velocity for that individual section. The area of the section is computed by multiplying the width of the section by the mean depth. The discharge of each section is then the product of the area multiplied by the mean velocity, and the total discharge of the stream results from summing up the discharge of the individual sections. In practice the work is tabulated in such a way as to render the computation very simple.*

Current-meter measurements are not practicable where there are eddies, cross currents, swirls, or passages for the water underneath stones. It is usually possible, however, to improve the channel by removing bowlders and rocks, so that a satisfactory measuring section may be obtained, even on rough, steep streams.

Three kinds of velocity-area gaging stations are in general use in Maine, according to the means provided for making the observations of the depth and velocity. They are wading, bridge, and cable stations.

A wading station is one at which measurements are made only by wading. Such stations are usually on ditches or wide

*For a discussion of methods of computing the discharge see Engineering News, June 25, 1908.

shallow streams, which do not fluctuate greatly in flow. Frequently, however, measurements are made at low stages by wading, even though other means exist for making measurements at higher stages.

A bridge station is one at which the meter is used from a bridge. In some places highway or other bridges are available from which to make measurements, but often they are not at the right place on the stream. Special bridges are then built.

A cable station is one at which measurements are made from a cable spanning the stream. The cable supports the car from which a man works above the water. Distances are marked off on a small auxiliary cable.

A suitable place for a gaging station having been selected a staff or chain gage is set, graduated to tenths, half-tenths, or hundredths of feet vertically. The gage is securely fastened to prevent displacement by floods and is so placed that the zero, or reference datum, is below extreme low water. The datum is also referred to a permanent bench mark as an additional precaution. An observer is then engaged to record the heights of water, morning and evening; the mean of the two readings being used as the mean gage height for the day.

Owing to the rapid rise and fall of some of the streams in Maine, two gage-height readings a day will not as a rule give a true mean for the 24 hours. For this reason, and also owing to the fact that some of the gaging stations are necessarily situated at points remote from all habitations and difficult of access, the use of automatic recording-gages has been found to be necessary.

The essential features of the automatic gage consist of a float free to rise and fall with fluctuations of the water surface, a means of transferring this motion of the float to the record, either directly or through a reducing mechanism, the recording device, and the clock: In most gages used on natural streams the float is connected with a counter weight by means of a chain or perforated tape which passes over a sprocket wheel connected with gearing in such a way as to reduce the motion caused by the rise and fall of the water surface to a convenient scale. This vertical motion of the float may be transferred either to the pencil or other recording device or to the cylinder carrying the paper. The time interval is given by the clock, which may move either the paper or the pencil, according to the float connection. For all autographic records the motions controlled by the float and the clock are brought at right angles so that there results a continuous curve where one set of ordinates represents gage heights, and the other the time interval.

The gage may be designed to accommodate any range of stage. Those used by the United States Geological Survey are designed for variations of 5, 10, 20, 30, and 36 feet, but so far those having a 20-foot range have been found to be sufficient for any stage.

Definition of Terms.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated more or less definitely with a certain class of work. These terms may be divided into two groups: (1) Those which represent a rate of flow, as "second-feet," "gallons per minute," "gallons per 24 hours," and "run-off in second-feet per square mile," and (2) those which represent the actual quantity of water, as "run-off in depth in inches," and "million gallons." They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second and is the unit for the rate of discharge of water flowing in a stream 1 square foot in cross section at a velocity of 1 foot per second. It is generally adopted as the fundamental unit in the measurement of flowing water and is the "natural" unit, as the foot and the second are the units used in making the physical determinations. Other units may be computed from this by the use of factors given in the table of equivalents.

"Gallons per minute" is generally used in connection with pumping and city water supply, the United States gallon of 231 cubic inches being the unit of quantity and 1 minute the unit of time.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off in inches" is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

A unit commonly used in connection with the measurement of water is the "million gallons." This is used with two meanings—(1) to indicate a rate of flow and (2) to express an actual quantity of water. In the former sense "million gallons per 24 hours" is inferred, 1,000,000 gallons being taken as the unit of quantity, and 24 hours as the unit of time. With this meaning the term is generally used in connection with pumping and irrigation. In the latter sense "million gallons" as an absolute quantity is used in the measurement of storage capacities of reservoirs.

"Millions of cubic feet" is applied to quantities of water stored in reservoirs, most frequently in connection with studies of flood control.

Convenient Equivalents.

The following is a list of convenient equivalents for use in hydraulic computations:

Table for converting discharge in second-feet per square mile into run-off in depth in inches over the area.

Discharge (Second-feet per Square Mile).	Run-off (Depth in Inches).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1	0.03719	1.041	1.079	1.116	1.153
2	.07438	2.083	2.157	2.231	2.306
3	.11157	3.124	3.236	3.347	3.459
4	.14876	4.165	4.314	4.463	4.612
5	.18595	5.207	5.393	5.578	5.764
6	.22314	6.248	6.471	6.694	6.917
7	.26033	7.289	7.550	7.810	8.070
8	.29752	8.331	8.628	8.926	9.223
9	.33471	9.372	9.707	10.041	10.376

Note.—For partial month multiply the values for one day by the number of days.

Table for converting discharge in second-feet into run-off in millions of cubic feet.

Discharge (second-feet).	Run-off (millions of cubic feet).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1	0.0864	2.419	2.506	2.592	2.678
2	.1728	4.838	5.012	5.184	5.356
3	.2592	7.257	7.518	7.776	8.034
4	.3456	9.676	10.02	10.37	10.71
5	.4320	12.10	12.53	12.96	13.39
6	.5184	14.51	15.04	15.55	16.07
7	.6048	16.93	17.54	18.14	18.75
8	.6912	19.35	20.05	20.74	21.42
9	.7776	21.77	22.55	23.33	24.10

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

Table for converting discharge in second-feet into run-off in millions of gallons.

Discharge (second-feet).	Run-off (millions of gallons).				
	1 day.	28 days.	29 days.	30 days.	31 days.
1	0.6463	18.10	18.74	19.39	20.04
2	1.293	36.20	37.48	38.78	40.08
3	1.939	54.30	56.22	58.17	60.12
4	2.585	72.40	74.96	77.56	80.16
5	3.232	90.50	93.70	96.95	100.2
6	3.878	108.6	112.4	116.3	120.2
7	4.524	126.7	131.2	135.7	140.3
8	5.171	144.8	149.9	155.1	160.3
9	5.817	162.9	168.7	174.5	180.4

NOTE.—For part of a month multiply the run-off for 1 day by the number of days.

Table for converting velocity in feet per second into velocity in miles per hour.

(1 foot per second =0.681818 mile per hour, or two-thirds mile per hour, very nearly; 1 mile per hour=1.4666 feet per second. In computing the table the values 0.68182 and 1.4667 were used.)

Feet per second (units)).	Miles per hour for tenths of foot per second.									
	0	1	2	3	4	5	6	7	8	9
0	0.000	0.068	0.136	0.205	0.273	0.341	0.409	0.477	0.545	0.614
1	.682	.750	.818	.886	.995	1.02	1.09	1.16	1.23	1.30
2	1.36	1.43	1.50	1.57	1.64	1.70	1.77	1.84	1.91	1.98
3	2.05	2.11	2.18	2.25	2.32	2.39	2.45	2.52	2.59	2.66
4	2.73	2.80	2.86	2.93	3.00	3.07	3.14	3.20	3.27	3.34
5	3.41	3.48	3.55	3.61	3.68	3.75	3.82	3.89	3.95	4.02
6	4.09	4.16	4.23	4.30	4.36	4.43	4.50	4.57	4.64	4.70
7	4.77	4.84	4.91	4.98	5.05	5.11	5.18	5.25	5.32	5.39
8	5.45	5.52	5.59	5.66	5.73	5.80	5.86	5.93	6.00	6.07
9	6.14	6.20	6.27	6.34	6.41	6.48	6.55	6.61	6.68	6.75

Table for converting discharge in second-feet into theoretical horsepower per foot of fall.

(1 second-foot=0.1136 theoretical horsepower per foot of fall. Weight of 1 cubic foot of water=62.5 pounds.

Tens.	Units.									
	0	1	2	3	4	5	6	7	8	9
0..........	0.00	0.114	0.227	0.341	0.454	0.568	0.682	0.795	0.909	1.02
1..........	1.14	1.25	1.36	1.48	1.59	1.70	1.82	1.93	2.04	2.16
2..........	2.27	2.39	2.50	2.61	2.73	2.84	2.95	3.07	3.18	3.29
3..........	3.41	3.52	3.64	3.75	3.86	3.98	4.09	4.20	4.32	4.43
4..........	4.54	4.66	4.77	4.88	5.00	5.11	5.23	5.34	5.45	5.57
5..........	5.68	5.79	5.91	6.02	6.13	6.25	6.36	6.48	6.59	6.70
6..........	6.82	6.93	7.04	7.16	7.27	7.38	7.50	7.61	7.72	7.84
7..........	7.95	8.07	8.18	8.29	8.41	8.52	8.63	8.75	8.86	8.97
8..........	9.09	9.20	9.32	9.43	9.54	9.66	9.77	9.88	10.0	10.1
9..........	10.2	10.3	10.5	10.6	10.7	10.8	10.9	11.0	11.1	11.2

1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,317 gallons for one day.

1 second-foot for one year covers 1 square mile 1.131 feet or 13,572 inches deep.

1 second-foot for one year equals 31,536,000 cubic feet.

1 second-foot for one day equals 86,400 cubic feet.

1,000,000,000 (1 United States billion) cubic feet equals 11,570 second-feet for one day.

1,000,000,000 cubic feet equals 414 second-feet for one 28-day month.

1,000,000,000 cubic feet equals 399 second-feet for one 29-day month.

1,000,000,000 cubic feet equals 386 second-feet for one 30-day month.

1,000,000,000 cubic feet equals 373 second-feet for one 31-day month.

1,000,000 United States gallons per day equals 1.55 second-feet.

100 United States gallons per minute equals 0.223 second-foot.

1 inch deep on 1 square mile equals 2,323,200 cubic feet.

1 inch deep on 1 square mile equals 0.0737 second-foot per year.

1 foot equals 0.3048 meter.

1 meter equals 3.2808 feet equals 39.37 inches.

1 mile equals 1.60935 kilometers.

1 kilometer equals 0.62137 miles.

1 mile equals 5,280 feet, equals 63,360 inches.

1 acre equals 0.4047 hectare.

1 acre equals 43,560 square feet.

1 acre equals 209 feet square, nearly.

1 square mile equals 2.59 square kilometers, equals 27,878,400 square feet.

1 cubic foot equals 0.0283 cubic meter, equals 7.4805 U. S. gallons.

1 cubic foot of water weighs 62.4 pounds.

1 cubic meter per minute equals 0.5886 second-foot.

1 U. S. gallon equals 2.31 cubic inches, equals 0.1337 cubic feet.

1 lb. per square inch equals 2.304 feet head.

1 foot head equals 0.434 lbs. per square inch.

1 grain per gallon equals 17.138 parts per million.
1 part per million equals .0583 grains per gallon.
Miles per hour × 1.467 equal feet per second.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1.34 horsepower equals 1 kilowatt.
1 cent per kilowatt-hour equals $87.60 per kilowatt-year.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ =net horsepower on water wheel realizing 80 per cent of theoretical power.

Office Methods of Computing and Studying Discharge and Run-Off.

At the end of each year the field or base data for current-meter gaging stations, consisting of daily gage heights, discharge measurements, and notes from observers' books are assembled. The measurements are plotted on cross-section paper and rating curves are drawn. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharge, and from these applications the tables of monthly discharge and run-off are computed.

Rating curves are drawn and studied with special reference to the class of channels which they represent. The discharge measurements for all classes of stations, when plotted with gage heights in feet as ordinates and discharges in second-feet as abscissas, define rating curves which are generally more or less parabolic in form. For many stations curves of area in square feet and mean velocity in feet per second are also constructed to the same scale of ordinates as the discharge curve. These are used mainly to extend the discharge curves beyond the limits of the plotted discharge measurements, to check the form of the discharge curve, and to determine and eliminate erroneous measurements.

For every rating table the following assumptions are made for the period of application of the table: (a) That the discharge is a function of and increases gradually with the stage; (b) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating is not applicable for periods during which the channel was obstructed; (c) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock and is not subject to the deposit of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will for all practical purposes be a true index of the discharge. Discharge measurements made at such stations usually plot within 2 or 3 per cent of the mean discharge curve, and the rating developed from that curve represents a very high degree of accuracy.

Class 2 comprises mainly stations on rough, mountainous streams with steep slopes. The beds of such streams are, as a rule, comparatively permanent during low and medium stages, and when the flow is sufficiently well defined by an adequate number of discharge measurements before and after each flood the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the few days of highest gage heights covering the period of actual change in conditions of flow.

Class 3 includes those stations where the stream bed is of a shifting character, or the controlling section below the gage frequently changes owing to cutting out by the current and the filling in of sand, gravel, and drift. In some cases changes are caused by the growth of vegetation in the stream bed. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly on the basis of the measurements of the current year, the engineer being guided largely by the history of the station and the following general law; if all measurements ever made at a station of this class are plotted on cross-section paper, they will define a mean curve which may be called a standard curve. It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to ordinates or gage heights. This law of the parallelism of rating curves is the fundamental basis of all ratings and estimates at stations with semi-permanent and shifting channels. It is not absolutely correct, but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. The law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut or fill, or both, at or near the measuring section. For all except small streams the changes in section usually occur at the bottom. The following simple but typical examples illustrate this law:

(a) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section, there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases all three values of discharge, area, and velocity for any gage height. In practice, however, such ideal conditions rarely exist.

(b) In the case of a cut or fill at the measuring section, there is a marked tendency toward decrease or increase, respectively, of the velocity. In other words, the velocity has a compensating effect, and if the compensation is exact at all stages the discharge at a given stage will be the same under both the new and old conditions.

(c) In the case of uniform change along the crest of a weir or rocky control, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve.

Of course, in actual practice such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another, and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of rating curves. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that in the lack of other data to the contrary the utilization of this law will yield the most probable results.

Slight changes at low or medium stages of an occillating character are usually averaged by a mean curve drawn among them parallel to the standard curve and if the individual measurements do not vary more than 5 per cent from the rating curve the results are considered good for stations of this class.

Class 4 comprises stations on streams that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency ranging from a measurement every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. These measurements are plotted and a mean or standard curve drawn among them. It is assumed that there is a different rating curve for every day of the year and that this rating is parallel to the standard curve. On the day of a measurement the rating curve for that day passes through that measurement. For days between successive measurements it is assumed that the rate of change is uniform, and hence the ratings for the intervening days are equally spaced between the ratings passing through the two measurements. This method must be modified or abandoned altogether under special conditions. Personal judgment and a knowledge of the conditions involved can alone dictate the course to pursue in such cases.

The computations have as a rule been carried to three significant figures. Computation machines and the 20-inch slide rule have been generally used. All computations are carefully checked.

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing periods are filled in, so far as practicable, by means of comparison with records for adjacent streams. The attempt is made to complete years or periods of discharge, thus eliminating fragmentary and disjointed records.

Explanation of Tables.

Distances and depths are measured in feet, and velocities in feet per second. The flow is thus obtained in cubic feet per second, or more briefly in "second-feet." To convert second-feet into million gallons per 24 hours multiply by 0.646.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height, and the corresponding discharge was consequently larger than given in the maximum column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet per second during the month.

Accuracy and Reliability of Field Data and Comparative Results.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous tests and experiments have been made to test the accuracy of current-meter work. These show that it compares very favorably with the results from standard weirs, and, owing to simplicity of methods, usually gives results that are much more reliable than those from the ordinary weir used under conditions widely different from those under which the weir formula was derived.

The work is, of course, dependent on the reliability of the observers. With relatively few exceptions, the observers perform their work honestly. Care is taken, however, to watch them closely and to inquire into any discrepancies. It is, of course, obvious that one or two gage readings a day do not always give the mean height for that day if the stage is changing rapidly. As an almost invariable rule, however, errors from this source are compensating and virtually negligible in a period of one month, although a single day's reading may, when taken by itself, be considerably in error.

Attention is called to the fact that the monthly discharge in second-feet per square mile and the run-off in depth in inches do not represent the natural flow from the basin because of artificial storage. The yearly discharge and run-off doubtless represent more nearly the natural flow for probably little stored water is held over from year to year.

PRECIPITATION, IN INCHES, AT STATIONS IN MAINE, DURING THE YEAR ENDING SEPTEMBER 30, 1916.

STATION.	October.	November.	December.	January.	February.	March.	April.	May.	June.	July.	August.	September.	Annual.
Ashland	2.20	2.26	2.96	1.48	1.28	0.69	1.07	2.65	3.23	5.75	1.21	4.40	29.18
Augusta	3.11	2.21	3.10	1.50	3.70	1.84	2.31	3.84	3.18	3.96	4.03	2.65	35.43
Aziscohos Dam	1.84	1.72	3.08	1.82	1.81	1.55	2.38	4.20	7.15	3.48	3.82	5.27	38.12
Bar Harbor	2.35	4.22	3.50	1.89	3.52	4.35	3.85	3.50	....	....	....	....	.....
Biddeford	1.60	3.1	2.8	1.0	3.1	0.0	6.6	7.6	8.2	3.9	2.0	2.0	41.9
Cambridge	....	2.20	4.23	1.49	2.56	1.62	0.89	5.11	....	....	....	....	.....
Chesuncook	2.43	2.12	3.45	2.03	2.92	1.38	1.80	4.02	2.58	5.37	2.43	3.94	34.47
Cornish	3.50	3.81	4.01	2.09	5.83	4.10	6.23	5.46	7.83	4.53	....	3.88	.....
Danforth	2.03	2.42	3.17	1.90	3.18	1.60	1.82	1.52	4.64	4.88	1.92	3.94	33.02
Eastport	1.86	2.16	3.82	1.86	2.65	1.64	2.57	1.38	3.79	4.87	1.82	2.41	30.83
Ellsworth	2.48	4.24	3.77	1.77	2.53	2.12	3.95	4.98	5.37	4.02	2.57	4.10	41.90
Errol Dam, N. H	2.10	1.82	3.37	2.44	2.80	1.83	2.86	4.63	6.49	4.75	3.98	5.23	42.30
Eustis	1.48	1.95	3.91	1.73	2.85	1.65	2.86	4.75	5.14	3.82	5.58	4.07	39.79
Fairfield	2.50	1.21	2.66	0.89	1.72	1.48	1.52	2.18	2.93	1.75	4.23	3.35	26.42
Farmington	2.32	3.15	4.08	1.49	4.21	2.23	4.28	6.79	5.04	3.95	7.50	5.25	50.29
Gardiner	2.95	3.08	3.74	1.87	3.85	3.25	4.00	4.65	4.45	3.30	3.01	3.14	41.29
Greenville	1.83	2.56	4.84	2.35	3.34	2.35	2.45	4.59	3.99	5.60	2.95	4.23	41.08
Houlton	1.52	1.46	3.85	2.15	3.20	0.95	1.35	1.09	2.62	4.32	1.57	1.42	25.50
Howe Brook	2.34	2.11	1.75	0.57	1.66	2.50	1.50	2.39	2.77	5.13	1.76	3.01	27.49
Langtown	....	....	....	....	....	....	....	3.21	4.35	3.23	4.19	4.02	.....
Lewiston	2.83	3.55	3.99	2.18	4.64	2.49	4.76	6.46	4.65	3.35	2.69	2.99	44.58
Livermore Falls	2.20	2.64	3.59	1.46	4.56	1.79	4.18	6.15	6.03	5.77	9.01	6.13	53.51
Madison	2.46	2.94	3.39	1.84	3.91	2.05	4.32	6.73	5.14	3.28	6.93	5.12	48.11
Middle Dam	2.06	2.26	3.19	1.31	2.31	1.32	2.68	5.02	6.18	3.65	4.76	5.00	39.74
Millinocket	2.08	2.85	4.40	1.57	2.98	1.64	2.39	4.01	2.93	5.68	2.35	3.38	36.26
Mirror Lake	2.30	4.76	3.59	1.77	2.79	2.12	4.55	7.00	6.98	4.44	1.90	3.20	45.40
North Bridgton	2.15	2.87	4.03	1.67	4.36	2.51	5.04	6.45	6.95	3.58	7.83	4.84	52.28
Oquossoc	1.80	1.70	1.39	1.43	2.60	....	....	....	....	....	....	....	.....
Orono	2.62	3.04	3.57	2.59	2.61	2.45	3.63	4.42	4.99	4.39	2.27	4.60	41.18
Patten	4.20	2.30	2.40	0.70	2.40	1.50	1.54	2.80	2.80	6.20	2.80	2.60	32.24
Pontocook Dam, N. H	2.12	2.30	3.51	2.71	3.02	2.07	2.65	4.06	7.18	6.31	5.18	4.92	46.03
Portland	1.49	2.77	4.87	2.15	4.30	5.22	5.56	5.64	6.32	3.82	2.14	1.47	45.75
Presque Isle	1.75	2.19	4.05	2.20	2.35	1.10	1.75	3.44	2.17	3.68	1.70	....	.....
Rumford	1.79	2.30	3.47	1.33	4.11	1.88	3.98	5.87	6.97	3.76	6.36	4.35	46.17
Songo	2.72	2.67	4.32	1.42	4.27	3.58	5.22	5.48	5.20	2.80	2.76	5.82	46.26
The Forks	1.20	1.50	3.90	....	2.70	1.70	3.00	3.70	3.10	4.83	2.93	6.13	.....
Upper Dam	1.59	1.87	3.04	0.89	2.15	2.03	2.48	5.20	5.18	3.30	3.97	3.86	35.56
Van Buren	2.44	2.06	3.79	2.69	2.20	1.80	1.40	4.85	2.25	7.34	1.69	3.33	35.84
Winslow	3.15	1.94	3.40	1.07	2.83	0.94	2.72	3.67	3.35	3.69	4.41	3.78	34.95
Woodland	2.13	4.25	2.13	0.77	2.50	0.0	2.03	2.50	5.73	6.69	2.42	4.07	35.22

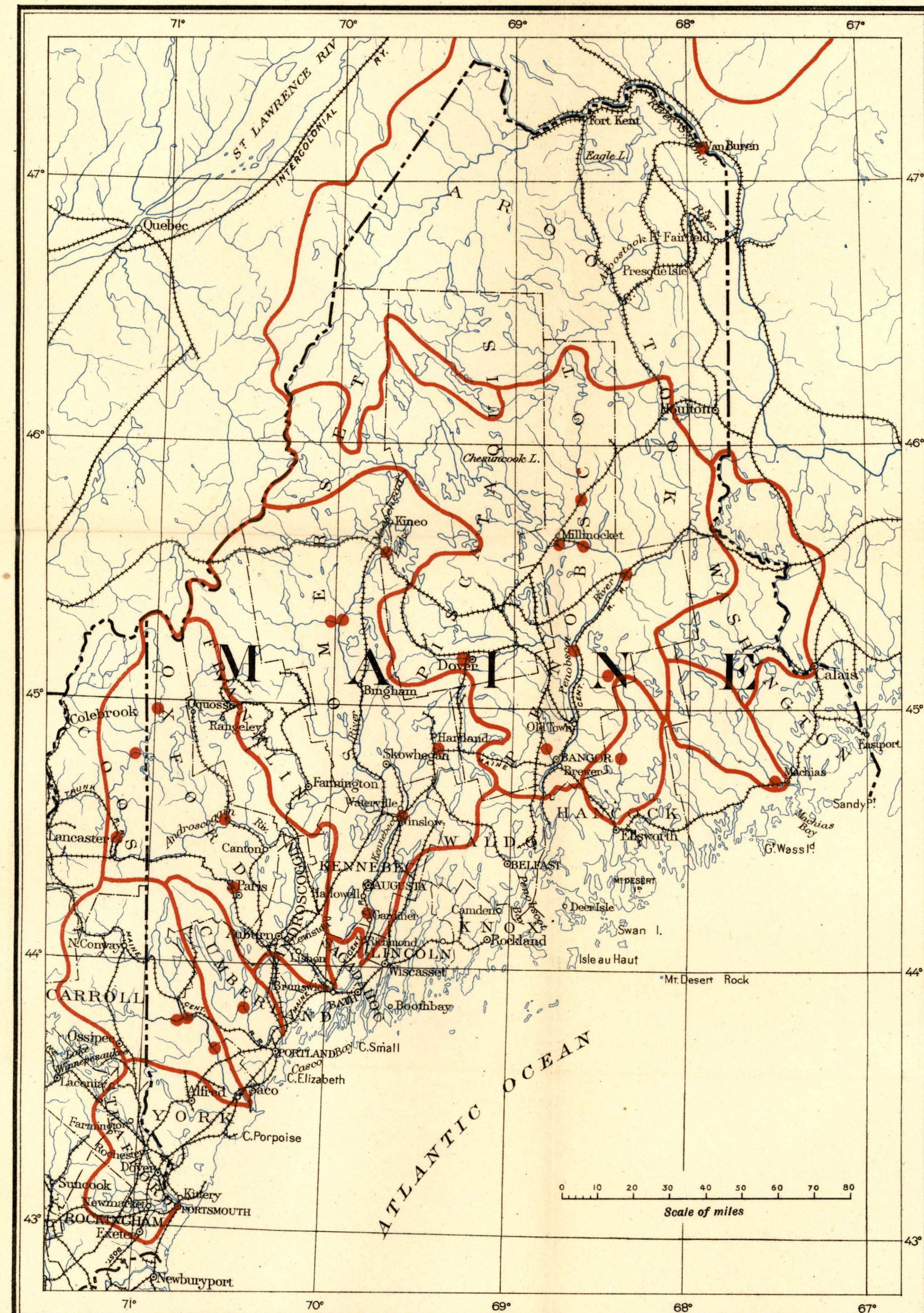
EVAPORATION.

An attempt to study the laws governing evaporation was made by the establishment of a station on June 4, 1915, at the gaging station for the Cobbosseecontee Stream at Gardiner, where the actual evaporation from a tank was measured, meteorological data kept, and the run-off of the stream computed. The records include maximum and minimum air temperatures, water temperatures in the tank and in the stream, precipitation records, and anemometer and psychrometer readings from June 4th to November 17th, 1915 and May 1 to November 14, 1916. The tank was constructed from U. S. Weather Bureau designs, and a standard weather bureau hook gage was used. Monthly records are published herewith.

Evaporation at Gardiner, Maine.

1915.	Evaporation in inches.	Mean daily evaporation in inches.	Mean wind velocity in miles per hour.	Mean per cent. humidity.	Precipitation in inches.	Mean daily precipitation in inches.	Mean Temperature.	
							Air.	Water.
June 5-30	3.87	.146	1.10	72	2.06	.078	57.8	68.2
July	3.99	.129	.93	79	9.17	.296	63.2	71.3
August	3.35	.108	.67	82	3.92	.126	61.7	69.3
September	3.40	.113	1.13	88	1.21	.040	58.0	64.8
October	1.90	.061	1.00	90	2.95	.095	45.3	51.7
November 1-17	1.19	.070	1.97	87	1.21	.071	38.4	42.3
1916.								
May	4.15	.134	1.15	79.2	4.69	.151	54.3	58.1
June	4.07	.136	0.44	83.4	4.47	.149	60.4	65.9
July	4.52	.146	0.97	83.5	3.33	.107	70.4	74.1
August	4.43	.143	0.79	81.8	3.03	.098	69.0	72.7
September	4.30	.143	1.26	85.2	3.15	.105	60.0	63.1
October	2.49	.080	1.05	85.5	2.59	.084	50.1	51.8
Nov. 1-14	0.69	.051	0.89	88.8	0.73	.054	38.7	40.8

Humidity readings missing July 13-15, August 21 to September 6, 1915 due to broken psychrometers. Figures given are average for days when observations were made.



EXTRACT FROM U.S.G.S. BASE MAP

GAGING STATIONS IN MAINE, SEPT. 30, 1916

GAGING STATIONS.

Note.—Dash after a date indicates that station was being maintained September 30, 1916. Period after a date indicates discontinuance.

ST. JOHN RIVER BASIN.

St. John River near Dickey, 1910-11.
St. John River at Fort Kent, 1905-16.
St. John River at Van Buren, 1908—
Allagash River near Allagash, 1910-11.
St. Francis River at St. Francis, 1910-11.
Fish River at Wallagrass, 1903-1908; 1911.
Madawaska River at St. Rose du Degele, Quebec, 1910-1911.
Aroostook River at Fort Fairfield, 1903-1910.

ST. CROIX RIVER BASIN.

St. Croix River near Woodland, 1902-1911.
St. Croix River at Baring 1913-1915.
West Branch, St. Croix River at Baileyville, 1910-1912.

MACHIAS RIVER BASIN.

Machias River at Whitneyville, 1903—

UNION RIVER BASIN.

Union River, West Branch (head of Union River), at Amherst, 1909—
Union River, West Branch, near Mariaville, 1909.
Union River at Ellsworth, 1909-10.
Union River, East Branch, near Waltham, 1909.
Webbs Brook at Waltham, 1909.
Green Lake (head of Green Lake Stream) at Green Lake, 1909—
Green Lake Stream at Lakewood, 1909—
Branch Lake (head of Branch Lake Stream) near Ellsworth, 1909-1915.
Branch Lake Stream near Ellsworth, 1909-1915.

PENOBSCOT RIVER BASIN.

Penboscot River, West Branch (head of Penobscot), at Millinocket, 1901—
Penobscot River, West Branch at Medway, 1916—
Penobscot River at West Enfield, 1901—
Penobscot River at Sunk Haze rips, near Costigan, 1899-1900.
Penobscot River, East Branch, at Grand Lake Dam, 1912.
Penobscot River, East Branch, at Grindstone, 1902—
Mattawamkeag River at Mattawamkeag, 1902—

Piscataquis River near Foxcroft, 1902—

Passadumkeag River at Lowell, 1915—

Cold Stream Pond (head of Cold Stream), 1900-1911 (record of opening and closing of pond).

Cold Stream at Enfield, 1904-1906.

Kenduskeag Stream near Bangor, 1908—

Phillips Lake outlets at Holden and Dedham, 1904-1908.

COASTAL BASIN, NO. 3.

St. George River near Union, 1913-1915.

KENNEBEC RIVER BASIN.

Moose River (head of Kennebec River) at Rockwood, 1902-1908; 1910-1912.

Moosehead Lake at East outlet, 1895— (stage only).

Kennebec River at The Forks, 1901—

Kennebec River at Bingham, 1907-1910.

Kennebec River at North Anson, 1901-1907.

Kennebec River at Waterville, 1892—

Kennebec River at Gardiner, 1785-1910 (record of opening and closing of navigation).

Roach River at Roach River, 1901-1908.

Dead River at The Forks, 1901-1907; 1910—

Carrabassett River at North Anson 1901-1907.

Sandy River at Farmington 1910-1916.

Sandy River at Madison, 1904-1908.

Sebasticook River at Pittsfield, 1908—

Messalonskee Stream at Waterville, 1903-1905.

Cobbosseecontee Lake, 1839-1911 (dates of opening and closing).

Cobbosseecontee Stream at Gardiner, 1890—

ANDROSCOGGIN RIVER BASIN.

Rangeley Lake (head of Androscoggin River), 1879-1911 (dates of opening and closing).

Androscoggin River at Errol Dam, N. H., 1905—

Androscoggin River at Berlin, N. H., 1913—

Androscoggin River at Gorham, N. H., 1903, (fragmentary).

Androscoggin River at Shelburne, N. H., 1903-1907 and 1910.

Androscoggin River at Rumford Falls, 1892—

Androscoggin River at Dixfield, 1902-1908.

Auburn Lake, 1890-1911 (date of opening).

Little Androscoggin River near South Paris, 1913—

Magalloway River at Aziscohos Dam 1912—

PRESUMPSCOT RIVER BASIN.

Presumpscot River at outlet of Sebago Lake, 1887—

SACO RIVER BASIN.

Saco River near Center Conway, N. H., 1903-1912.
Saco River at West Buxton, 1907—
Saco River at Cornish, 1916—
Ossipee River at Cornish, 1916—

ST. JOHN RIVER BASIN

"The International Commission pertaining to the St. John River which was appointed in 1909 "to investigate and report upon the conditions and uses of the St. John River and to make recommendations for the regulation of the use thereof by the citizens and subjects of the United States and Great Britain, according to the provisions of treaties between the two countries" has finally reported to the Congress of the United States. This report contains data of value relative to the water resources of the St. John River Basin, the details of which are not, at this time, available for use in this office."

St. John River at Fort Kent, Maine.

Location.—At suspension footbridge in town of Fort Kent, a short distance above Fish River and about 15 miles below St. Francis River.

Drainage Area.—4,880 square miles; not including 270 square miles of Chamberlain Lake drainage area which is partly tributary to Penobscot basin (See Water Supply Paper 281, p. 28).

Records Available.—October 13, 1905, to December 31, 1915.

Gage.—Inclined staff, 22 feet long, in two sections, attached to the new concrete pier nearest New Brunswick shore of river. The lower part of the gage is placed in a groove in side of pier; the upper part is fastened to down-stream end of same pier. The gage datum has remained unchanged during the maintenance of the station. Gage read by F. L. Hamilton.

Channel and Control.—Practically permanent; both banks high, rocky, cleared, and not subject to overflow except in extreme freshets.

Discharge Measurements.—Made from footbridge.

Ice.—Stage-discharge relation seriously affected by ice.

Regulation.—A few dams on the upper headwaters are used for log driving; the operation of these dams only slightly affects the flow past the gage. No corrections applied.

ACCURACY.—Stage-discharge relation practically permanent; occasionally affected by backwater caused by logs jamming on bridge piers and, during the winter, by ice. Gage read to tenths twice daily. Rating curve well defined below 15,000 second-feet, poorly defined between 15,000 and 90,000 second-feet.

DAILY DISCHARGE, IN SECOND-FEET, OF ST. JOHN RIVER, AT FORT KENT, MAINE, FOR OCTOBER 1 TO DECEMBER 31, 1915.

Day.	October.	November.	December.
1	12,100	7,500	5,040
2	10,300	7,660	5,320
3	9,040	8,340	4,240
4	8,000	7,660	4,900
5	8,340	7,330	4,900
6	10,300	6,690	4,760
7	11,100	6,070	4,630
8	10,500	5,320	4,630
9	7,830	4,900	4,110
10	6,070	4,500	3,740
11	4,900	4,110	3,030
12	4,370	4,110	2,140
13	4,110	4,370	2,140
14	3,610	4,900	2,140
15	3,490	4,760	2,510
16	3,490	4,500	2,510
17	3,860	4,370	2,610
18	3,490	4,370	3,030
19	3,370	4,110	2,920
20	3,610	3,860	2,510
21	3,610	4,370	2,510
22	4,110	4,370	2,320
23	5,770	4,370	2,320
24	5,470	4,370	2,510
25	5,180	3,860	2,710
26	4,370	3,490	2,710
27	4,370	3,140	2,710
28	4,370	3,610	2,700
29	4,630	3,740	2,700
30	5,920	4,500	2,700
31	6,380	....	2,700
Total	186,060	149,250	100,400

NOTE.—Discharge estimated December 28-31.

MONTHLY DISCHARGE OF ST. JOHN RIVER AT FORT KENT, MAINE, OCTOBER 1 TO DECEMBER 31, 1915.
[Drainage area, 4,880 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	12,100	3,370	6,000	1.23	1.42
November	8,340	3,140	4,980	1.02	1.14
December	5,320	2,140	3,240	.664	.77

ST. JOHN RIVER AT VAN BUREN, MAINE.

LOCATION.—At new International Bridge at Van Buren, Maine, about 14 miles above Grand Falls, New Brunswick.

DRAINAGE AREA.—8,270 square miles.

RECORDS AVAILABLE.—May 4, 1908, to September 30, 1916.

GAGE.—Painted vertically on second pier from Van Buren side of bridge; zero of gage is 407.69 feet above sea level. Previous to May 6, 1912, gage heights were read on a vertical rod attached to the pier of the sawdust carrier of Hammonds mill, about 700 feet below the International Bridge, but as published they are reduced to the bridge datum. Gage read by W. H. Scott.

DISCHARGE MEASUREMENTS.—Made from International Bridge.

ICE.—Stage-discharge relation seriously affected by ice. Estimate of winter flow based on gage heights observed at Grand Falls, N. B.

REGULATION.—The little storage above for log driving probably does not affect the discharge.

ACCURACY.—Stage-discharge relation probably permanent. Gage read to half tenths twice daily. Results considered good.

COÖPERATION.—Station established by the International Commission, River St. John, and maintained by that Commission until May 6, 1912. Winter gage heights at Grand Falls furnished by H. S. Ferguson, consulting engineer, New York City.

ST. JOHN RIVER AT VAN BUREN, MAINE.

The following discharge measurements were made:

DATE		GAGE HEIGHT	DISCHARGE
1916	Feb. 10	6.20	46.20

DAILY DISCHARGE, IN SECOND-FEET, OF ST. JOHN RIVER AT VAN BUREN, FOR THE YEAR ENDING SEPT. 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1........	20,300	12,300	11,200	6,970	4,700	4,160	8,790	65,100	27,600	12,900	7,720	1,890
2........	17,900	13,500	11,000	6,970	4,890	4,510	9,790	61,600	28,800	11,500	6,880	1,890
3........	16,000	13,600	10,800	6,970	5,090	4,990	9,960	61,600	27,200	10,600	5,820	1,890
4........	14,400	13,500	10,500	6,840	5,090	5,290	10,500	61,400	24,200	11,500	5,250	1,960
5........	13,000	12,600	10,700	6,840	5,090	5,720	10,800	56,800	22,900	13,900	5,030	2,360
6........	12,800	12,100	11,200	6,700	5,090	6,190	12,300	51,200	21,200	18,800	5,360	2,200
7........	15,700	11,500	10,300	6,440	5,190	6,190	13,900	46,800	20,800	19,200	6,640	2,200
8........	16,000	10,700	9,790	6,320	5,090	6,190	14,700	46,500	21,000	17,100	7,240	2,440
9........	15,200	10,200	9,450	6,190	4,890	6,320	16,100	44,800	19,700	14,600	7,360	2,530
10........	13,200	9,630	8,790	5,950	4,700	6,700	17,200	41,300	17,900	13,000	7,360	2,530
11........	11,400	9,240	7,250	5,610	4,600	6,700	18,500	37,700	16,600	11,900	7,000	2,200
12........	9,500	8,980	5,840	5,500	4,510	6,570	19,400	33,900	16,500	11,100	6,760	2,530
13........	9,240	9,500	4,510	5,500	4,330	6,440	20,100	31,500	15,400	9,890	6,160	2,440
14........	9,240	9,760	5,500	5,500	4,080	6,190	20,300	29,200	14,600	8,980	5,360	2,200
15........	8,980	9,500	5,500	5,400	3,990	5,720	21,600	27,000	13,900	7,970	4,590	2,040
16........	8,980	9,760	5,720	5,400	3,820	5,400	22,800	24,700	12,800	6,880	4,160	2,200
17........	8,720	9,630	5,400	5,090	3,660	5,290	24,100	23,400	11,800	6,640	3,840	2,040
18........	8,470	9,370	5,840	4,890	3,660	5,290	28,300	25,100	11,100	6,160	3,540	1,890
19........	8,470	8,850	6,440	4,700	3,660	5,090	46,000	27,800	11,400	5,820	3,540	2,440
20........	8,400	8,220	6,700	4,700	3,350	4,700	52,500	27,800	11,100	5,700	3,250	2,360
21........	8,470	8,850	7,400	4,510	3,280	4,600	58,300	30,200	12,500	5,940	3,060	2,200
22........	8,980	9,370	5,950	4,330	3,200	4,330	60,800	28,600	13,300	6,520	3,250	2,360
23........	9,370	9,110	5,610	4,330	3,200	3,990	67,800	26,000	14,100	6,880	2,880	2,360
24........	9,370	8,600	5,500	4,510	3,200	3,500	74,400	23,600	13,900	7,840	2,620	2,280
25........	9,500	8,790	5,190	4,510	4,800	3,350	79,800	22,000	12,800	8,470	2,280	2,200
26........	9,110	8,310	6,190	4,510	4,800	3,050	84,200	22,400	12,500	21,300	2,120	2,530
27........	8,850	7,840	6,440	4,420	3,200	3,820	84,600	24,000	13,000	15,800	2,360	2,440
28........	8,720	7,690	7,840	4,330	3,350	4,510	81,300	21,700	13,300	11,800	2,280	2,360
29........	8,720	9,620	8,100	4,240	3,660	5,950	76,200	21,000	13,600	10,200	2,530	2,200
30........	9,110	10,700	7,540	4,240	....	6,700	70,500	20,600	13,200	9,240	2,280	2,040
31........	10,400	....	6,840	4,330	....	8,100	....	24,200	....	8,600	2,040	....

MONTHLY DISCHARGE OF ST. JOHN RIVER AT VAN BUREN, ME., FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 8,270 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	20,300	8,400	11,200	1.35	1.56
November	13,600	7,690	10,000	1.21	1.35
December	11,200	4,510	7,580	0.917	1.06
January	6,970	4,240	5,380	0.651	0.75
February	5,190	3,200	4,210	0.509	0.55
March	8,100	3,050	5,340	0.646	0.74
April	84,600	8,790	37,900	4.58	5.11
May	65,100	20,600	35,200	4.26	4.91
June	28,800	11,100	16,600	2.01	2.24
July	21,300	5,700	10,900	1.32	1.52
August	7,720	2,040	4,530	0.548	0.63
September	2,530	1,890	2,240	0.271	0.30
The year	48,600	1,890	12,600	1.52	20.72

NOTE.—Ice conditions November 25 to April 18, inclusive—Discharge applied during frozen season from gage heights at Grand Falls, N. B., by means of a rating curve based on discharge measurements at Van Buren. Maximum discharge—84,900 G. H. corresp. 21.6 April 26-27, 1916. Minimum discharge—1,820 G. H. corresp. 1.45 September 1-2, 1916.

MACHIAS RIVER BASIN.

Machias River at Whitneyville, Maine.

Location.—At wooden highway bridge in the town of Whitneyville; 4 miles above Machias; 200 feet below a storage dam.

Drainage Area.—465 square miles.

Records Available.—October 17, 1903, to September 30, 1916.

Gage.—Chain installed on wooden highway bridge October 10, 1911; prior to October 3, 1905, chain gage on the Washington County railroad bridge, three-fourths mile down stream. Backwater was occasionally experienced here from the dam at Machias, and on October 3, 1905, a staff gage was installed on the highway bridge at datum of present chain gage. Gage read by I. S. Albee.

Channel and Control.—Practically permanent.

Discharge Measurements.—Made from railroad bridge. Low-water measurements may be made by wading at a point 200 feet above the railroad bridge.

Ice.—River does not ordinarily freeze over at the gage, and stage-discharge relation is not usually affected by ice.

Regulation.—Opening and closing of gates in storage dam immediately above station during low stages causes considerable fluctuation.

Accuracy.—Stage-discharge relation practically permanent; probably affected by log jams of short duration in the spring. Gage read to tenths once daily. Results considered fair. Rating curve well defined between 100 and 4,000 second-feet.

Machias River at Whitneyville, Maine.

The following discharge measurements were made:

Date		Gage Height	Discharge
1916	Jan. 21	3.60	302
	March 1	5.20	1050
	March 14	4.00	444
	April 18	5.41	1500

DAILY DISCHARGE, IN SECOND-FEET, OF MACHIAS RIVER, AT WHITNEYVILLE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	267	178	654	1,230	412	1,050	2,530	1,360	1,780	1,040	626	626
2	267	221	626	1,100	412	800	2,440	1,430	1,710	1,100	571	626
3	314	221	626	981	387	740	2,360	1,430	1,640	1,230	517	626
4	362	267	626	860	387	682	2,270	1,490	1,560	1,430	517	626
5	362	267	571	682	412	626	2,180	1,430	1,490	1,560	517	598
6	517	267	517	626	412	626	2,100	1,430	1,430	1,360	517	571
7	517	267	517	571	412	626	1,940	1,430	1,230	1,100	464	517
8	464	267	490	517	412	571	1,780	1,490	1,040	981	464	517
9	464	244	464	412	314	517	1,780	1,640	1,040	920	517	517
10	464	244	412	362	314	490	1,640	1,710	1,100	860	464	464
11	412	221	362	362	362	490	1,560	1,780	1,780	800	412	464
12	362	221	314	362	362	490	1,560	1,860	2,360	740	362	464
13	314	221	267	362	412	438	1,640	2,020	2,100	626	314	464
14	267	221	221	387	412	438	1,670	2,020	1,780	517	412	464
15	267	267	221	412	412	438	1,710	2,020	1,290	464	412	464
16	267	314	221	412	362	464	1,640	2,020	800	412	412	517
17	267	314	221	412	314	464	1,560	2,100	682	800	412	981
18	267	314	221	387	314	490	1,490	4,380	1,430	800	314	860
19	314	517	1,290	362	314	490	2,530	3,880	2,360	740	267	740
20	362	740	1,360	362	314	517	2,800	3,280	2,360	682	221	682
21	412	800	1,360	314	314	571	2,440	2,890	2,020	626	314	626
22	412	800	1,170	314	314	598	1,940	2,620	1,560	571	362	571
23	412	800	981	314	338	626	1,490	2,440	1,360	517	314	571
24	362	770	860	314	362	626	1,490	2,800	1,040	1,230	314	682
25	314	740	800	338	362	626	1,560	2,890	682	2,620	267	860
26	267	740	860	362	517	682	1,430	2,620	1,040	1,940	267	860
27	221	740	2,180	362	860	800	1,290	2,180	1,040	1,780	267	740
28	178	682	2,100	387	1,290	920	1,230	2,020	1,100	1,430	464	682
29	178	682	1,780	412	1,170	1,230	1,230	1,940	1,170	981	800	626
30	178	682	1,490	412	....	1,640	1,290	1,860	1,100	860	740	517
31	178	....	1,360	412	....	2,100	....	1,780	....	682	682	....

MONTHLY DISCHARGE OF MACHIAS RIVER AT WHITNEYVILLE FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 465 square miles.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	517	178	329	0.708	0.82
November	800	178	440	0.946	1.06
December	2,180	221	811	1.74	2.01
January	1,230	314	487	1.05	1.21
February	1,290	314	448	0.964	1.04
March	2,100	438	705	1.52	1.75
April	2,800	1,230	1,820	3.91	4.36
May	4,380	1,360	2,140	4.60	5.30
June	2,360	682	1,440	3.10	3.46
July	2,620	412	1,010	2.17	2.50
August	800	221	436	0.938	1.08
September	981	464	617	1.33	1.48
The year	4,380	178	890	1.91	26.07

NOTE.—Ice conditions February 1 to March 19 inclusive.
Maximum discharge—4,380 G. H. corresp. 8.8 May 18, 1916.
Minimum discharge—178 G. H. corresp. 3.3 October 28–November 1, 1915.

UNION RIVER BASIN.

UNION RIVER, WEST BRANCH, AT AMHERST, MAINE.*

LOCATION.—At highway bridge three-fourths mile west of Amherst post office on road to Bangor, about one mile below highway bridge at old tannery dam.

DRAINAGE AREA.—140 square miles.

RECORDS AVAILABLE.—July 25, 1909, to September 30, 1916.

GAGE.—Standard chain, installed June 2, 1910, at same datum as old vertical gage nailed to a log abutment; read by Mrs. Emma Sumner.

CHANNEL AND CONTROL.—Gravel, unlikely to change except in unusual flood.

DISCHARGE MEASUREMENTS.—Made from downstream side of the bridge.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—A few log-driving dams above the station, but the regimen of stream is only slightly affected by them.

ACCURACY.—Stage-discharge relation practically permanent; subject to occasional backwater from log jams. Rating curve well defined below 1100 second-feet; discharge values above that point should be used with caution. Gage read to half tenths twice daily.

* Published in reports for 1912 to 1915 as "Union River at Amherst."

UNION RIVER, WEST BRANCH, AT AMHERST, MAINE.

The following discharge measurements were made:

	DATE	GAGE HEIGHT	DISCHARGE
1916	Jan. 25	9.08	171
	March 2	8.71	239
	March 21	7.77	97
	Sept. 20	6.40	159

Daily Discharge, in Second-feet, of Union River, West Branch, at Amherst, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	78	72	190	669	190	264	984	461	284	217	96	31
2	59	72	173	656	190	236	1,020	438	245	208	90	28
3	47	72	173	643	182	140	830	415	190	226	83	28
4	44	72	156	630	173	72	724	392	190	264	72	28
5	37	63	156	380	173	96	682	369	190	304	63	37
6	40	59	156	347	156	125	630	347	173	304	63	34
7	44	55	156	336	140	125	605	336	156	254	55	34
8	72	55	148	325	110	125	580	325	140	226	55	34
9	72	51	148	304	90	132	556	304	125	208	72	47
10	68	226	173	304	78	140	532	294	125	190	72	40
11	68	164	208	304	72	148	508	284	132	182	63	40
12	68	125	226	294	63	140	592	226	125	156	55	34
13	63	110	226	294	55	140	630	190	164	125	55	34
14	63	110	245	284	47	132	682	190	156	110	55	31
15	59	140	226	264	44	125	656	190	148	110	47	31
16	59	125	226	245	40	118	605	190	140	125	40	284
17	55	118	226	226	34	118	618	190	125	156	40	140
18	51	118	304	208	31	110	682	274	284	156	37	125
19	51	156	347	190	26	118	798	404	369	140	34	190
20	51	208	304	190	26	125	862	369	415	132	34	156
21	47	254	304	190	23	103	814	336	392	125	31	140
22	47	254	304	190	23	90	768	304	336	118	28	125
23	47	264	304	182	23	96	738	294	304	125	28	125
24	51	264	314	182	28	103	630	325	284	173	47	125
25	44	245	347	173	34	110	580	325	245	190	40	110
26	44	208	484	173	40	132	605	314	226	208	40	90
27	51	173	738	182	110	156	592	314	226	208	40	83
28	68	173	738	182	284	226	556	304	217	190	40	72
29	72	190	724	190	264	314	532	284	245	148	40	63
30	78	190	710	190	....	605	484	284	245	125	37	59
31	78	....	879	190	....	783	....	325	....	110	34	....

MONTHLY DISCHARGE OF UNION, WEST BRANCH RIVER AT AMHERST, ME., FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 140 square miles.]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	78	37	57	0.407	0.47
November	264	51	146	1.04	1.16
December	879	148	323	2.31	2.66
January	669	173	294	2.10	2.42
February	284	23	95	0.678	0.73
March	783	72	176	1.26	1.45
April	1,020	484	669	4.78	5.33
May	461	190	309	2.21	2.55
June	415	125	220	1.57	1.75
July	304	110	178	1.27	1.46
August	96	28	51	0.364	0.42
September	284	28	80	0.571	0.64
The year	1,020	23	217	1.55	21.04

NOTE.—Ice conditions December 10 to 15 and 26 to 29; January 1 to April 1 inclusive.
Maximum discharge—1,110 G. H. corresp. 10.1 April 2, 1916.
Minimum discharge—23 G. H. corresp. 7.7 February 21-23, 1916.

PENOBSCOT RIVER BASIN.

Ripogenus Dam.

From information furnished by H. S. Ferguson, Consulting Engineer, New York.

By Chapter 206, Private and Special Laws for 1907, the West Branch Driving and Reservoir Dam Company was authorized to erect a dam at the outlet of Ripogenus Lake to such height as would raise the water four and one-half feet above the maximum level of Chesuncook Lake as flowed by the present Chesuncook Dam. This structure has been recently completed, and a plan and statement filed with the Commission. This dam is of concrete and is approximately 700 feet long between abutments, with earthen embankments extending beyond each abutment about 75 feet, making the total length of the construction about 850 feet. The maximum height of the dam on the floor of the operating bridge, at the point where the foundations are deepest, is about 80 feet. The dam is designed for a maximum high water elevation of 940, which is four and one-half feet higher than the highest elevation sustained by the present dam at the outlet of Chesuncook Lake. The dam is provided with four west gates, each having 75 square feet of area. The bottom of these gates is at elevation 885, or 55 feet below the proposed high water line. There is a spillway having a clear width of 442 feet. The crest of the spillway is at elevation 932, or eight feet below the proposed high water line. Flow from the crest of this spillway will be controlled by stop-logs handled from an operating bridge above the crest.

This dam will raise the water level of Ripogenus Lake about 40 feet above its present high water mark, and when the reservoir is full Ripogenus and Chesuncook Lakes will form a single body of water having an area of about 38 square miles.

The area of land which will be flowed when the water in the reservoir is at elevation 940 will be about 3700 acres, in addition to that now flowed by the two dams which the new one replaces. The total volume of water which can be stored by the new dam will be about 25,000,000,000 cubic feet. The effect of this increased reservoir capacity upon the flow of the West Branch of the Penobscot River, and on the entire Penobscot River below the mouth of the West Branch, will be very beneficial. With the storage at present available on the West Branch, the flood period in the spring has already been reduced to about two months in length in an ordinary year. It is expected that hereafter the flow of the West Branch will be very uniform throughout the year of normal flow and that the freshet volume will be very small in those years of extraordinary run-off. This will have a marked effect on the entire river to Bangor, by reducing the tensity of floods and by insuring a substantial flow of water during periods of drought, when the quantity of power which could otherwise be developed at the various power plants along the river would be very deficient.

West Branch of Penobscot River at Millinocket, Maine.

Location.—At Quakish Lake dam and Millinocket mill of the Great Northern Paper Co. at Millinocket, Maine.

Drainage Area.—1,880 square miles.

Records Available.—January 11, 1901, to September 30, 1916.

Gage.—Water-stage recorder at Quakish Lake dam and gages in forebay and tailrace at mill.

Channel and Control.—Crest of concrete dam.

Discharge.—Flow computed by considering flow over dam, through wheels, and water used through log sluices and filters. Wheels rated at Holyoke, Mass., before being placed. As the head, averaging about 110 feet, is much greater than the head under which they were tested, numerous tube-float and current meter measurements in the channel leading to the mill have been made as a check on the wheel ratings. When flow of river is less than 2,500 second-feet, all of the water generally flows through the wheels.

Ice.—Not seriously affected by ice. Ferguson Pond, just above entrance to canal, eliminates effect from anchor ice.

Regulation.—Storage dams at the outlets of North Twin and Chesuncook Lakes store water on surface of 65 square miles with a capacity of about 32 billion cubic feet. Except during time (usually in August) when excess water has to be supplied for log driving on the river below and for a short time during the spring freshet, run-off is regulated by storage. Results corrected for storage.

ACCURACY.—Results considered good.

CO-OPERATION.—Results obtained and computations made by engineers of the Great Northern Paper Co. The Company furnishes values of monthly discharge only.

MONTHLY DISCHARGE AT PENOBSCOT, W. BRANCH RIVER AT MILLINOCKET, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

CORRECTED FOR STORAGE.

[Drainage area, 1,880 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	....	....	1,530	0.814	0.94
November	....	....	1,390	0.739	0.82
December	....	....	2,080	1.11	1.28
January	....	....	1,890	1.00	1.15
February	....	....	1,370	0.729	0.79
March	....	....	1,390	0.739	0.85
April	....	....	7,640	4.06	4.53
May	....	....	6,200	3.30	3.80
June	....	....	3,830	2.04	2.28
July	....	....	3,800	2.02	2.33
August	....	....	2,430	1.29	1.49
September	....	....	1,850	0.984	1.10
The year	....	....	2,950	1.57	21.36

MONTHLY DISCHARGE OF PENOBSCOT, W. BRANCH RIVER AT MILLINOCKET, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 1,880 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	....	....	2,300	1.22	1.41
November	....	....	2,270	1.21	1.35
December	....	....	2,280	1.21	1.40
January	....	....	2,230	1.19	1.37
February	....	....	2,230	1.19	1.28
March	....	....	2,590	1.38	1.59
April	....	....	2,970	1.58	1.76
May	....	....	2,660	1.42	1.64
June	....	....	2,880	1.53	1.71
July	....	....	3,550	1.89	2.18
August	....	....	3,040	1.62	1.87
September	....	....	2,560	1.36	1.52
The year	....	....	2,630	1.40	19.80

West Branch of Penobscot River at Medway, Maine.

Location.—Two miles below East Millinocket and one-half mile above mouth of East Branch.

Drainage Area.—2100 square miles.

Records Available.—February 20, 1916, to September 30, 1916.

Gages.—Chain on left bank; read by A. T. Reed; automatic water stage recorder on left bank installed August 4, 1916.

Discharge Measurements.—Made from cable near gage.

Channel and Control.—Probably permanent.

Winter Flow.—Discharge relation probably not seriously affected by ice.

Regulation.—Flow at station depends on discharge through dams of Great Northern Paper Co. above. Not corrected for storage.

Accuracy.—Rating curve not well defined at present time and publication of discharge is withheld.

West Branch Penobscot River at Medway, Maine.

The following discharge measurements were made:

	Date	Gage Heights	Discharge
1916	Aug. 3	4.20	2920
	Aug. 8	4.46	3950
	Aug. 9	5.10	5500
	Aug. 18	4.45	3910
	Sept. 22	3.70	2520

Penobscot River at West Enfield, Maine.

Location.—At steel highway bridge 3 miles west of railroad station at Enfield, Maine, and 1,000 feet below mouth of Piscataquis River.

Drainage Area.—6,600 square miles.

Records Available.—January 1, 1902, to September 30, 1916.

Gages.—Standard chain attached to highway bridge; Friez water-stage recorder installed on left bank December 11, 1912, at same datum.

Channel and Control.—Practically permanent; broken by four bridge piers; banks high and rocky and not subject to overflow. The control is at Passadumkeag Rips about 5 miles below the gage; a wing dam at this point overflows at about 5.5 feet gage height.

DISCHARGE MEASUREMENTS.—Made from downstream side of bridge.

ICE.—Stage-discharge relation seriously affected by ice; winter flow estimated by comparison with records at Sunkhaze Rips, 20 miles below.

REGULATION.—Flow of river since about 1900 largely controlled by storage in lakes tributary to West Branch. Variations in gate openings at dam of International Paper Co., 1 mile above the gage, and the Piscataquis near its mouth, cause diurnal fluctuation. Results not corrected for storage.

ACCURACY.—Stage-discharge relation practically permanent; results considered good. Rating curve well defined.

CO-OPERATION.—Gage height records and several discharge measurements furnished by Thomas W. Clark, Hydraulic Engineer, Old Town, Maine. Discharge measurements also made by students of the University of Maine under the direction of Professor H. S. Boardman.

PENOBSCOT RIVER AT WEST ENFIELD, MAINE.

The following discharge measurements were made:

	DATE	GAGE HEIGHT	DISCHARGE
1915	Oct. 7	3.05	5480
1916	Apr. 6	11.17	24600
	Apr. 11	7.80	19700
	Sept. 20	2.91	4830
	Sept. 26	2.53	4320

Daily Discharge, in Second-feet, of Penobscot River at West Enfield, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	6,390	6,520	9,570	13,900	6,020	7,710	19,700	16,800	14,600	11,100	9,270	5,650
2	5,890	6,260	9,880	12,300	6,140	7,440	24,700	17,400	13,200	9,880	9,270	5,770
3	5,770	6,140	8,980	10,800	6,020	7,300	26,300	17,400	12,600	9,720	8,680	5,190
4	5,190	5,770	8,680	10,800	6,260	7,040	27,100	16,200	11,100	14,600	8,260	5,190
5	5,420	5,420	8,260	10,500	6,390	6,520	25,200	16,200	10,200	20,400	8,260	5,080
6	5,540	5,190	7,840	10,000	6,140	5,770	24,700	16,800	11,800	20,800	7,710	5,190
7	5,540	4,960	7,840	9,570	5,650	5,770	23,000	16,400	12,000	18,200	7,300	5,300
8	5,540	4,840	7,580	8,830	5,770	6,140	21,300	15,400	10,800	16,600	7,840	4,960
9	5,540	4,840	7,300	8,120	5,890	6,140	21,100	15,800	10,200	16,200	10,500	4,960
10	5,420	4,730	6,650	7,710	6,020	6,390	20,200	15,400	10,500	14,600	11,100	5,080
11	5,540	4,730	5,890	7,980	5,770	6,390	19,300	13,900	12,000	13,000	9,880	5,300
12	5,190	4,730	5,190	7,980	5,540	6,140	20,800	13,500	12,600	13,200	8,830	5,300
13	5,190	4,730	4,730	7,580	5,540	5,420	21,300	12,600	14,800	12,600	8,120	5,080
14	5,080	4,730	5,420	7,300	5,300	5,770	22,500	11,000	14,600	12,300	7,840	4,730
15	4,840	4,730	5,890	6,910	5,080	6,140	23,000	9,570	14,100	12,000	7,040	4,730
16	4,730	5,650	5,770	6,520	4,840	6,140	22,500	9,420	12,800	10,800	7,300	4,730
17	4,620	6,390	5,650	6,390	4,730	6,020	22,700	9,420	12,300	11,000	7,300	5,080
18	4,280	6,140	6,260	6,140	4,730	5,770	27,600	14,200	13,000	12,300	7,170	4,960
19	4,060	5,770	6,650	6,390	4,840	5,540	26,100	23,200	14,600	11,800	6,780	4,960
20	4,620	6,780	6,910	6,390	4,620	5,080	34,100	20,600	15,000	10,700	6,020	5,190
21	4,620	9,720	7,710	6,520	4,280	5,300	31,900	17,800	13,700	9,570	6,020	4,960
22	4,730	10,200	7,710	6,390	4,390	5,540	29,800	16,000	13,900	8,830	5,420	4,730
23	4,960	9,570	7,040	6,260	4,840	5,540	28,400	15,000	12,500	9,120	5,540	4,620
24	4,620	8,680	7,040	5,650	4,730	5,420	29,600	15,400	10,700	8,830	5,890	4,280
25	4,170	8,260	6,910	6,260	4,730	5,540	29,000	15,800	9,720	8,980	5,420	4,280
26	4,170	7,580	8,260	6,520	4,840	5,540	26,500	16,200	10,200	8,830	5,770	4,390
27	4,960	7,300	13,000	6,390	5,650	6,020	25,000	15,000	10,800	10,800	5,770	4,390
28	5,890	7,040	18,600	6,390	6,260	7,580	23,000	14,100	11,100	12,800	5,540	4,280
29	6,390	6,910	17,600	6,390	7,710	9,270	20,800	12,600	12,300	11,800	5,650	4,170
30	6,260	7,840	16,400	6,260	....	11,800	18,600	13,400	12,100	11,500	5,770	4,170
31	6,520	....	14,800	6.140	....	15,800	....	14,400	....	10,300	5,770	....

MONTHLY DISCHARGE OF PENOBSCOT RIVER AT WEST ENFIELD, FOR THE YEAR ENDING SEPTEMBER 30 1916.

[Drainage area, 6660 square miles.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	6,520	4,060	5,220	0.784	0.90
November	10,200	4,730	6,400	0.961	1.07
December	18,600	4,730	8,580	1.29	1.49
January	13,900	5,650	7,780	1.17	1.35
February	7,710	4,280	5,470	0.822	0.89
March	15,800	5,080	6,710	1.01	1.16
April	36,100	18,600	24,900	3.74	4.17
May	23,200	9,420	15,100	2.27	2.62
June	15,000	9,720	12,300	1.85	2.06
July	20,800	8,830	12,400	1.86	2.14
August	11,100	5,420	7,320	1.10	1.27
September	5,770	4,170	4,890	0.734	0.82
The year	36,100	4,060	9,750	1.46	19.94

NOTE.—Ice conditions December 10, 1915 to April 11, 1916, inclusive.
Maximum discharge 36,700 G. H. corresponding 10.40 April 19, 1916.
Minimum discharge 3,950 G. H. corresponding 2.35 October 19, 1915.

East Branch of Penobscot River at Grindstone, Maine.

Location.—At Bangor & Aroostook Railroad bridge half a mile south of railroad station at Grindstone, one-eighth mile above Grindstone Falls, and about 8 miles above mouth (at Medway).

Drainage Area.—1,100 square miles; includes 270 square miles tributary to Chamberlain Lake.

Records Available.—October 23, 1902, to September 30, 1916.

Gage.—Chain attached to railroad bridge. Read by R. D. Porter.

Channel and Control.—Practically permanent; stream confined by abutments of bridge and broken by one pier; velocity medium at moderate and high stages, but sluggish at low water.

Discharge Measurements.—Made from railroad bridge.

Ice.—Stage-Discharge relation seriously affected by ice.

Regulation.—Several dams maintained at outlets of lakes and ponds near source of river are regulated in the interests of log driving; during summer and fall gates are generally left open. Results not corrected for storage and diversions.

Accuracy.—Stage-discharge relation practically permanent; affected by occasional backwater from log jams at station and at Grindstone Falls immediately below. Results considered good for moderate and high stages, but somewhat uncertain for low stages. Rating curve well defined between 300 and 5000 second-feet. Gage read to tenths twice daily.

East Branch Penobscot River at Grindstone, Maine.

The following discharge measurements were made:

	Date	Gage Height	Discharge
1916	Jan. 26	5.50	829
	Feb. 18	5.12	514
	March 20	5.80	709
	Sept. 21	4.60	383

Daily Discharge, in Second-Feet, of Penobscot River, E. Branch, at Grindstone, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	620	650	1,250	1,810	830	1,590	2,880	3,700	2,620	4,090	1,380	560
2	560	620	1,250	1,660	830	1,520	3,700	3,890	2,960	4,290	1,380	533
3	505	560	1,590	1,520	790	1,520	5,120	4,090	3,510	4,490	1,380	533
4	455	505	1,320	1,380	790	1,450	5,120	3,510	3,800	4,910	1,380	560
5	455	505	1,130	1,250	750	1,250	4,490	3,700	4,090	6,660	1,380	505
6	455	455	1,130	1,250	715	1,080	3,890	3,510	4,290	4,700	1,250	505
7	455	455	1,020	1,250	680	920	3,320	3,510	2,450	5,550	1,250	505
8	455	405	1,020	1,250	680	970	3,320	3,510	2,280	5,550	1,250	505
9	455	405	970	1,190	680	970	3,230	3,320	2,280	4,090	1,960	505
10	382	360	920	1,130	680	970	3,140	2,960	2,280	2,960	1,520	505
11	315	360	620	1,080	650	970	3,050	3,140	2,540	2,790	1,320	505
12	315	430	680	1,020	620	970	3,320	3,510	2,790	2,620	1,250	455
13	315	455	920	1,080	590	970	3,510	3,510	2,120	2,450	1,130	405
14	275	455	830	1,080	560	1,250	3,600	2,960	3,890	2,450	1,020	405
15	275	480	750	1,130	560	1,590	3,700	2,450	3,890	2,200	1,020	405
16	275	505	680	1,130	560	1,250	3,700	1,960	4,090	2,200	920	455
17	275	505	680	1,130	560	920	4,290	1,960	3,890	2,120	875	455
18	275	455	620	1,080	505	715	5,660	3,700	2,700	2,120	830	455
19	275	405	715	1,020	455	715	6,540	4,910	3,320	2,120	830	405
20	275	590	830	920	430	715	6,210	4,290	4,090	1,960	830	405
21	295	875	750	830	405	715	5,990	3,890	2,790	1,660	750	405
22	382	1,080	715	750	405	715	5,990	3,700	1,250	1,660	680	405
23	405	1,020	650	750	405	790	5,770	3,700	2,120	1,660	680	360
24	405	920	620	750	405	875	6,210	3,700	2,790	1,520	680	405
25	360	1,380	920	790	405	970	5,770	3,700	4,290	1,380	680	405
26	360	970	1,660	830	405	875	5,120	3,700	3,890	1,660	680	360
27	405	1,020	2,450	830	620	790	4,910	3,700	4,090	2,790	620	405
28	560	970	2,450	830	875	920	4,700	3,510	4,090	2,120	620	360
29	505	970	2,450	830	1,080	1,080	4,290	3,320	3,890	1,810	620	360
30	505	1,190	2,450	830	....	1,520	3,320	3,510	3,890	1,520	560	405
31	560	....	2,120	830	....	2,120	....	3,320	....	1,250	560	....

Monthly Discharge of Penobscot (E. Branch) River at Grindstone, Maine, for the Year Ending September 30, 1916.

[Drainage area, 1100 square miles.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	620	275	400	0.364	0.42
November	1,380	360	665	0.604	0.67
December	2,450	620	1,170	1.06	1.22
January	1,810	750	1,070	0.973	1.12
February	1,080	405	618	0.562	0.61
March	2,120	715	1,090	0.991	1.14
April	6,540	2,880	4,460	4.06	4.53
May	4,910	1,960	3,480	3.16	3.64
June	4,290	1,250	3,230	2.94	3.28
July	6,660	1,250	2,880	2.62	3.02
August	1,960	560	1,010	0.918	1.06
September	560	360	448	0.407	0.45
The year	6,660	275	1,710	1.55	21.16

Note.—Ice conditions December 13 to April 11, inclusive.
Maximum discharge 6,890 G. H. corresponding 8.7 July 5, 1916.
Minimum discharge 275 G. H. corresponding 4.3 October 14-21, 1915.

Mattawamkeag River at Mattawamkeag, Maine.

Location.—At Maine Central Railroad Bridge at Mattawamkeag, half a mile above mouth of river.

Drainage Area.—1,500 square miles.

Records Available.—August 26, 1902, to September 30, 1916.

Gage.—Chain attached to railroad bridge; read by W. T. Mincher.

Channel and Control.—Practically permanent; broken by two bridge piers.

Discharge Measurements—Made from bridge, which is slightly oblique to the current; low water measurements made by wading at a point about 1 mile above the station.

Ice.—Stage-discharge relation seriously affected by ice.

Regulation.—Dams are maintained at outlets of several large lakes and ponds above, but stored water is used only for log driving.

Accuracy.—Stage-discharge relation at times affected by backwater from log jams. Results considered good. Gage read to tenths twice daily. Rating curve well defined below 2600 second-feet.

Mattawamkeag River at Mattawamkeag, Maine.

The following discharge measurements were made:

	DATE.	GAGE HEIGHT	DISCHARGE
1915	Oct. 26	3.92	681
1916	Feb. 5	6.53	786
	March 1	6.78	1220
	March 3	6.90	1320
	May 5	6.61	4160
	June 14	6.02	3130

DAILY DISCHARGE, IN SECOND-FEET, OF MATTAWAMKEAG RIVER AT MATTAWAMKEAG, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1........	1,470	1,470	2,040	6,140	995	1,240	2,680	5,080	2,240	1,840	1,410	505
2........	1,240	1,350	2,170	6,140	950	1,300	3,620	5,080	2,530	1,840	1,240	505
3........	1,190	1,350	2,380	6,140	860	1,350	4,680	5,080	2,240	1,900	1,140	505
4........	1,140	1,240	2,380	6,360	860	1,300	7,480	5,080	2,100	2,310	1,040	505
5........	1,040	1,140	2,530	6,360	780	1,240	9,290	5,080	1,970	5,280	950	450
6........	1,140	1,040	2,310	6,720	780	1,300	10,100	5,080	1,840	5,490	950	450
7........	1,040	950	2,100	7,220	740	1,300	9,290	5,080	1,840	5,490	860	505
8........	950	860	1,970	7,730	740	1,350	7,990	5,810	1,840	5,280	995	505
9........	860	860	1,840	7,100	740	1,350	6,980	4,980	1,840	4,700	1,240	565
10........	780	860	1,710	6,480	740	1,350	6,480	4,380	1,900	3,800	1,240	565
11........	780	860	1,710	5,810	740	1,350	6,360	4,090	2,100	2,900	1,240	565
12........	780	860	1,710	5,280	740	1,350	6,360	3,800	2,380	2,460	1,240	505
13........	780	860	1,710	4,090	740	1,350	6,360	3,260	3,340	2,170	1,140	505
14........	780	860	1,840	3,000	700	1,300	6,600	2,760	3,170	1,900	1,040	505
15........	700	905	2,100	2,100	700	1,240	6,850	2,240	3,080	1,710	860	450
16........	700	1,090	2,310	1,900	700	1,240	7,100	1,970	2,680	1,470	860	535
17........	700	1,410	2,680	1,840	665	1,190	7,100	1,970	2,530	1,190	780	700
18........	700	1,470	2,840	1,780	665	1,190	7,730	2,040	2,380	1,590	700	780
19........	700	1,530	2,840	1,650	665	1,140	8,380	2,530	2,530	1,590	700	780
20........	630	1,710	3,000	1,590	630	1,090	8,640	2,840	2,840	1,590	630	860
21........	630	1,710	3,170	1,530	630	1,090	8,900	2,680	2,760	1,350	630	780
22........	630	1,900	3,340	1,410	598	1,040	9,160	2,460	2,460	1,240	630	700
23........	630	2,310	3,340	1,350	598	950	8,900	2,460	2,040	1,140	565	700
24........	700	2,240	3,620	1,350	665	905	8,250	2,920	1,780	1,240	630	630
25........	700	1,970	3,900	1,300	740	860	7,860	3,000	1,530	1,240	700	630
26........	700	1,840	4,090	1,300	820	780	7,350	2,760	1,410	1,350	630	630
27........	995	1,710	4,480	1,240	905	780	6,720	3,170	1,780	1,900	565	565
28........	1,140	1,710	4,980	1,240	995	780	6,030	2,760	2,040	2,240	565	565
29........	1,240	1,710	5,280	1,190	1,140	780	5,380	2,310	2,170	2,240	565	505
30........	1,350	1,840	5,600	1,140	....	1,240	5,080	2,170	2,100	2,040	505	505
31........	1,470	....	5,920	1,090	....	1,900	....	2,530	....	1,650	505	....

Monthly Discharge of Mattawamkeag River at Mattawamkeag, for the Year Ending September 30, 1916.

[Drainage area, 1520 square miles.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,470	630	912	0.600	0.69
November	2,310	860	1,390	0.914	1.02
December	5,920	1,710	2,960	1.95	2.25
January	7,730	1,090	3,530	2.32	2.68
February	1,140	598	766	0.504	0.54
March	1,900	780	1,180	0.776	0.89
April	10,100	2,680	7,130	4.69	5.23
May	5,810	1,970	3,470	2.28	2.63
June	3,340	1,410	2,250	1.48	1.65
July	5,490	1,140	2,390	1.57	1.81
August	1,410	505	863	0.568	0.65
September	860	450	582	0.383	0.43
The year	10,100	450	2,290	1.51	20.47

Note.—Ice conditions January 6 to April 5, inclusive.
Maximum discharge 10,200 G. H. corresponding 9.1 April 6, 1916.
Minimum discharge 450 G. H. corresponding 3.6 September 5, 6, 15, 1916.

PISCATAQUIS RIVER NEAR FOXCROFT, MAINE.

LOCATION.—At Low's highway bridge, between Guilford, and Foxcroft, three-fourths mile above Black Stream and 3 miles below Mill Stream.

DRAINAGE AREA.—286 square miles.

RECORDS AVAILABLE.—August 17, 1902, to September 30, 1916.

GAGE.—Staff attached to left abutment. Read by A. F. D. Harlow.

CHANNEL AND CONTROL.—Practically permanent; banks high and overflowed only during extreme floods.

DISCHARGE MEASUREMENTS.—At medium and high stages made from bridge; at low stages by wading either above or below bridge.

ICE.—Stage-discharge relation usually affected by ice.

REGULATION.—The stream is used at several manufacturing plants above the station.

ACCURACY.—Stage-discharge relation practically permanent, excepting occasional effect from backwater from log jams. Considerable diurnal fluctuation caused by irregular use of water by mills above during low stages. Rating curve well defined below 5000 second-feet, but results uncertain for higher stages. Gage read to tenths twice daily.

PISCATAQUIS RIVER AT FOXCROFT, MAINE.

The following discharge measurements were made:

	DATE	GAGE HEIGHT	DISCHARGE
1915	Oct. 2	2.78	345
	" 2	2.91	364
	" 2	2.91	382
	" 2	3.10	524
	" 8	2.84	379
	" 9	2.74	309
	" 9	2.95	453
1916	March 5	4.15	363
	" 8	4.02	328
	May 17	2.99	362
	" 20	4.99	2100

DAILY DISCHARGE, IN SECOND FEET, OF PISCATAQUIS RIVER AT FOXCROFT, MAINE, FOR THE YEAR ENDING SEPTEMBER, 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	180	437	502	....	....	1,450	5,180	1,720	1,620	569	318	148
2	148	502	437	....	....	1,210	6,040	1,720	1,020	569	318	148
3	180	406	437	....	....	980	5,650	1,070	674	569	244	123
4	220	267	406	....	....	600	3,970	1,070	638	938	220	148
5	220	220	406	....	....	405	1,960	1,160	709	782	148	148
6	200	220	406	....	....	345	2,020	1,110	980	709	81	200
7	244	267	406	....	....	320	1,840	858	1,020	709	81	267
8	374	346	406	....	....	345	1,840	938	782	1,020	136	267
9	220	318	470	....	....	290	782	938	674	374	200	220
10	318	244	569	....	....	265	782	709	1,070	437	502	180
11	318	200	709	....	....	245	938	536	1,400	502	374	180
12	292	148	1,020	....	....	200	1,300	437	1,900	638	318	123
13	200	123	638	....	....	200	1,460	406	1,960	782	318	112
14	148	123	180	....	....	180	1,720	318	1,400	374	292	112
15	148	136	318	....	....	180	1,720	318	1,070	180	267	100
16	123	164	267	....	....	220	1,900	318	782	180	148	180
17	123	220	220	....	....	180	3,020	2,080	980	437	148	220
18	148	374	292	....	....	220	4,890	7,610	1,620	437	148	136
19	148	244	374	....	....	245	5,270	4,700	1,620	406	123	81
20	148	1,020	374	....	....	245	3,790	2,420	1,510	318	81	81
21	244	1,780	437	....	....	245	3,520	1,460	1,210	318	244	81
22	244	1,560	437	....	....	265	3,020	1,070	980	406	244	81
23	148	980	374	....	....	265	3,610	820	782	437	244	72
24	180	782	292	....	....	265	4,060	1,110	782	604	180	81
25	180	437	292	....	....	320	3,260	1,210	638	470	148	100
26	136	437	1,620	....	....	570	2,560	820	638	569	90	112
27	136	437	3,100	....	....	820	2,280	746	709	782	81	136
28	148	437	2,940	....	....	1,110	2,420	502	674	638	148	123
29	164	437	1,840	....	....	2,020	2,220	709	709	470	148	123
30	346	709	1,560	....	....	2,490	1,900	938	674	374	148	180
31	437	....	980	....	....	3,970	....	1,460	....	346	164	....

Monthly Discharge of Piscataquis River at Foxcroft, Maine, for the Year Ending September 30, 1916.

[Drainage area, 286 square miles.]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	437	123	208	0.727	0.84
November	1,780	123	466	1.63	1.82
December	3,100	180	733	2.56	2.95
January			569	1.99	2.29
February			292	1.02	1.10
March			667	2.33	2.69
April	6,040	782	2,830	9.90	11.04
May	7,610	318	1,330	4.65	5.36
June	1,960	638	1,040	3.64	4.06
July	1,020	180	527	1.84	2.12
August	502	81	203	0.710	0.82
September	267	72	142	0.496	0.55
The year	7,610	72	750	2.62	35.64

Note.—Ice conditions January 1 to March 27, inclusive.
Maximum discharge 7,810 G. H. corresponding 8.0.
Minimum discharge 64 G. H. corresponding 2.0 August 6-7; September 15, 19, 20, 22, 23, 1916. Observers G. H. March 3-5 discarded.

PASSADUMKEAG RIVER AT LOWELL, MAINE.

LOCATION.—About one-half mile below highway bridge at Lowell.

DRAINAGE AREA.—301 square miles.

RECORDS AVAILABLE.—October 1, 1915, to September 30, 1916.

GAGE.—Chain on right bank reading from 0.0 to 7.0 feet; staff reading from 4.5 to 12.0 feet; read by F. A. Lord. Staff above dam for supplementary use during winter.

DISCHARGE MEASUREMENTS.—Made from cable at gage; above 5.5 gage height made from Hathaway bridge 8 miles below; wading measurements made under cable at low stages.

CHANNEL AND CONTROL.—Practically permanent control about 500 feet below gage. Left bank will overflow at 5.5 feet gage height. Channel rough and somewhat irregular.

ICE.—Stage-discharge relation seriously affected by ice from December to April.

REGULATION.—Dam one-half mile above affects flow at station during part of year.

ACCURACY.—Results considered good. Stage-discharge relation practically permanent. Gage read to tenths once daily. Rating curve not well defined and discharge tables for 1915-1916 will be published in our next annual report.

PASSADUMKEAG RIVER AT LOWELL, MAINE.

The following discharge measurements were made:

	DATE	GAGE HEIGHT	DISCHARGE
1915	Sept. 30	1.95	285
	Oct. 1	2.89	636
	" 1	1.80	255
	" 16	1.85	279
	" 16	1.00	89
	Nov. 6	1.30	132
	" 7	2.43	450
	" 8	1.20	102

1916	Jan. 12	3.42	196
	" 26	2.40	219
	" 27	2.22	225
	Feb. 11	2.45	205
	Mar. 22	2.32	167
	" 22	2.31	166
	Apr. 6	3.02	716
	June 20	3.74	940
	June 23	3.59	887
	Aug. 1.	2.64	518
	Sept. 21	1.79	230

KENDUSKEAG STREAM NEAR BANGOR, MAINE.

LOCATION.—At highway bridge at Sixmile Falls, about 6 miles northwest of Bangor, and 7 miles below mouth of Black Stream.

DRAINAGE AREA.—191 square miles. At high stages a part of the water of Souadabscook Stream finds its way through an artificial cut into Black Stream.

RECORDS AVAILABLE.—September 15, 1908, to September 30, 1916.

GAGE.—Chain attached to bridge; read by Fred Cort.

CHANNEL AND CONTROL.—Practically permanent; channel broken by one pier.

DISCHARGE MEASUREMENTS.—Made from bridge.

ICE.—Stage-discharge relation seriously affected by ice.

DIVERSIONS.—A number of years ago an artificial cut was made for log driving between Souadabscook Stream and Black Stream, the latter entering the Kenduskeag about 7 miles above the station. During high stages of the Souadabscook a portion of its waters flow into the Kenduskeag; at low stages of the Souadabscook all flow continues down its own channel. Black Stream probably sends its waters only to the Kenduskeag.

ACCURACY.—Stage-discharge relation practically permanent. Rating curve well defined below 2,600 second-feet. Gage read to tenths twice a day.

KENDUSKEAG STREAM NEAR BANGOR.

The following discharge measurements were made:

DATE		GAGE HEIGHT	DISCHARGE
1915	Oct. 25	2.01	52
1916	Feb. 11	2.70	101
	Mar. 22	3.10	83
	Apr. 19	6.30	1940
	" 20	5.90	1730
	May 3	3.12	326
	" 4	3.33	356
	" 22	3.75	539
	June 13	3.81	553
	" 22	3.69	459

Daily Discharge, in Second-feet, of Kenduskeag Stream, Near Bangor, Maine, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1........	188	366	520	1,210	290	431	2,430	398	382	431	128	102
2........	188	276	483	1,120	305	350	3,180	366	350	335	128	78
3........	146	236	483	1,030	290	276	3,100	290	335	483	137	71
4........	119	211	398	922	276	236	1,940	262	366	978	128	78
5........	94	211	350	845	262	156	1,340	366	398	978	119	110
6........	137	211	290	722	249	156	1,210	414	398	678	102	137
7........	166	223	290	655	236	146	1,030	398	366	576	110	110
8........	199	211	335	795	211	137	820	335	320	655	188	86
9........	199	188	262	820	199	137	820	276	305	655	249	119
10........	236	156	236	895	146	128	655	223	382	538	350	119
11........	188	156	335	770	102	119	870	211	596	414	276	86
12........	156	146	335	700	102	119	1,150	211	576	448	249	119
13........	166	188	276	615	102	110	1,610	223	448	350	211	102
14........	146	199	199	596	102	94	1,370	199	366	290	166	94
15........	102	223	166	557	102	86	1,370	177	320	262	128	128
16........	102	501	199	335	102	78	1,120	156	305	249	110	137
17........	86	501	199	320	102	71	1,240	156	465	236	119	156
18........	94	655	382	305	102	71	1,470	922	678	211	94	156
19........	110	722	483	290	102	64	2,060	1,720	978	211	102	146
20........	119	770	465	276	102	64	1,680	1,440	870	199	128	156
21........	102	1,060	483	276	110	64	1,300	950	655	236	102	137
22........	86	870	448	276	110	64	1,060	538	483	236	86	146
23........	86	655	366	276	119	71	950	414	398	199	119	119
24........	64	501	520	262	119	78	870	382	305	305	128	102
25........	57	448	655	262	188	94	922	382	335	398	110	78
26........	71	382	1,090	249	320	102	820	576	398	290	86	94
27........	166	320	2,020	249	465	276	722	700	538	320	119	102
28........	382	290	2,390	262	465	501	615	615	722	249	137	86
29........	335	305	1,640	262	448	845	557	557	795	223	137	86
30........	398	431	1,270	276	....	1,300	483	483	576	199	128	119
31........	431	....	1,240	276	....	1,860	....	445	....	166	94	....

MONTHLY DISCHARGE OF KENDUSKEAG STREAM, NEAR BANGOR, ME., FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 191 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	431	57	165	0.864	1.00
November	1,060	146	387	2.05	2.29
December	2,390	166	607	3.18	3.67
January	1,210	249	539	2.82	3.25
February	448	102	201	1.05	1.13
March	1,860	64	267	1.40	1.61
April	3,180	483	1,290	6.75	7.53
May	1,720	156	477	2.50	2.88
June	978	305	480	2.51	2.80
July	978	166	387	2.05	2.36
August	350	86	144	0.754	0.87
September	156	71	112	0.586	0.65
The year	3,180	57	421	2.20	30.04

NOTE.—Ice conditions January 16 to April 1, inclusive.
Maximum discharge 3,410 G. H. corresponding 7.9 April 2, 1916.
Minimum discharge 57 G. H. corresponding 1.9 October 25, 1915.

KENNEBEC RIVER BASIN.

Moosehead Lake at East Outlet, Maine.

Location.—At wharf at east outlet of lake, about 8 miles from Kineo.

Drainage Area.—1,240 square miles.

Records Available.—April 1, 1895, to September 30, 1915.

Gage.—Staff, at end of boat landing; two datums have been used, the first (or original) datum is at elevation 1,011.30 feet above mean sea level and approximately 10 feet below sills of outlet gates; gage is read to this datum; the second, to which all gage readings published to and including 1911 have been referred, is 10 feet higher; that is, the zero is at the sill of the gates. As it was believed that low water may go below sill of gates (zero of second datum) gage heights since 1912 are published as read; that is, to original datum.

Regulation.—The lake is regulated to a capacity of 23,735,000,000 cubic feet. The dam at the east outlet is controlled by 35 gates; the sills of 15 old gates are at gage height 10 feet (original datum) and the sills of 20 gates at gage height 8 feet (original datum). At extreme low stages the flow is controlled not by the gates but by a bar above the dam at an approximate gage height of 9 feet (original datum). The records show only fluctuations in the level of the lake, and are used in the studies of regulation of the lake and in computing the natural flow of the Kennebec at The Forks.

Co-operation.—Record furnished by Hollingsworth & Whitney Company.

Daily Gage Height, in Feet, Moosehead Lake, East Outlet, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1		13.30				13.25		16.60				16.35
2			13.10		13.50				17.50		16.90	
3		13.20	13.10	13.40			13.10	16.65		17.50		
4	14.00				13.55	13.20			17.50		16.80	16.10
5		13.20		13.45			13.30	16.90		17.45		
6	13.95		13.10			13.20						16.00
7					13.50				17.45	17.40	16.80	
8	13.90	13.20	13.10	13.45			13.40	17.10				
9					13.50	13.30					16.90	16.00
10		13.20	13.05	13.50		13.30	13.90	17.20	17.40			
11					13.50					17.30	17.05	15.85
12	13.85	13.00	13.00	13.60			13.95	17.45	17.40	17.30		
13	13.80					13.30						15.75
14					13.50	13.30			17.30	17.25	16.90	
15		12.95	12.90				14.20	17.45				15.60
16	13.75			13.55	13.50				17.25		16.80	
17		12.90	12.90	13.50		13.30				17.25		
18	13.70						14.40	17.55				15.65
19		12.90		13.60	13.45		14.80	17.55	17.30	17.20	16.70	
20	13.70		12.90			13.20						15.50
21				13.55	13.55		15.10		17.40	17.20	16.60	
22	13.65	12.90	12.85			13.10		17.50				15.40
23					13.40				17.40		16.55	
24		12.95		13.50		13.05	15.65	17.50		17.10		
25	13.50		12.85		13.30							
26		13.00						17.50	17.40	17.10	16.40	15.40
27	13.45			13.50		12.90	16.10					15.40
28			13.10	13.50	13.30		16.20		17.45	17.10		
29	13.40	13.10	13.15			12.85		17.40			16.40	15.40
30									17.50		16.40	
31			13.20	13.55		13.00		17.50		17.00		

MONTHLY DISCHARGE OF MOOSEHEAD LAKE, EAST OUTLET, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, — square miles]

Month.	Gage Height, in Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	14.00	13.40	13.72	....	....
November	13.30	12.90	13.06	....	....
December	13.20	12.85	13.02	....	....
January	13.60	13.40	13.51	....	....
February	13.35	13.30	13.45	....	....
March	13.30	12.85	13.16	....	....
April	16.20	13.10	14.51	....	....
May	17.55	16.60	17.27	....	....
June	17.50	17.25	17.40	....	....
July	17.50	17.00	17.24	....	....
August	17.05	16.40	16.70	....	....
September	16.35	15.40	15.72	....	....

KENNEBEC RIVER AT THE FORKS, MAINE.

LOCATION.—At wooden highway bridge about 2,000 feet above the mouth of Dead River.

DRAINAGE AREA.—1,570 square miles.

RECORDS AVAILABLE.—September 28, 1901, to September 30, 1916.

GAGES.—Chain attached to bridge; vertical staff attached to timber retaining wall on left bank 75 feet above bridge, and water-stage recorder installed June 21, 1912, on left abutment, used May to November only. Gage read by S. C. Durgin.

CHANNEL AND CONTROL.—Practically permanent; unbroken by piers.

DISCHARGE MEASUREMENTS.—Made from the bridge.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Flow regulated by storage in Moosehead Lake. During May, June, July and August, Indian Pond, about 12 miles above the station, is under regulation for log driving, causing diurnal fluctuations of from 2 to 5 feet. Records of monthly discharge have been corrected for storage by adding or subtracting the amount of water stored in or released from Moosehead Lake.

ACCURACY.—Distribution of flow affected by regulation of stream for log driving and for waterpower plants below. The left abutment is on the concave side of a distinct bend in the river and the chain gage is about 90 feet from the left abutment. Although set to the same datum the water-stage recorder does not read the same as the chain gage above about 1.2 feet gage height. A careful determination of the cross section of the water surface at chain-gage height 5.5 feet showed the transverse slope and checked the table of relation at that stage. A rating curve referred to gage heights by water-stage recorder was developed from the well defined rating curve referred to chain-gage heights by means of the table of gage relation. Discharge for each 2 hour period was computed from this rating curve and the daily discharge is the mean of the discharge for the twelve periods.

KENNEBEC RIVER AT THE FORKS, MAINE.

The following discharge measurements were made:

	DATE	GAGE HEIGHT	DISCHARGE
1916	Feb. 1	2.90	1450
	" 23	3.80	2100
	Mar. 10	3.45	1450
	July 18	1.84	1110

Daily Discharge, in Second-feet, of Kennebec River at The Forks, Maine, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,110	1,700	1,280	1,160	1,480	2,200	1,630	3,690	5,850	3,300	3,100	2,480
2	2,080	1,690	1,160	1,160	1,330	2,200	1,530	4,960	4,720	2,890	2,920	2,570
3	1,820	1,650	1,160	1,160	1,240	2,200	2,330	4,820	4,260	4,610	3,100	2,540
4	1,720	1,590	952	1,160	1,200	2,200	1,850	2,690	3,890	6,710	2,820	2,540
5	1,640	1,640	990	1,240	1,200	1,580	1,740	2,140	3,970	4,660	3,680	2,540
6	1,620	1,620	1,030	1,280	1,200	1,430	1,530	2,340	4,900	3,340	3,190	2,540
7	1,600	1,590	1,160	1,200	1,110	1,380	1,330	2,790	4,000	3,310	3,270	2,540
8	1,620	1,540	1,160	1,380	1,070	1,330	1,330	2,780	3,640	3,310	3,530	2,540
9	1,650	1,500	1,330	1,630	1,070	1,330	1,330	3,130	3,980	3,440	3,670	2,540
10	1,640	1,460	1,430	2,200	1,030	1,480	1,160	2,230	4,440	3,390	1,160	2,540
11	1,620	1,440	1,530	2,200	990	1,850	1,160	2,670	4,620	3,110	1,480	2,460
12	1,580	1,460	1,800	2,200	1,110	1,850	1,160	1,930	3,690	2,990	2,160	2,240
13	1,550	1,440	2,200	2,330	1,330	1,850	1,160	2,230	3,130	3,150	3,510	2,200
14	1,540	1,390	2,200	2,400	1,330	1,740	1,240	2,230	3,550	3,400	3,530	2,180
15	1,840	1,390	2,460	2,600	1,430	1,850	1,330	3,470	3,110	3,430	4,020	2,210
16	1,610	1,380	2,800	2,460	1,430	1,850	1,530	3,640	3,960	3,080	3,620	2,480
17	1,540	1,360	2,880	2,530	1,430	1,800	1,960	3,290	3,020	3,650	3,900	2,270
18	1,540	1,360	2,660	2,800	1,530	2,600	2,880	6,000	3,810	3,840	3,610	1,940
19	1,560	1,340	2,460	2,740	1,680	2,600	4,500	7,740	4,130	3,740	3,160	2,090
20	1,590	1,500	2,460	2,530	1,740	2,600	4,150	8,080	2,870	3,290	2,850	2,060
21	1,580	1,340	2,460	2,800	1,740	2,600	2,600	7,340	2,770	3,270	2,650	1,830
22	1,760	763	1,960	2,460	2,020	2,600	3,170	6,790	2,780	3,270	4,220	1,970
23	1,540	535	1,850	2,080	2,080	2,600	3,170	6,560	3,470	3,420	3,060	2,030
24	1,450	475	1,850	2,020	2,200	2,740	3,480	6,310	3,660	3,310	2,760	2,500
25	1,400	450	1,960	1,910	2,200	2,740	2,600	6,060	3,110	3,400	2,690	1,830
26	1,400	472	1,680	1,630	2,600	3,020	2,330	5,440	3,670	3,430	2,790	1,500
27	1,420	805	1,200	1,630	3,560	3,320	2,330	5,230	3,200	3,460	2,640	1,360
28	1,410	1,530	1,160	1,580	3,480	3,170	2,600	4,190	3,010	3,240	2,590	1,370
29	1,440	1,630	1,160	1,430	3,480	3,020	4,150	3,970	3,250	3,260	2,540	1,370
30	1,660	1,530	1,160	1,480	....	2,740	3,170	4,240	2,960	3,980	2,510	1,600
31	1,660	....	1,160	1,430	....	2,880	....	4,490	....	3,200	2,490	....

MONTHLY DISCHARGE OF KENNEBEC RIVER AT THE FORKS, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 1570 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	2,110	1,410	1,620	1.03	1.19
November	1,700	450	1,320	0.842	0.94
December	2,880	952	1,700	1.08	1.24
January	2,800	1,160	1,900	1.21	1.40
February	3,560	990	1,700	1.08	1.16
March	3,320	1,330	2,240	1.43	1.65
April	4,500	1,160	2,210	1.41	1.57
May	8,080	1,930	4,310	2.74	3.16
June	5,850	2,770	3,710	2.36	2.63
July	6,710	2,890	3,540	2.25	2.59
August	4,220	1,160	3,010	1.92	2.21
September	2,570	1,360	2,160	1.38	1.54
The year	8,080	450	2,460	1.57	21.28

NOTE.—Ice conditions January 1 to March 29, inclusive.
Automatic Gage: October 1 to November 26 and May 1 to September 30.
Maximum discharge 10,700; G. H. corresp. 7.2 May 20, 1916.
Minimum discharge 395; G. H. corresp. 0.7 November 26-27, 1915.

MONTHLY DISCHARGE OF KENNEBEC RIVER AT THE FORKS, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

CORRECTED FOR STORAGE.

[Drainage area, 1570 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	....	....	675	0.430	0.50
November	....	....	1,020	0.650	0.72
December	....	....	1,820	1.16	1.34
January	....	....	2,320	1.48	1.71
February	....	....	1,380	0.879	0.95
March	....	....	1,890	1.20	1.38
April	....	....	6,440	4.10	4.57
May	....	....	5,580	3.55	4.09
June	....	....	3,710	2.36	2.63
July	....	....	2,930	1.87	2.16
August	....	....	2,290	1.46	1.68
September	....	....	930	0.592	0.66
The year	....	....	2,590	1.65	22.39

KENNEBEC RIVER AT WATERVILLE, MAINE.

LOCATION.—At dam and mill of Hollingsworth & Whitney Co., at Waterville, 2 miles above Sebasticook River and about 3½ miles above Messalonskee Stream.

DRAINAGE AREA.—4,270 square miles.

RECORDS AVAILABLE.—March 22, 1892, to September 30, 1916.

GAGES.—Rod Gages in pond above dam and in tailrace of mill.

DISCHARGE.—Discharge computed from flow over dam, through logway, and through 18 wheels of the mill. Most of the wheels were rated at Holyoke, Mass., under practically the same head—about 23 feet. When the flow of the river is less than about 3,500 second-feet all the water is used through the wheels.

ICE.—Not seriously affected by ice. During most years the winter flow passes through the wheels of the mill.

REGULATION.—Numerous power plants and much storage above the station. Results not corrected for storage.

ACCURACY.—Results considered fair only, as many wheels are in operation and only one reading a day is made for each wheel The record is valuable because of its length and continuity.

CO-OPERATION.—Records obtained and estimates of daily discharge furnished by the Hollingsworth & Whitney Co.

Daily Discharge, in Second-feet, of Kennebec River at Waterville, Maine, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1..........	3,220	4,380	4,860	5,450	4,890	8,640	23,500	20,600	16,300	9,920	10,300	3,890
2..........	3,570	3,760	5,020	5,410	4,910	8,180	23,100	17,700	15,700	8,720	5,420	4,200
3..........	1,360	3,780	4,420	5,520	5,290	7,300	29,000	19,700	13,300	7,180	4,740	2,350
4..........	4,560	3,760	3,990	5,190	6,500	6,800	25,200	20,200	12,200	7,380	3,800	4,290
5..........	4,040	3,340	817	4,010	5,480	4,340	20,000	17,200	10,700	11,100	4,120	4,440
6..........	4,010	3,760	4,130	4,210	1,810	5,860	17,400	15,900	10,700	10,500	2,460	4,220
7..........	3,750	635	2,790	4,120	4,310	4,970	16,300	13,400	10,700	8,380	7,170	4,210
8..........	3,700	3,980	3,790	4,360	5,790	4,210	13,500	13,400	11,600	8,030	6,210	3,980
9..........	4,000	3,640	3,760	921	3,600	4,000	12,600	9,980	12,100	7,550	11,000	4,520
10.........	2,230	3,450	3,450	3,750	3,450	4,000	11,500	12,900	13,300	8,420	26,000	3,000
11.........	4,160	2,850	3,490	3,510	3,460	3,860	12,500	8,730	18,400	7,490	16,000	4,500
12.........	3,890	3,120	530	3,780	3,170	3,070	23,600	11,900	20,000	6,100	10,100	4,370
13.........	3,200	3,030	3,120	4,350	1,980	4,160	12,500	12,500	20,000	5,680	7,040	5,150
14.........	2,880	455	3,350	3,870	5,130	4,010	13,500	9,100	15,000	6,330	7,990	3,520
15.........	3,390	3,970	2,940	4,160	3,420	3,980	14,500	9,380	13,800	5,080	7,720	3,830
16.........	2,550	3,730	3,090	1,240	3,200	3,780	12 600	8,120	12,700	4,960	6,870	4,570
17.........	1,000	3,750	2,900	3,810	3,720	3,750	14,000	7,700	10,700	9,790	6,540	6,270
18.........	3,720	2,830	3,440	3,440	3,740	3,750	20,400	38,600	14,500	6,950	6,060	7,760
19.........	3,020	3,060	716	3,400	3,820	3,380	32,800	44,500	18,500	7,730	4,810	5,970
20.........	2,710	3,870	5,130	3,120	1,980	4,190	27,300	30,800	18,400	8,120	3,200	4,950
21.........	3,030	7,730	4,590	3,060	3,960	3,780	25,000	24,900	14,200	5,970	4,730	4,670
22.........	2,700	7,280	4,160	3,530	3,770	3,780	22,300	21,600	12,100	5,880	4,150	4,120
23.........	2,610	5,940	3,790	1,660	3,340	3,850	22,100	18,300	10,500	7,020	3,990	3,630
24.........	768	5,340	3,820	4,300	3,610	3,850	35,400	15,100	10,900	8,980	5,560	3,010
25.........	3,070	2,960	2,940	4,050	3,750	3,870	30,400	15,200	9,910	8,820	4,970	7,590
26.........	2,490	4,380	5,110	4,370	3,740	2,840	25,200	16,900	9,900	7,570	4,580	5,880
27.........	2,700	3,440	13,700	4,160	5,660	4,910	25,900	14,500	11,300	8,270	3,380	5,250
28.........	2,760	1,640	12,700	4,360	13,800	5,860	22,400	13,800	9,600	11,600	8,530	4,070
29.........	2,740	4,600	11,100	3,400	10,000	7,880	23,100	13,300	10,700	8,410	3,860	3,860
30.........	2,690	4,630	8,750	3,100	....	12,300	20,300	10,200	12,200	7,380	4,660	4,000
31.........	626	....	7,360	4,880	....	19,400	....	18,400	....	6,820	4,640	....

Monthly Discharge of Kennebec River at Waterville, Maine, for the Year Ending September 30, 1916.

[Drainage area, 4270 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	4,560	626	2,940	0.688	0.79
November	7,730	455	3,770	0.883	0.98
December	13,700	530	4,640	1.09	1.26
January	5,520	921	3,820	0.895	1.03
February	13,800	1,810	4,530	1.06	1.14
March	19,400	2,840	5,440	1.27	1.46
April	35,400	11,500	20,900	4.90	5.47
May	44,500	7,700	16,900	3.96	4.56
June	20,000	9,600	13,300	3.12	3.48
July	11,600	4,960	7,810	1.83	2.11
August	26,000	2,460	6,800	1.59	1.83
September	7,760	2,350	4,540	1.06	1.18
The year	44,500	455	7,960	1.86	25.29

DEAD RIVER AT THE FORKS, MAINE.

LOCATION.—One-eighth mile above farm house of Jeremiah Durgin; one and one-half miles west of The Forks.

DRAINAGE AREA.—878 square miles.

RECORDS AVAILABLE.—September 29, 1901, to August 15, 1907; March 16, 1910 to September 30, 1916.

GAGE.—Staff bolted to large boulder on left bank; read by H. J. Farley.

CHANNEL AND CONTROL.—Practically permanent; banks medium high; overflowed only at extreme high water.

DISCHARGE MEASUREMENTS.—Made from cable 700 feet above gage.

ICE.—Stage discharge relation seriously affected by ice.

REGULATION.—A number of dams on the lakes above, used for log driving during May and June.

ACCURACY.—Stage discharge relation practically permanent. Gage read to half tenths twice daily. Rating curve well defined below 8,000 second feet.

DEAD RIVER AT THE FORKS, MAINE.

The following discharge measurements were made:

DATE		GAGE HEIGHT	DISCHARGE
1916	Feb. 1	3.65	1640
	" 23	1.60	395
	Mar. 10	3.40	831

DAILY DISCHARGE, IN SECOND-FEET, OF DEAD RIVER AT THE FORKS, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	325	510	610	902	1,620	1,390	4,220	4,460	2,660	1,240	665	240
2	415	610	840	840	200	1,390	4,710	4,710	2,750	1,240	510	160
3	415	610	1,100	780	100	1,390	5,240	4,100	3,340	1,390	415	160
4	462	510	840	720	60	1,390	4,840	4,100	2,750	1,240	415	100
5	560	510	610	665	25	1,390	4,340	4,580	2,560	1,100	462	282
6	610	510	510	610	42	1,240	3,550	3,440	2,560	1,100	720	840
7	560	370	510	560	60	1,170	1,700	3,440	2,750	1,100	1,240	1,240
8	415	370	462	510	100	1,032	1,460	3,140	2,380	1,100	1,700	120
9	510	370	510	415	160	965	1,170	3,880	2,660	1,100	3,240	325
10	510	415	610	370	240	840	1,170	3,660	3,040	1,030	4,970	415
11	510	415	510	370	370	780	1,320	2,940	3,140	965	4,220	415
12	510	510	510	325	510	720	1,540	3,440	3,140	840	3,040	780
13	462	462	415	240	415	610	1,940	2,840	2,940	720	2,200	780
14	415	462	415	200	415	560	2,030	1,540	2,940	560	1,620	780
15	370	510	325	160	415	462	2,290	2,380	2,660	370	1,390	780
16	370	462	240	100	370	415	2,290	1,700	2,290	282	1,170	1,170
17	325	510	240	160	370	370	2,560	2,030	2,120	780	902	1,780
18	370	510	1,100	160	325	325	2,660	6,790	2,200	1,780	665	1,240
19	415	462	1,700	100	282	325	4,460	7,660	2,200	1,390	610	720
20	415	610	1,460	160	370	325	3,240	6,460	2,470	1,240	610	462
21	370	780	1,240	200	370	325	2,940	5,240	2,380	1,030	610	415
22	325	1,030	1,100	325	370	325	3,140	4,840	2,290	902	510	282
23	325	1,240	902	240	415	325	4,460	5,240	1,940	965	462	282
24	240	1,030	780	370	415	1,240	4,340	5,830	1,620	902	510	610
25	200	780	610	370	462	1,240	4,580	5,830	1,390	840	840	560
26	160	610	1,540	325	510	1,240	6,790	5,530	1,170	965	840	510
27	160	510	2,840	370	840	1,240	3,880	4,580	965	1,100	665	415
28	160	510	2,200	415	965	2,380	4,580	4,100	1,390	1,100	665	325
29	160	510	1,620	325	1,170	3,990	6,460	3,340	1,390	1,100	510	240
30	240	610	1,240	240	....	4,220	4,340	3,140	1,390	1,100	665	370
31	370	....	965	902	....	3,990	....	3,550	....	902	510	....

Monthly Discharge of Dead River at The Forks, Maine, for the Year Ending September 30, 1916.

[Drainage area, 878 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	610	160	376	0.428	0.49
November	1,240	370	577	0.657	0.73
December	2,840	240	922	1.05	1.21
January	902	100	401	0.457	0.53
February	1,620	25	413	0.470	0.51
March	4,220	325	1,210	1.38	1.59
April	6,790	1,170	3,410	3.87	4.32
May	7,660	1,540	4,150	4.73	5.45
June	3,140	965	2,320	2.64	2.94
July	1,780	370	1,010	1.15	1.33
August	4,970	415	1,210	1.38	1.59
September	1,780	100	560	0.638	0.71
The year	7,660	25	1,380	1.57	21.40

Note.—Ice condtions January 1 to March 31, inclusive.
Maximum G. H. 5.1; discharge 10,100 May 18, 1916.
Minimum G. H. 1.3; discharge 25 February 5, 1916.

Sandy River near Farmington, Maine.

Location.—At Fairbanks highway bridge, 3 miles above Farmington.

Drainage Area.—270 square miles.

Records Available.—July 11, 1910, to December 31, 1916.

Gage.—Chain attached to bridge; read by L. A. Daggett.

Channel and Control.—Sand and gravel; probably shifting.

Discharge Measurements.—Made from bridge; by wading at low stages.

Ice.—Stage-discharge relation seriously affected by ice.

Regulation.—No storage basins above station; the water-power dam at Phillips may slightly affect flow.

Accuracy.—Stage-discharge relation not permanent; results considered fair only. Publication of discharge withheld because of uncertainty regarding gage heights and station has been discontinued.

Sebasticook River at Pittsfield, Maine.

Location.—At steel highway bridge just above Maine Central Railroad bridge in Pittsfield.

Drainage Area.—320 square miles.

Records Available.—July 27, 1908, to September 30, 1916.

Gage.—Chain attached to highway bridge. Read by C. D. Morrill.

Channel and Control.—Practically permanent; banks high and rocky and not subject to overflow.

Discharge Measurements.—Made from highway bridge.

Ice.—Stage-discharge relation not affected by ice, as rapid fall and proximity of power plant above the station tend to keep the river open.

Regulation.—About 800 feet upstream from the station is the dam of the American Woolen Company, (Pioneer Mills) and the Smith Textile Company; about half a mile farther upstream is the dam of the American Woolen Company's Waverly mill. Not corrected for storage.

Accuracy.—Stage-discharge relation permanent; accuracy more or less affected by fluctuations in stage caused by operation of the mills above the station and night storage. Monthly means considered fair, although values for individual days may be considerably in error by reason of two daily gage heights not giving correct mean stage for 24 hours. Gage read to tenths twice daily. Rating curve fairly well defined between 70 and 3000 second feet.

SEBASTICOOK RIVER AT PITTSFIELD, MAINE.

The following discharge measurement was made:

DATE	GAGE HEIGHT	DISCHARGE
1916 May 2	4.15	949

MONTHLY DISCHARGE OF SEBASTICOOK RIVER AT PITTSFIELD, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1914.

[Drainage area, 320 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	600	71	256	0.80	0.92
November	668	395	504	1.58	1.76
December	668	230	409	1.28	1.48
January	395	97	272	0.850	0.98
February	438	125	321	1.00	1.04
March	668	193	470	1.47	1.70
April	6,380	668	2,720	8.50	9.48
May	2,590	193	1,070	3.33	3.84
June	250	50	133	0.416	0.46
July	193	50	109	0.340	0.39
August	71	30	52	0.162	0.19
September	60	30	44	0.137	0.15
The year	6,380	30	530	1.66	22.39

Monthly Discharge of Sebasticook River at Pittsfield, Maine, for 1915-16.

[Drainage area, 320 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1914-1915					
October	60	22	35	0.109	0.13
November	111	22	66	0.206	0.23
December	71	22	38	0.119	0.14
January	230	14	93	0.291	0.34
February	1,140	71	303	0.947	1.02
March	1,200	310	589	1.84	2.12
April	1,710	438	878	2.74	3.06
May	3,400	193	1,250	3.91	4.51
June	270	14	198	0.619	0.69
July	485	50	324	1.01	1.16
August	1,250	97	532	1.66	1.91
September	745	97	329	1.03	1.15
The year	3,400	14	388	1.21	16.46
1915-1916					
October	352	50	235	0.734	0.85
November	668	193	379	1.18	1.32
December	1,470	230	492	1.54	1.78
January	1,250	193	526	1.64	1.89
February	395	193	322	1.01	1.09
March	838	158	337	1.05	1.21
April	2,860	1,200	2,070	6.47	7.22
May	2,080	97	656	2.05	2.36
June	938	438	677	2.12	2.36
July	1,040	270	513	1.60	1.84
August	438	193	312	0.975	1.12
September	352	158	268	0.838	0.94
The year	2,860	50	564	1.76	23.97

Note.—(1915) Discharge October 1 to March 2 inclusive, applied from G. H. corrected for night flow.

Maximum discharge 3,400; G. H. corresp. 6.2 May 4, 1915.
Minimum discharge 14; G. H. corresp. 2.3 January 14, 17, 18: 2.2 June 20, 1915.
(1916) Discharge corrected for night flow March 5-31 May 4-September 9, 1916.
Maximum discharge 2,860; G. H. corresp. 5.8 April 6, 1916.
Minimum discharge 50; G. H. corresp. 2.4 October 10, 1915.

COBBOSSEECONTEE STREAM AT GARDINER, MAINE.

LOCATION.—At dam of Gardiner Water Power Co. in Gardiner.

DRAINAGE AREA.—220 square miles. See Accuracy.

RECORDS AVAILABLE.—June 16, 1890, to September 30, 1916.

GAGES.—Staff in pond above dam and in tailrace of power house.

DISCHARGE.—Discharge determined by considering (1) flow over dam, usually nothing except for a short time in the spring; (2) flow through two gates; and (3) flow through 39-inch Victor wheel installed in 1907.

ICE.—Not affected by ice.

REGULATION.—The many lakes in the basin are controlled and the stream affords a remarkable example of regularity of flow. Results not corrected for storage.

ACCURACY.—Results considered good. Run-off per square mile and depth in inches on drainage area, 1890 to 1912 inclusive, should be recomputed, using new value for drainage area.

CO-OPERATION.—Computation of daily discharge made by engineers of the S. D. Warren Co., Cumberland Mills, Me.

Daily Discharge, in Second-feet, of Cobbosseecontee Stream at Gardiner, Maine, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1........	180	250	250	250	280	542	1,090	961	250	250	250	250
2........	180	250	250	(a) 30	280	537	(a) 1,090	929	250	(a) 0	250	250
3........	(a) 0	250	250	250	280	534	1,090	800	250	250	250	(a) 0
4........	250	250	250	250	280	532	1,090	520	(a) 0	250	250	250
5........	250	250	(a) 20	250	280	(a) 532	1,030	310	250	250	250	250
6........	250	250	250	250	(a) 0	460	997	280	250	250	(a) 0	250
7........	250	(a) 0	250	250	280	335	967	(a) 280	250	250	250	250
8........	250	250	250	250	280	370	962	260	250	250	250	250
9........	250	250	250	(a) 0	280	450	(a) 962	250	250	(a) 0	250	250
10........	(a) 0	250	250	250	280	546	933	250	250	250	250	(a) 0
11........	250	250	250	250	280	541	901	250	(a) 0	250	250	250
12........	250	250	(a) 0	250	280	(a) 500	873	250	250	250	250	250
13........	250	250	250	250	(a) 0	544	842	250	260	250	(a) 0	250
14........	250	(a) 0	250	250	280	539	760	(a) 250	280	250	250	250
15........	250	250	250	250	280	539	680	250	300	250	250	250
16........	250	250	250	(a) 0	280	539	(a) 675	250	310	(a) 0	250	250
17........	(a) 0	250	250	250	280	557	671	250	330	250	250	(a) 0
18........	250	250	250	250	270	554	667	670	(a) 1,490	250	250	250
19........	250	250	(a) 0	250	270	(a) 400	667	1,650	1,280	250	250	250
20........	250	250	250	250	(a) 130	359	675	2,100	960	250	(a) 0	250
21........	250	(a) 0	250	250	270	392	720	(a) 18,870	640	250	250	250
22........	250	250	250	250	270	356	863	1,700	340	250	250	250
23........	250	250	250	(a) 0	270	356	(a) 870	1,600	250	(a) 0	250	250
24........	(a) 0	250	250	250	270	380	950	1,460	250	250	250	(a) 0
25........	250	250	90	250	270	360	1,020	1,350	(a) 0	250	250	250
26........	250	250	(a) 0	250	300	(a) 507	1,050	1,350	250	250	250	250
27........	250	250	250	250	(a) 401	498	1,020	860	250	250	(a) 0	250
28........	250	(a) 0	250	250	545	508	1,020	(a) 310	250	250	250	250
29........	250	250	250	250	542	519	1,000	250	250	250	250	250
30........	250	250	250	(a) 0	....	600	(a) 960	120	250	(a) 0	250	250
31........	(a) 0	....	250	280	....	860	....	250	....	250	250	....

(a) Sunday.

MONTHLY DISCHARGE OF COBBOSSEECONTEE STREAM AT GARDINER, MAINE, FOR THE YEAR ENDING SEPTEMBER, 30, 1916.

[Drainage area, 220 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	250	0	205	0.932	1.07
November	250	0	217	0.986	1.10
December	250	0	213	0.968	1.12
January	280	0	212	0.964	1.11
February	545	0	276	1.25	1.35
March	860	335	492	2.23	2.57
April	1,090	667	903	4.10	4.57
May	2,100	120	714	3.25	3.75
June	1,490	0	348	1.58	1.76
July	250	0	210	0.954	1.10
August	250	0	218	0.991	1.14
September	250	0	217	0.986	1.10
The year	2,100	0	353	1.60	21:74

ANDROSCOGGIN RIVER BASIN.

ANDROSCOGGIN RIVER AT ERROL DAM, N. H.

LOCATION.—At Errol dam, 1 mile above Errol, N. H.

DRAINAGE AREA.—1,095 square miles.

RECORDS AVAILABLE.—January 1, 1905, to September 30, 1916.

GAGE.—Movable rod gage; readings taken daily from sill of deep gate No. 6; elevation of zero of gage (sill of gate) is 1,231.3 feet above mean sea level.

DISCHARGE.—Computed from discharge through 14 gates in dam by means of coefficients determined from discharge measurements.

The dam is a wooden structure completely housed over, about 175 feet between abutments. Extensive repairs were made on the dam during November and December, 1912. The entire flow passes through 14 gates of different sizes there being no provision for overflow besides the gates. Beginning at the left end, the gates are as follows: One gate 10 feet deep by 15 feet wide, seldom used; three gates 10½ feet deep by 15 feet wide, open most of the time; nine gates 15 feet deep by 7 feet wide open a portion of the time only; one gate 15 feet deep by 5 feet wide, gristmill gate and used only occasionally. The cap of all 14 gates is one continuous beam thus making the bottom of the various gates at different levels.

A "deadhead" of 2.66 feet exists a short distance above the present dam, this point at present controlling the low flow. The depth in the deep gates does not indicate the true height of water in Umbagog Lake on account of this "deadhead," the lowest point of which is about 4 feet above the sills.

ICE.—Little affected by ice.

REGULATION.—Errol dam controls the storage of Umbagog Lake, the lower of the Rangeley series, (the storage of which amounts to nearly 20 billion cubic feet) and also a recently developed site on Magalloway River at the Aziscohos dam, which stores about 9.6 billion cubic feet, thus making the total storage about 29.6 billion cubic feet. Errol dam is about 5 miles below the outlet of Umbagog Lake and about 3.5 miles below the mouth of Magalloway River, thus making this latter stream one of the feeders of Umbagog Lake. Results not corrected for storage.

ACCURACY.—Discharge derived from coefficients applied to the various gate openings as determined from current meter gagings. Ratings, however, are not as thorough as could be desired, and results are considered roughly approximate.

CO-OPERITION.—Records obtained and computation of daily discharge made under the direction of Mr. Walter H. Sawyer, agent for Union Water Power Co., Lewiston, Maine.

Daily Discharge, in Second-feet, of Androscoggin River, Errol Dam, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,510	1,610	1,640	1,680	1,050	1,740	956	2,030	3,460	2,760	1,790	1,740
2	1,480	1,580	1,660	1,580	1,050	1,680	1,020	2,060	4,870	2,450	1,880	1,710
3	1,450	1,520	1,670	1,580	1,130	1,640	1,080	2,080	3,900	2,440	1,870	1,670
4	1,470	1,470	1,670	1,570	1,310	1,640	1,100	2,090	3,420	2,920	1,880	1,820
5	1,480	1,480	1,740	1,500	1,290	1,660	1,140	2,110	3,500	3,050	1,920	1,860
6	1,440	1,620	1,800	1,260	1,300	1,660	1,160	2,110	4,240	3,050	2,000	1,830
7	1,420	1,680	1,800	1,500	1,410	1,650	1,160	2,110	5,630	2,990	1,970	1,760
8	1,400	1,670	1,790	1,630	1,540	1,700	1,160	2,050	5,820	2,500	1,700	1,670
9	1,380	1,640	1,790	1,630	1,620	1,710	1,160	1,730	5,880	1,900	1,370	1,530
10	1,410	1,600	1,790	1,550	1,670	1,680	1,260	1,590	5,930	1,810	1,420	1,590
11	1,790	1,560	1,870	1,460	1,670	1,680	1,280	1,580	5,870	1,690	1,580	1,780
12	1,600	1,620	1,850	1,460	1,800	1,690	1,280	1,580	5,970	1,500	1,940	1,880
13	1,550	1,620	1,810	1,460	1,700	1,680	1,170	1,610	6,340	1,250	1,940	1,900
14	1,570	1,640	1,780	1,470	1,650	1,680	1,290	1,580	6,230	1,440	1,870	1,940
15	1,570	1,600	1,810	1,500	1,630	1,660	1,530	1,570	5,350	1,550	1,870	1,660
16	1,600	1,570	1,760	1,590	1,630	1,680	1,410	1,560	4,060	1,630	1,860	1,020
17	1,570	1,490	1,730	1,520	1,630	1,700	1,320	1,540	3,070	1,640	1,830	1,170
18	1,530	1,530	1,700	1,560	1,630	1,740	1,370	2,470	2,840	1,680	1,810	1,610
19	1,610	1,610	1,680	1,640	1,630	1,770	1,420	3,130	2,880	1,680	1,790	2,020
20	1,700	1,650	1,630	1,670	1,630	1,820	1,480	3,170	3,920	1,690	1,770	2,100
21	1,640	1,650	1,620	1,650	1,630	1,790	1,510	3,130	5,390	1,710	1,760	2,060
22	1,590	1,660	1,640	1,690	1,630	1,810	1,550	3,110	5,880	1,710	1,720	1,970
23	1,570	1,680	1,710	1,460	1,630	1,810	1,570	2,820	5,090	1,710	1,700	1,930
24	1,630	1,660	1,730	1,490	1,630	1,790	1,680	2,150	4,160	1,710	1,690	1,900
25	1,660	1,590	1,760	1,520	1,630	1,790	1,810	2,050	3,550	1,720	1,670	1,900
26	1,680	1,650	1,380	1,510	1,310	1,790	1,870	2,040	3,260	1,730	1,650	1,880
27	1,630	1,680	1,080	1,450	1,210	1,770	1,940	2,070	3,260	1,720	1,620	1,930
28	1,630	1,690	1,200	1,110	1,430	1,220	1,980	2,090	3,140	1,710	1,600	1,960
29	1,640	1,690	1,280	1,040	1,590	855	2,000	2,130	2,530	1,680	1,580	1,960
30	1,670	1,620	1,420	1,190	....	823	2,010	2,420	2,740	1,640	1,660	1,660
31	1,660	....	1,590	1,080	....	894	....	2,600	....	1,640	1,770	....

MONTHLY DISCHARGE OF ANDROSCOGGIN RIVER AT ERROL DAM, N. H., FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 1095 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,790	1,380	1,570	1.43	1.65
November	1,690	1,470	1,610	1.47	1.64
December	1,870	1,080	1,660	1.52	1.75
January	1,690	1,040	1,480	1.35	1.56
February	1,800	1,050	1,500	1.37	1.48
March	1,820	823	1,620	1.48	1.71
April	2,010	956	1,420	1.30	1.45
May	3,170	1,540	2,140	1.95	2.25
June	6,340	2,530	4,410	4.03	4.50
July	3,050	1,250	1,940	1.77	2.04
August	2,000	1,370	1,760	1.61	1.86
September	2,100	1,020	1,780	1.63	1.82
The year	6,340	823	1,910	1.74	23.71

Androscoggin River, Berlin, N. H.

Location.—At upper or sawmill dam of the Berlin Mills Co. at Berlin, N. H.

Drainage Area.—1,350 square miles.

Records Available.—October 1, 1913, to September 30, 1916.

Gages.—Fixed gages maintained above forebay racks and in tailrace; gages are referred to same datum. A gage is also attached to each wheel gate from which the gate opening can be ascertained.

Discharge.—Computed from curves prepared from Holyoke tests of the wheel runners. Water wasted over dam computed by Francis Formula for discharge over weirs.

Ice.—Not affected by ice.

Regulation.—Under an agreement between the power users on the Androscoggin River the flow at Berlin, N. H., is maintained at a minimum of 1,550 second-feet and at such a higher point above 1,550 second-feet, as is consistent with the constant maintenance of that quantity. The actual fine regulation of the river is carried on at Pontocook Dam, N. H. where there is a pond containing about one day's supply. The primary regulation is made at Errol, N. H., about 30 miles above Berlin.

In the event of rain or sudden thaw in the winter the gates at Errol are closed, and water is accumulated in Umbagog Lake. If the area between Pontocook and Berlin is supplying sufficient water to maintain the flow, the gates at Pontocook are closed and water retained above that dam. In the event of a sudden cold snap, or of a reduction of flow by evaporation, a portion of the water in Pontocook is discharged, and the gates in Errol partially opened to make up the deficiency.

Accuracy.—Results probably correct within 2%.

Co-operation.—Records kept under the direction of Mr. John H. Wilson of the Berlin Mills Co.; furnished by Mr. Walter H. Sawyer, agent for the Union Water Power Co., Lewiston, Maine.

DAILY DISCHARGE, IN SECOND-FEET, OF ANDROSCOGGIN RIVER AT BERLIN, N. H., FOR THE YEAR ENDING SEPTEMBER 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1........	1,750	1,760	1,780	1,870	1,940	1,980	2,600	3,800	4,550	4,400	1,970	2,010
2........	1,750	1,760	1,750	1,910	1,930	1,970	2,750	3,950	5,000	3,800	1,940	2,090
3........	1,740	1,780	1,780	1,920	1,850	1,930	2,900	4,200	5,000	4,400	1,970	2,030
4........	1,750	1,760	1,780	1,890	1,800	1,850	2,750	4,000	4,900	5,500	2,000	2,030
5........	1,750	1,740	1,780	1,920	1,800	1,840	2,450	3,950	5,400	5,500	2,000	2,030
6........	1,760	1,730	1,780	1,900	1,800	1,820	2,200	3,650	6,850	4,700	2,000	2,030
7........	1,740	1,740	1,780	1,780	1,730	1,780	2,050	3,500	7,400	4,100	2,030	2,010
8........	1,780	1,750	1,780	1,850	1,720	1,750	1,950	3,400	7,300	5,200	2,030	2,030
9........	1,760	1,750	1,780	1,850	1,720	1,780	1,850	3,150	7,650	4,900	3,000	2,230
10........	1,740	1,740	1,770	1,930	1,730	1,780	1,750	2,950	8,200	3,300	4,200	2,200
11........	1,740	1,710	1,740	1,930	1,730	1,760	1,850	2,750	9,500	2,650	3,500	2,100
12........	1,750	1,710	1,780	1,840	1,740	1,760	1,970	2,850	9,500	2,450	3,000	2,040
13........	1,750	1,720	1,850	1,790	1,720	1,750	2,050	2,600	9,200	2,250	3,000	2,030
14........	1,750	1,730	1,910	1,780	1,710	1,760	2,350	2,500	8,550	2,000	3,000	2,000
15........	1,750	1,750	1,930	1,750	1,720	1,760	2,350	2,500	8,000	1,940	2,800	2,130
16........	1,740	1,750	1,930	1,760	1,740	1,760	2,700	2,500	7,000	2,000	2,500	2,400
17........	1,740	1,720	1,910	1,760	1,770	1,760	3,100	3,750	6,000	2,150	2,500	2,000
18........	1,740	1,730	1,960	1,770	1,740	1,770	3,900	7,300	6,200	2,160	2,450	1,870
19........	1,680	1,720	1,940	1,760	1,790	1,760	4,500	7,000	7,900	2,150	2,450	1,900
20........	1,700	1,880	1,890	1,770	1,790	1,770	3,700	6,200	7,000	2,150	2,450	1,930
21........	1,740	1,890	1,790	1,780	1,780	1,770	3,500	4,800	7,500	2,150	2,300	1,880
22........	1,750	1,770	1,760	1,780	1,760	1,760	4,000	4,300	7,850	2,150	2,100	1,970
23........	1,740	1,810	1,780	1,780	1,830	1,760	4,500	4,000	7,500	2,300	2,100	1,950
24........	1,750	1,800	1,780	1,770	1,810	1,760	6,500	3,600	6,400	2,400	2,130	1,950
25........	1,740	1,810	1,800	1,770	1,840	1,760	5,400	3,250	5,700	2,400	2,080	1,950
26........	1,750	1,780	1,980	1,780	1,920	1,760	5,000	3,250	5,200	2,330	2,000	1,920
27........	1,760	1,760	2,300	1,780	1,950	1,770	4,300	3,200	4,600	2,300	2,000	1,890
28........	1,760	1,750	2,250	2,000	1,930	1,850	3,950	3,200	5,150	2,250	1,930	1,870
29........	1,760	1,760	2,020	1,880	1,950	2,100	3,850	3,100	4,600	2,130	1,870	2,080
30........	1,770	1,900	1,820	1,950	....	2,430	3,700	3,150	4,600	2,050	1,970	2,650
31........	1,760	....	1,780	1,960	....	2,500	....	3,950	....	2,020	2,000	....

MONTHLY DISCHARGE OF ANDROSCOGGIN RIVER AT BERLIN, N. H., FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 1350 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,780	1,680	1,750	1.29	1.49
November	1,900	1,710	1,760	1.30	1.45
December	2,300	1,740	1,860	1.38	1.59
January	2,000	1,750	1,840	1.36	1.57
February	1,950	1,710	1,800	1.33	1.43
March	2,500	1,750	1,850	1.37	1.58
April	6,500	1,750	3,210	2.38	2.66
May	7,300	2,500	3,750	2.78	3.20
June	9,500	4,550	6,670	4.94	5.51
July	5,500	1,940	2,970	2.20	2.54
August	4,200	1,870	2,360	1.75	2.02
September	2,650	1,870	2,040	1.51	1.68
The year	9,500	1,680	2,660	1.97	26.72

ANDROSCOGGIN RIVER AT RUMFORD, MAINE.

LOCATION.—Dam of Rumford Falls Power Company at Rumford.

DRAINAGE AREA.—2,090 square miles.

RECORDS AVAILABLE.—May 18, 1892, to September 30, 1916.

GAGES.—Staff in pond above dam, and in tailrace of power house.

DISCHARGE.—Computed from discharge over dam, using Francis weir formula with modified coefficient, and quantities passing through the various wheels of the power house, which have been carefully rated.

ICE.—Little affected by ice.

REGULATION.—Storage in Rangeley system of lakes at headwaters of Androscoggin River, aggregating 29.6 billion cubic feet, is largely under control. The stored water is regulated in the interests of waterpower users below and is under such excellent management that this is one of the best regulated streams in the country. Results not corrected for storage.

ACCURACY.—Results considered good.

CO-OPERATION.—Records obtained and computations made by Mr. Charles A. Mixer, engineer, Rumford Falls Power Company.

Daily Discharge, in Second-feet, of Androscoggin River at Rumford, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2,000	2,060	2,950	2,550	3,430	3,110	8,050	6,990	5,380	4,630	2,630	2,350
2	1,970	2,060	2,720	(a) 2,230	3,730	2,990	(a) 8,900	7,230	5,860	(a) 3,880	2,490	2,430
3	(a) 1,520	2,100	2,430	2,510	3,060	2,870	7,380	7,090	5,980	5,750	2,430	(a) 1,940
4	2,010	2,020	2,350	2,500	2,830	2,830	6,160	6,530	(a) 5,900	6,880	2,470	1,880
5	2,100	2,050	(a) 1,860	2,620	2,580	(a) 2,420	4,840	6,590	6,980	7,850	2,450	2,420
6	2,270	2,060	2,390	2,560	(a) 2,110	2,440	4,610	5,730	7,170	6,380	(a) 2,490	2,440
7	2,280	(a) 1,380	2,160	2,660	2,500	2,480	4,220	(a) 5,770	8,430	5,000	2,570	2,380
8	2,270	1,930	2,160	2,310	2,470	2,390	3,970	5,630	8,910	5,250	2,660	2,370
9	2,390	2,050	2,110	(a) 2,150	2,220	2,400	(a) 3,230	5,600	13,200	(a) 5,410	6,260	2,400
10	(a) 1,570	2,020	1,580	2,310	2,280	2,390	3,480	4,630	15,900	4,390	8,130	(a) 1,970
11	2,030	1,990	1,500	2,490	2,330	2,380	3,560	4,280	(a) 15,800	3,690	5,610	2,210
12	2,130	1,990	(a) 1,420	2,410	2,390	(a) 2,280	4,010	4,540	13,500	3,240	3,980	2,280
13	2,060	2,030	1,930	2,410	(a) 2,000	2,310	4,210	3,800	12,800	3,130	(a) 2,950	2,260
14	2,010	(a) 1,420	1,830	2,210	2,100	2,350	4,800	(a) 3,330	10,900	3,020	3,440	2,200
15	2,040	2,100	1,910	2,100	2,230	2,370	4,210	3,090	9,370	2,980	3,210	2,890
16	2,040	2,120	1,840	(a) 2,100	2,180	2,320	(a) 4,200	3,460	8,100	(a) 2,040	2,980	6,020
17	(a) 1,630	2,110	2,050	2,190	2,340	2,220	6,000	8,930	7,940	2,770	2,870	(a) 3,610
18	1,900	1,920	2,330	2,110	2,240	2,200	7,910	19,500	(a) 10,500	2,820	2,780	2,760
19	1,960	2,030	(a) 2,060	2,060	2,270	(a) 1,870	9,150	11,300	12,500	2,820	2,710	2,610
20	1,870	3,260	2,640	2,030	(a) 2,160	2,180	6,980	8,290	9,910	2,750	(a) 1,970	2,530
21	1,880	(a) 2,670	2,490	2,100	2,070	2,240	6,630	(a) 6,470	8,300	2,790	2,560	2,500
22	1,960	2,810	2,260	2,310	2,030	2,200	7,110	6,440	7,830	2,930	2,560	2,450
23	1,910	2,570	2,130	(a) 2,140	2,060	2,200	(a) 11,100	5,820	7,610	(a) 2,450	2,510	2,520
24	(a) 1,310	2,460	2,150	2,570	2,040	2,200	14,900	5,320	6,920	3,500	2,950	(a) 2,310
25	1,880	2,310	1,500	2,460	2,260	2,200	10,300	4,730	(a) 5,570	3,330	2,750	2,530
26	1,930	2,190	(a) 3,650	2,430	4,600	(a) 1,980	9,310	4,440	5,880	3,020	2,570	2,430
27	1,930	2,140	5,670	2,650	(a) 7,480	2,660	8,210	4,010	5,380	2,830	(a) 1,710	2,380
28	1,980	(a) 1,730	4,440	3,220	4,480	3,340	7,210	(a) 4,100	7,220	2,860	2,550	2,400
29	2,000	2,410	3,550	4,240	3,400	4,070	6,940	3,750	6,270	2,680	2,620	2,360
30	2,060	3,050	2,790	(a) 2,840	....	5,730	(a) 6,410	4,290	5,230	(a) 2,090	2,420	2,970
31	(a) 1,450	....	2,600	3,030	....	7,720	....	6,230	....	2,690	2,330	....

(a) Sunday.

MONTHLY DISCHARGE OF ANDROSCOGGIN RIVER AT RUMFORD, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 2090 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	2,390	1,310	1,950	0.93	1.07
November	3,260	1,380	2,170	1.04	1.16
December	5,670	1,420	2,430	1.16	1.34
January	4,240	2,030	2,470	1.18	1.36
February	7,480	2,000	2,750	1.32	1.42
March	7,720	1,870	2,750	1.32	1.52
April	14,900	3,230	6,600	3.16	3.53
May	19,500	3,090	6,060	2.90	3.34
June	15,900	5,230	8,710	4.17	4.65
July	7,850	2,040	3,740	1.79	2.06
August	8,130	1,710	3,050	1.46	1.68
September	6,020	1,940	2,560	1.22	1.36
The year	19,500	1,310	3,770	1.80	24.49

MAGALLOWAY RIVER, AZISCOHOS DAM.

LOCATION.—About 15 miles above the mouth; outlet is into Androscoggin River above Errol Dam.

DRAINAGE AREA.—215 square miles.

RECORDS AVAILABLE.—January 1, 1912, to September 30, 1916.

GAGE.—Vertical cast iron staff in two sections, the upper fastened to the concrete gate tower, and the lower to one of the concrete buttresses.

DISCHARGE.—The balanced cylinder gates are provided with scales and amount of gate opening may be determined very closely. Discharge at different gate openings ascertained by current meter measurements at a station about a mile below the dam.

REGULATION.—The storage of about 9,593,000,000 cubic feet is wholly under control and the discharge represents such amounts as are required for the water power interests below. The operation of the gates is planned to maintain as nearly as possible a constant flow at Berlin, N. H. Results not corrected for storage.

CO-OPERATION.—Discharge computed by Mr. Walter H. Sawyer, agent, Union Water Power Company, Lewiston, Maine.

MONTHLY DISCHARGE OF MAGALLOWAY RIVER AT AZISCOHOS DAM, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 215 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	898	76	147	.684	.78
November	148	84	97	.452	.50
December	88	86	86	.400	.46
January	935	88	213	.991	1.14
February	1,480	77	798	3.71	4.00
March	79	78	79	.367	.42
April	89	79	83	.386	.44
May	1,340	89	672	3.13	3.61
June	1,960	110	1,120	5.21	5.81
July	1,370	130	610	2.84	3.27
August	1,820	99	414	1.92	2.21
September	1,430	98	248	1.15	1.28
The year	1,960	76	378	1.76	23.92

Little Androscoggin River Near South Paris.

Location.—At left end of old dam at Biscoe Falls, and 200 feet below highway bridge, 5½ miles above South Paris.

Drainage Area.—75 square miles.

Records Available.—September 14, 1913, to September 30, 1916.

Gage.—Chain on left bank installed April 16, 1914; original vertical staff carried out by ice March 2, 1914; from March 18 to April 9, 1914, chain gage on foot bridge was used. All gages referred to same datum and at practically same place. Gage read by G. A. Jackson.

Channel and Control.—At low and medium stages through opening at left of dam; opening was enlarged by flood of April 9, 1914. Water flows over dam at gage height 5.30.

Discharge Measurements.—Made at low stages by wading at dam; at medium and high stages from highway bridge.

Ice.—Stage-discharge relation not affected by ice.

Regulation.—Storage at Snow's Falls, 1½ miles above the station, and at West Paris, 4 miles above, has some effect on regimen of stream.

Accuracy.—Stage-discharge relation practically permanent. Rating curve well defined below 700 second-feet and fairly well defined between 700 and 1600 second-feet. Gage read once daily to tenths. Results considered good.

Little Androscoggin River near South Paris, Maine.

The following discharge measurements were made:

	Date	Gage Height	Discharge
1915	Oct. 14	1.84	37.1
1916	Apr. 25	6.58	586
	" 27	5.78	421
	May 1	5.36	365
	" 8	3.12	140
	" 18	8.03	1700
	" 18	7.65	1320
	June 16	4.28	270
	" 20	5.48	345
	Aug. 23	1.50	23.1
	" 28	3.18	147
	Sept. 6	1.82	33.9

Daily Discharge, in Second-feet, of Little Androscoggin River near South Paris, for the Year Ending September 30, 1914.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	48	139	115	50	83	500	307	493	47	24	9	40
2	56	111	111	53	90	890	890	366	47	29	4	24
3	307	86	94	56	70	700	419	292	40	34	12	16
4	111	111	90	48	48	500	361	314	54	20	12	12
5	83	83	86	56	53	400	297	325	132	24	12	12
6	58	83	83	53	51	300	277	348	124	29	9	6
7	53	83	94	53	67	200	257	264	108	29	4	6
8	56	73	339	50	58	100	237	209	76	24	3	12
9	53	131	237	58	64	100	648	830	47	24	3	4
10	48	530	166	58	53	100	760	475	54	22	3	9
11	48	407	152	48	53	105	558	336	47	20	3	12
12	56	277	123	48	53	110	458	303	34	20	4	12
13	90	237	115	48	53	115	426	259	34	24	4	3
14	76	188	83	53	53	120	411	219	16	29	3	3
15	111	184	90	56	53	125	397	159	29	29	3	3
16	119	156	83	56	53	130	384	149	29	29	1	4
17	119	148	83	58	53	135	411	124	29	12	4	16
18	104	127	83	43	53	152	442	149	18	9	4	16
19	100	119	83	48	53	152	585	140	24	9	5	16
20	135	222	83	48	53	135	1,320	124	24	20	6	16
21	521	197	76	48	53	104	2,120	108	16	24	12	24
22	267	152	76	48	53	93	675	108	29	20	12	20
23	156	135	73	48	53	90	512	124	24	9	4	16
24	119	127	70	48	53	97	384	76	20	20	3	24
25	143	119	53	104	53	104	336	132	24	12	6	24
26	247	111	58	119	53	135	325	124	24	9	6	16
27	395	111	56	111	53	188	466	116	20	16	3	9
28	272	111	56	115	53	419	475	92	9	6	4	16
29	207	111	58	104	....	395	475	76	14	16	12	16
30	307	111	56	83	....	361	475	54	24	12	26	16
31	170	....	56	83	....	339	....	47	....	9	54	....

Daily Discharge, in Second-feet, of Little Androscoggin River near South Paris, for the Year Ending September 30, 1915.

Day.	Oct.	Nov.	Dec.	Jan	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	16	3	34	9	84	458	140	1,180	54	54	100	92
2	16	9	32	9	68	348	149	535	47	84	132	68
3	16	12	68	61	61	270	132	458	47	108	124	68
4	4	12	54	47	29	239	140	411	54	100	124	61
5	12	9	47	34	47	219	159	360	47	124	189	47
6	12	20	16	24	47	189	159	325	40	149	154	68
7	16	20	34	16	61	149	179	281	40	124	140	61
8	9	4	34	149	61	140	249	219	34	100	140	54
9	12	16	16	84	68	149	325	179	34	2,470	149	47
10	6	16	12	47	47	140	360	199	47	585	169	47
11	4	16	16	47	61	132	466	159	54	325	159	34
12	9	20	16	40	61	140	990	132	54	303	124	24
13	12	2	6	47	61	132	760	140	40	249	140	29
14	6	16	12	40	29	116	426	159	47	209	140	29
15	9	2	29	34	47	124	325	159	47	169	159	29
16	9	16	20	34	92	132	239	140	54	159	108	24
17	6	84	20	20	124	124	239	149	84	159	124	24
18	2	54	16	34	108	124	219	124	84	159	116	29
19	9	47	12	108	84	116	199	116	76	140	92	26
20	12	47	6	169	84	108	179	108	61	124	92	24
21	20	34	9	116	84	108	140	108	68	100	84	47
22	20	16	12	76	68	124	124	68	61	100	40	179
23	20	34	16	84	84	116	124	47	54	92	76	124
24	20	20	9	76	92	124	132	100	47	76	84	84
25	9	20	6	68	830	159	219	84	54	54	124	61
26	20	16	4	68	2,470	179	360	92	47	194	169	54
27	12	20	4	68	760	140	325	108	24	234	116	61
28	9	24	9	61	535	140	219	92	40	132	100	54
29	16	16	9	68	....	124	219	47	40	159	84	47
30	16	24	12	68	....	124	325	47	34	159	84	34
31	12	....	12	61	....	124	....	47	....	132	100	....

DAILY DISCHARGE, IN SECOND-FEET, OF LITTLE ANDROSCOGGIN RIVER AT SOUTH PARIS, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

DAY.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	40	68	108	124	159	189	990	366	219	124	40	54
2	40	47	100	108	169	159	990	292	199	84	34	54
3	68	40	68	124	132	140	865	219	159	502	29	47
4	47	47	54	108	124	124	615	219	169	325	24	61
5	54	61	40	92	116	108	426	209	199	502	20	32
6	61	54	54	108	108	92	442	169	169	325	24	47
7	54	47	47	100	108	108	458	140	149	199	24	47
8	92	61	47	92	92	108	458	132	194	199	20	29
9	84	54	40	68	92	100	384	124	475	159	239	308
10	76	47	47	61	108	92	360	132	1,040	124	314	159
11	68	29	34	54	108	100	325	124	865	159	124	92
12	68	47	47	54	76	76	397	116	558	149	108	76
13	47	61	34	68	47	84	458	100	475	149	84	47
14	40	47	34	68	68	84	493	76	397	124	108	47
15	47	68	40	68	68	76	458	92	303	92	76	47
16	40	84	29	61	61	68	411	108	244	61	47	484
17	29	76	29	54	54	68	512	615	426	76	47	249
18	34	61	40	47	47	61	558	1,870	675	68	34	159
19	40	54	40	54	61	61	990	585	434	61	24	179
20	34	169	47	54	54	61	493	442	348	61	16	124
21	29	149	47	54	47	68	458	360	303	100	12	108
22	34	108	40	68	47	54	372	292	239	108	9	92
23	29	100	47	92	54	61	632	259	179	108	219	140
24	29	76	47	92	47	61	1,320	239	140	84	360	320
25	24	54	40	84	47	68	558	219	124	68	132	149
26	34	47	219	92	219	100	458	199	124	76	108	140
27	68	47	493	108	524	199	384	149	159	54	124	128
28	54	40	270	179	325	325	360	132	209	61	132	116
29	61	47	199	159	219	493	512	124	159	54	132	108
30	124	124	140	132	....	760	512	348	159	47	108	116
31	108	....	132	132	....	945	....	397	....	47	54	....

Monthly Discharge of Little Androscoggin River near South Paris, Maine, for the Year Ending September 30, 1914.

[Drainage area, 75 square miles]

Month.	Discharge in Second-Feet.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	521	48	149	1.99	2.29
November	530	73	159	2.12	2.36
December	339	53	99	1.32	1.52
January	119	43	63	0.840	0.97
February	90	48	57	0.760	0.79
March	890	90	238	3.18	3.67
April	2,120	237	536	7.14	7.97
May	830	47	224	2.99	3.45
June	132	9	41	.546	.61
July	34	6	20	.267	.31
August	54	1	8	.106	.12
September	40	3	14	.187	.21
The year	2,120	1	134	1.79	24.27

Note.—G. H. of flood of March 2, 1914, as estimated on gage by observer 7.5.
Maximum discharge 2,570 second-feet; G. H. corresp. 8.9 7 a. m. April 21.
Minimum discharge 1 second-foot; G. H. corresp. 0.7 August 16.

MONTHLY DISCHARGE OF LITTLE ANDROSCOGGIN RIVER NEAR SOUTH PARIS, MAINE, FOR 1915-16.

[Drainage area, 75 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
1914-1915					
October	20	2	12	0.160	0.18
November	84	2	22	0.293	0.33
December	68	4	19	0.253	0.29
January	169	9	60	0.800	0.92
February	2,470	29	216	2.88	3.11
March	458	108	162	2.16	2.49
April	990	124	274	3.65	4.07
May	1,180	47	205	2.73	3.15
June	84	24	50	0.666	0.74
July	2,470	54	236	3.15	3.63
August	189	40	120	1.60	1.84
September	179	24	54	0.720	0.80
The year	2,470	2	119	1.59	21.55
1915-1916					
October	124	29	53	0.706	0.81
November	169	29	67	0.893	1.00
December	493	29	86	1.15	1.33
January	179	47	89	1.19	1.37
February	524	47	117	1.56	1.68
March	945	54	164	2.19	2.52
April	1,320	325	555	7.40	8.26
May	1,870	76	285	3.80	4.38
June	1,040	124	316	4.21	4.70
July	502	47	140	1.87	2.16
August	360	9	91	1.21	1.40
September	484	29	125	1.67	1.86
The year	1,870	9	174	2.32	31.47

NOTE.—(1915) Not affected by ice
Maximum discharge 2,970; G. H. corresp. 9.3 July 9, 1915.
Minimum discharge 2; G. H. corresp. 0.8 October 18 and November 13, 1914.
(1916) Not affected by ice.
Maximum discharge 2,420; G. H. corresp. 8.75 May 18, 1916.
Minimum discharge 9; G. H. corresp. 1.2 August 22, 1916.

PRESUMPSCOT RIVER BASIN.

Presumpscot River at Outlet of Sebago Lake, Maine.

Location.—Outlet dam at Sebago Lake and hydroelectric plant at Eel Weir Falls, 1 mile below.

Drainage Area.—436 square miles.

Records Available.—January 1, 1887, to September 30, 1916. Recomputation of data from 1887 to 1911 in second annual report Maine Water Storage Commission.

Gages.—On bulkhead of gatehouse at outlet dam and in forebay and tailrace of power plant.

Discharge.—Prior to March, 1904, discharge was determined from records of opening of gates in dam, the discharge capacity of which had been determined and tabulated by Mr. Hiram F. Mills of Lowell. Since March, 1904, discharge through the canal (about a mile long) has been recorded by three Allen meters, one on each pair of 30-inch Hercules wheels. These meters were rated by test at Holyoke, Mass., of one pair of wheels and the wheels and meters have been checked by current-meter measurements, brake tests of wheels, and electrical readings of generator output. Excess of water is wasted through a pair of regulating gates at the power station. A record of the opening of these gates is kept and flow computed, using a coefficient determined from current-meter tests. At times the flow from the lake may be greater than is safe to carry through the canal, though this has not yet happened. At such times it would be necessary to waste a part of the water through the old regulating gates in the main dam.

Ice.—Not affected by ice.

Regulation.—Sebago Lake (area, 46 square miles) is under complete control. Results not corrected for storage.

Accuracy.—Results considered good for a station of this type.

Co-operation.—Records obtained and computations made by S. D. Warren Co., Cumberland Mills, Me.

Daily Discharge, in Second-feet, of Presumpscot River, Outlet Sebago Lake, for the year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1........	643	562	687	(a) 577	590	615	445	555	674	872	798	782
2........	520	663	628	(a) 178	624	672	(a) 93	597	795	(a) 757	770	620
3........	(a) 178	680	648	644	630	653	537	598	802	740	783	(a) 162
4........	653	550	585	660	640	592	525	588	(a) 827	720	708	383
5........	622	637	(a) 222	645	570	(a) 232	638	600	937	1,250	695	755
6........	553	535	647	670	(a) 218	628	577	632	925	1,520	(a) 257	785
7........	650	(a) 208	702	652	648	638	637	(a) 138	965	1,480	802	837
8........	583	637	697	619	589	657	543	645	1,270	944	860	824
9........	581	681	682	(a) 210	664	622	(a) 153	632	1,620	(a) 914	876	700
10........	(a) 228	587	627	602	612	630	654	684	1,920	938	874	(a) 293
11........	632	585	667	622	650	670	552	632	(a) 1,980	952	882	767
12........	558	648	(a) 218	660	635	(a) 200	577	664	2,000	948	874	774
13........	482	628	612	658	(a) 248	607	472	638	2,040	950	(a) 252	810
14........	637	(a) 232	642	672	597	632	550	(a) 230	2,080	928	872	782
15........	640	727	635	657	637	683	530	658	2,070	910	872	803
16........	563	691	623	(a) 183	654	603	(a) 152	635	2,110	(a) 283	815	645
17........	(a) 232	612	642	660	627	674	638	382	2,180	705	867	(a) 323
18........	635	632	563	594	635	590	518	97	(a) 2,200	722	870	876
19........	625	605	(a) 147	664	619	(a) 232	432	434	2,200	782	867	874
20........	532	367	612	690	(a) 225	610	529	427	2,180	770	(a) 322	764
21........	637	(a) 230	670	619	640	625	577	(a) 577	2,280	774	835	824
22........	683	662	625	610	614	638	542	510	2,440	572	847	890
23........	513	605	638	(a) 227	692	630	(a) 18	642	2,440	(a) 442	840	862
24........	(a) 225	607	485	637	662	650	307	630	2,360	640	815	(a) 275
52	680	472	597	640	602	578	453	627	(a) 1,790	752	847	890
26........	587	715	(a) 417	587	212	(a) 187	515	580	1,450	800	820	888
27........	670	272	413	572	(a) 118	544	529	635	1,320	724	(a) 260	862
28........	598	(a) 280	517	577	504	507	502	(a) 212	1,000	772	850	892
29........	645	808	613	612	580	447	432	612	828	733	840	885
30........	597	602	643	(a) 213	....	467	(a) 168	585	878	(a) 305	824	892
31........	(a) 162	....	678	680	....	368	....	564	....	767	825	....

(a) Sunday.

MONTHLY DISCHARGE OF PRESUMPSCOT RIVER AT OUTLET SEBAGO LAKE, MAINE, FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 436 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	683	162	540	1.24	1.43
November	727	208	557	1.28	1.43
December	702	147	574	1.32	1.52
January	690	178	564	1.29	1.49
February	692	118	550	1.26	1.36
March	683	187	551	1.26	1.45
April	654	18	460	1.06	1.18
May	684	97	537	1.23	1.42
June	2,440	674	1,620	3.72	4.15
July	1,520	283	818	1.88	2.17
August	882	252	758	1.74	2.01
September	892	162	724	1.66	1.85
The year	2,440	18	687	1.58	21.46

SACO RIVER BASIN.

Great Falls Dam.

From information furnished by J. A. Leonard, Hydraulic Engineer, Cumberland County Power & Light Co.

The only recent development on the Saco River is that of the Cumberland County Power & Light Company at Great Falls, about 1½ miles below Hiram, where a dam and power house are now under construction.

The present development includes:

Concrete Dam:
- Spillway 290 ft. long.
- Bulkhead 250 ft. long.
- Average height 10 ft.
- Maximum height 30 ft.

Penstock:
- Wood stave pipe
- 11 ft. in diameter
- 465 ft. long.

Power Installation:
- Head 70 to 75 ft.
- Vertical shaft single runner turbine
- Direct connected to 3000 KVA generator
- 2300 volt 60 cycle, 3 phase.

Saco River at West Buxton, Maine.

Location.—At hydroelectric plant of Portland Electric Company at West Buxton, Maine.

Drainage Area.—1,550 square miles.

Records Available.—October 19, 1907, to September 30, 1916.

Gages.—Staff in pond above dam and in tailrace of power house.

Channel and Control.—Crest of concrete dam, about 300 feet long.

Discharge.—Flow over dam and through rated wheels of power plant determined by means of readings every hour of gages and gate openings.

Winter Flow.—Not affected by ice.

REGULATION.—Dams on numerous but comparatively small lakes in basin above station. Storage probably effects regimen of stream but not to extent that obtains in other basins in Maine where natural storage facilities are better and more fully developed.

ACCURACY.—Reprogle friction type of governors used with little change in gate openings; fluctuations in load taken up at Bonney Eagle development above; S. Morgan Smith wheels with Holyoke rating under similar head are used; results considered good.

CO-OPERATION.—Records furnished by Cumberland County Power and Light Company Portland, Me.

Daily Discharge, in Second-feet, of Saco River at West Buxton, for the Year Ending September 30, 1916.

Day.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	1,630	1,690	2,080	2,990	3,110	4,430	9,030	11,400	5,540	5,530	2,680	1,640
2	1,600	1,840	2,060	2,720	3,190	4,100	9,940	10,100	5,460	5,070	2,450	1,420
3	1,210	1,650	1,920	3,090	3,180	3,930	10,300	9,450	5,230	5,480	2,100	1,400
4	1,670	1,760	1,800	2,760	3,200	3,760	9,960	9,120	5,090	6,820	2,120	1,220
5	1,760	1,840	1,440	2,720	3,170	3,370	9,820	8,730	5,700	7,960	1,800	1,750
6	1,610	1,600	1,960	2,680	2,830	3,550	9,930	8,420	5,610	7,980	1,430	1,390
7	1,660	1,180	1,900	2,590	3,040	3,740	9,670	7,830	5,510	7,700	2,080	1,230
8	1,620	1,660	1,840	2,550	2,820	4,040	9,250	7,610	5,260	7,420	1,610	1,150
9	1,620	1,700	1,800	2,250	2,820	3,700	8,640	7,390	5,820	7,060	1,850	1,070
10	1,420	1,820	1,660	3,040	2,800	3,740	8,600	7,000	7,930	6,760	1,930	1,060
11	1,960	1,700	1,440	2,240	2,770	3,460	8,440	6,610	9,120	6,240	2,550	1,420
12	1,800	1,630	767	2,280	2,730	3,080	8,310	6,150	10,400	5,880	2,750	1,510
13	1,750	1,600	1,160	2,410	2,350	3,380	7,880	5,720	11,500	5,380	2,540	1,170
14	1,690	1,070	1,150	2,240	2,460	3,100	7,410	5,030	12,000	5,130	2,730	1,140
15	1,690	1,500	1,230	2,170	2,060	3,110	7,470	5,170	11,600	4,670	2,530	1,300
16	1,590	1,490	1,200	1,790	2,140	2,990	7,450	4,840	10,900	4,160	2,300	1,420
17	1,210	1,480	1,230	2,390	2,020	2,860	7,680	6,980	10,800	4,190	2,220	2,280
18	1,580	1,470	1,440	2,180	1,980	2,730	7,840	12,400	11,400	3,600	2,070	2,850
19	1,660	1,780	1,500	2,000	1,780	2,410	8,440	11,500	11,600	3,200	1,860	2,590
20	1,720	2,140	2,240	1,920	1,480	2,870	8,330	11,300	11,600	2,960	1,480	2,400
21	1,450	1,740	2,200	1,770	2,100	2,720	8,140	11,100	11,100	3,010	1,990	2,110
22	1,270	2,580	2,040	1,800	1,710	2,740	7,760	11,000	10,500	3,300	1,840	2,030
23	1,460	2,300	1,960	1,610	2,120	2,440	8,840	10,200	9,970	3,130	1,590	2,060
24	1,110	2,200	1,980	2,200	1,730	2,540	12,300	9,390	9,080	3,690	1,740	1,770
25	1,340	1,860	1,670	2,140	1,900	2,350	12,900	8,820	8,110	3,360	1,460	2,410
26	1,390	2,280	2,160	2,140	3,520	2,240	13,500	8,070	8,530	3,210	1,530	2,090
27	1,300	2,240	3,180	2,440	5,590	2,920	14,100	7,400	7,800	3,020	1,410	2,100
28	1,570	1,560	3,150	2,630	5,310	3,230	13,600	6,500	7,170	2,950	1,950	1,990
29	1,720	2,100	3,200	2,790	4,870	4,130	13,100	6,610	6,660	2,980	1,550	1,970
30	1,640	2,110	3,000	2,440	....	5,720	12,100	5,940	6,020	2,510	1,630	1,880
31	1,410	....	3,020	3,010	....	7,700	....	5,900	....	3,010	1,690	....

MONTHLY DISCHARGE OF SACO RIVER AT WEST BUXTON, MAINE FOR THE YEAR ENDING SEPTEMBER 30, 1916.

[Drainage area, 1550 square miles]

MONTH.	DISCHARGE IN SECOND-FEET.				Run-off—Depth in inches on drainage area.
	Maximum.	Minimum.	Mean.	Per square mile.	
October	1,960	1,110	1,550	1.00	1.15
November	2,580	1,070	1,780	1.15	1.28
December	3,200	767	1,910	1.23	1.42
January	3,090	1,610	2,380	1.54	1.78
February	5,590	1,710	2,780	1.79	1.93
March	7,700	2,240	3,460	2.23	2.57
April	14,100	7,410	9,690	6.25	6.97
May	12,400	4,840	8,180	5.28	6.09
June	12,000	5,090	8,440	5.45	6.08
July	7,980	2,510	4,750	3.06	3.53
August	2,750	1,410	1,980	1.28	1.48
September	2,850	1,060	1,730	1.12	1.25
The year	14,100	767	4,060	2.62	35.53

SACO RIVER AT CORNISH, MAINE.

LOCATION.—At highway bridge near Cornish Station; one half mile below mouth of Ossipee River.

DRAINAGE AREA.—1300 square miles.

RECORDS AVAILABLE.—June 4, 1916, to September 30, 1916.

GAGE.—Chain attached to bridge; read by S. J. Elliott.

DISCHARGE MEASUREMENTS.—Made from bridge.

CHANNEL AND CONTROL.—Sand and boulders; channel broken by one pier.

ICE.—Stage-discharge relation seriously affected by ice.

REGULATION.—Development at Swan Falls and Kezar Falls above the station probably have little effect on the flow.

ACCURACY.—Rating curve not well defined and publication of discharge withheld; uncertainty at present as to permanence of stage-discharge relation. Gage read to half-tenths twice daily.

Saco River at Cornish, Maine.

The following discharge measurements were made:

	Date	Gage Height	Discharge
1916	Jan. 25-26	3.77	1630
	May 11	4.30	5290
	May 19	5.70	9140
	July 15	3.56	4160
	Aug. 15	2.52	2200

Ossipee River at Cornish, Maine.

Location.—At highway bridge in Cornish 1¼ miles from mouth.

Drainage Area.—448 square miles.

Records Available.—July 5, 1916, to September 30, 1916.

Gage.—Chain attached to bridge; read by O. W. Adams.

Discharge Measurements.—Made from bridge.

Channel and Control.—Sand probably shifting; channel broken by one pier.

Ice.—Stage-discharge relation seriously affected by ice.

Regulation.—Flow affected by dams at Kezar Falls and at outlet of Great Ossipee Lake; not corrected for storage.

Accuracy.—Rating curve not well defined and publication of discharge withheld; uncertainty at present concerning permanence of stage-discharge relation. Gage read to half-tenths once daily.

Ossipee River at Cornish, Maine.

The following discharge measurements were made:

	Date	Gage Height	Discharge
1916	July 6	4.30	2240
	Aug. 15	2.08	847

LAKES AND PONDS IN MAINE.

WATER SURFACE ELEVATIONS FROM RECORDS AND TOPOGRAPHIC MAPS OF THE UNITED STATES GEOLOGICAL SURVEY.

LOCALITY.	COUNTY.	Elevation.
Abrams Pond, w. s	Hancock	167
Alamoosook Lake, w. s	Hancock	20
Alford Lake, w. s	Knox	269
Allen Pond, w. s	Androscoggin	342
Anasagunticook Lake, w. s	Oxford	403
Anonymous Pond, w. s	Cumberland	294
Annabessacook Lake, w. s	Kennebec	171
Auburn Lake, w. s	Androscoggin	259
Austin Pond, w. s	Somerset	1,185
Baker Pond, w. s	Somerset	1,063
Barker Pond, w. s	Somerset	378
Bear Pond, w. s	Androscoggin, Oxford	373
Bear Pond, w. s	Oxford	375
Beach Hill Pond, w. s	Hancock	199
Black Brook Pond, w. s	Somerset	893
Branch Lake, w. s	Hancock	236
Brandy Pond, w. s	Cumberland	267
Brewer Pond, w. s	Penobscot, Hancock	107
Bryant Pond, w. s	Oxford	694
Chase Pond, w. s	Somerset	1,353
Chemo Pond, w. s	Penobscot	126
Chickawaukie Pond, w. s	Knox	123
China Lake, w. s	Kennebec	195
Cobbosseecontee Pond, w. s	Kennebec	168
Cochnewagan Pond, w. s	Kennebec	271
Craig Pond, w. s	Hancock	213
Crawford Lake, w. s	Knox	110
Damariscotta Pond, w. s	Lincoln	51
Davis Pond, w. s	Penobscot	200
Dry Pond, w. s	Cumberland	305
Duck Pond, w. s	Cumberland	185
Dyer Long Pond, w. s	Lincoln	128
Eagle Lake, w. s	Hancock	275
East Pond, w. s	Kennebec	257
Ellis Pond, w. s	Kennebec	270
Embden Pond, w. s	Somerset	419
Fish Pond, w. s	Knox	355
Floods Pond, w. s	Hancock	298
Flying Pond, w. s	Kennebec	335
Goose Pond, w. s	Cumberland	275
Goose Pond, w. s	Hancock	307
Great Pond, w. s	Hancock	52
Great Pond, w. s	Kennebec	247
Greeley Pond, w. s	Kennebec	290
Green Lake, w. s	Hancock	156
Green Lake, w. s	Hancock	156
Halfmoon Pond, w. s	Waldo	328
Hancock Pond, w. s	Somerset	517
Hayden Lake	Somerset	330
Hermon Pond, w. s	Penobscot	122
Highland Lake, w. s	Cumberland	423
Highland Lake, w. s	Cumberland	426
Hobbs Pond, w. s	Knox	356
Holbrook Pond, w. s	Penobscot	200
Jordan Pond, w. s	Hancock	195
Keoka Lake, w. s	Oxford	492
Kezar Lake, w. s	Oxford	376
Kezar Pond, w. s	Oxford	374
Kimball Pond, w. s	Oxford	379
Lake George, w. s	Somerset	228
Little Austin Pond, w. s	Somerset	1,213
Little Sebago Lake	Cumberland	285
Long Lake, w. s	Cumberland	267
Long Pond, w. s	Kennebec	238
Long Pond, w. s	Oxford	533
Long Pond, w. s	Kennebec	238

LAKES AND PONDS IN MAINE. (Concluded.)

LOCALITY.	COUNTY.	Elevation.
Long Pond, w. s	Kennebec, Lincoln	190
Lovewell Pond, w. s	Oxford	358
Lower Patten Pond, w. s	Hancock	131
Mainstream Pond, w. s	Somerset	314
Maranacook Lake, w. s	Kennebec	212
Megunticook Lake, w. s	Knox	139
Messalonskee Lake, w. s	Kennebec	232
Middle Range Pond, w. s	Androscoggin	305
Moose Pond, w. s	Cumberland, Oxford	418
Moose Pond, w. s	Somerset	243
Mountain Pond, w. s	Hancock	264
Moxie Pond, w. s	Somerset	962
Mud Pond, w. s	Penobscot	117
Nehumkeag Pond, w. s	Kennebec	82
Nequasset Pond, w. s	Sagadahoc	15
North Pond, w. s	Oxford	719
North Pond, w. s	Kennebec, Somerset	250
Notched Pond, w. s	Cumberland	345
Panther Pond, w. s	Cumberland	277
Pennesseewassee Lake, w. s	Oxford	398
Phillips Lake, w. s	Hancock	223
Pleasant Lake, w. s	Cumberland	425
Pleasant Pond, w. s	Lincoln	146
Pleasant Pond, w. s	Somerset	1,262
Purgatory Pond, w. s	Kennebec	172
Pushaw Lake, w. s	Penobscot	117
Range Pond, w. s	Androscoggin	305
Rattlesnake Pond, w. s	Cumberland	277
Rowe Pond, w. s	Somerset	1,206
Sabbathday Pond, w. s	Cumberland	298
Sabattus Pond, w. s	Androscoggin	243
Scammon Pond, w. s	Hancock	146
Schoodic Lake, w. s	Washington	223
Sebago Lake, w. s	Cumberland	262
South Pond, w. s	Oxford	719
Stafford Pond, w. s	Somerset	262
Starbird Pond, w. s	Somerset	426
Stearns Pond, w. s	Oxford	444
Swan Lake, w. s	Waldo	200
Sweets Pond, w. s	Hancock	188
Taylor Pond, w. s	Androscoggin	239
Third Pond, w. s	Hancock	142
Thompson Lake, w. s	Oxford, Androscoggin Cumberland	325
Three-Cornered Pond, w. s	Kennebec	185
Three-Mile Pond, w. s	Kennebec	177
Toddy Pond, w. s	Hancock	158
Togus Pond, w. s	Kennebec	185
Tripp Pond, w. s	Androscoggin	306
Turtle Lake, w. s	Hancock	325
Twitchell Pond, w. s	Oxford	763
Upper Patten Pond	Hancock	162
Webb Pond, w. s	Hancock	133
Weber Pond, w. s	Kennebec	135
Wentworth Pond, w. s	Somerset	579
Williams Pond, w. s	Hancock	263

Altitudes of Summits in Maine, taken from Records and Topographic Maps of the United States Geological Survey.

Locality.	County.	Elevation.
Adams Hill	Cumberland	593
Bald Head	York	1,017
Bald Mountain	Hancock	1,261
Bald Mountain (triangulation station)	Somerset	2,630
Bald Mountain	Knox	1,272
Bear Mountain (triangulation station)	Oxford	1,207
Bald Pate	Cumberland	1,160
Beach Ridge	Cumberland	1,052
Bear Mountain	Oxford	1,065
Beaver Hill	York	626
Beech Hill	Kennebec	543
Beech Mountain	Hancock	855
Bigelow Hill (triangulation station)	Somerset	785
Big Hill	Hancock	1,090
Blackstrap Hill	Cumberland	505
Blaisdell Hill	Hancock	560
Blinn Hill	Lincoln	442
Blue Hill (triangulation station)	Hancock	940
Bradbury Mountain	Cumberland	484
Brown Hill	Cumberland	548
Browns Mountain	Hancock	880
Call Hill	Lincoln	342
Cedar Mountain	York	1,220
Chase Mountain	Hancock	820
Cobb Hill (triangulation station)	Hancock	562
Clark Mountain	Androscoggin	707
Curtis Hill (triangulation station)	Oxford	1,475
Cushman Hill	Lincoln	221
Day Mountain	Hancock	610
Dennis Hill	Kennebec	447
Dimmick Mountain	Somerset	1,876
Dodling Hill	Kennebec	650
Dog Mountain	Hancock	670
Douglas Hill	Cumberland	1,407
Dry Mountain	Hancock	1,268
Dutton Hill	Cumberland	571
Dyer Hill	Lincoln	430
East Peak	Hancock	971
East Royce Mountain	Oxford	3,125
Ephraim Mountain (triangulation station)	Waldo	720
Eustis Mountain	Waldo	545
Fitch Hill	Cumberland	1,143
Fitz Mountain	Hancock	605
Flag Hill	Hancock	952
Fletcher Mountain (triangulation station)	Somerset	1,700
Flying Moose Mountain	Hancock	916
Fort Ridge	York	1,124
Frost Hill	Oxford	970
Frost Hill	York	301
Gloucester Hill	Cumberland	493
Goose Pond Mountain	Hancock	240
Great Pond Hill	Hancock	540
Great Mountain	Hancock	1,037
Green Hill	Somerset	586
Green Mountain (Mt. Desert triangulation station)	Hancock	1,532
Haggett Hill	Lincoln	245
Hawk Mountain	Oxford	1,065
Heagan Mountain	Waldo	560
Herman Hill	Penobscot	364
Hinkley Hill (triangulation station)	Penobscot	490
Holt Hill	Oxford	1,005
Hopkins Hill (triangulation station)	Hancock	423
Horse Hill	Oxford	875
Hosac Mountain	York	1,080
Howland Hill	Kennebec	705
Hunt Hill	Lincoln	351
Jewell Hill (triangulation station)	Somerset	611
Jones Hill	Kennebec	368

ALTITUDES OF SUMMITS IN MAINE. (Concluded.)

Locality.	County.	Elevation.
Jordan Mountain	Hancock	1,180
Joy Ridge	Kennebec	426
Katahdin Mountain (highest point in state yet determined) *Water Resources Branch Bulletin* 279	Piscataquis	5,273
Kenniston Hill	Lincoln	290
McCloud Mountain	Hancock	334
McFarland Mountain	Hancock	761
Mack Mountain	Waldo	605
Mann Mountain	York	1,075
Mason Mountain	Hancock	601
Mead Mountain	Hancock	675
Megunticook Mountain	Knox	1,380
Merrill Hill (triangulation station)	Androscoggin	674
Moody Mountain	York	783
Mosquito Mountain	Waldo	545
Mosquito Mountain	Somerset	2,230
Mount Ararat	Sagadahoc	255
Mount Henry	Cumberland	666
Mount Tom	Somerset	765
Mount Tirem	Oxford	1,047
Moxie (triangulation station)	Somerset	2,925
Newport Mountain	Hancock	1,060
Oak Hill	Hancock	880
Ossipee Hill	York	1,050
Peaked Hills	Cumberland	1,107
Peaked Mount (Saunders triangulation station)	Hancock	1,104
Philip Mountain	Kennebec	750
Picket Mountain	York	854
Pigeon Hill	Washington	202
Pike Hill	Oxford	870
Pleasant Mountain	Knox	1,064
Pleasant Mountain (triangulation station)	Oxford	2,007
Peak of Otter	Hancock	506
Pigeon Hill	Washington	307
Pleasant Pond Mountain	Somerset	2,480
Province Mountain	York	1,152
Quaker Hill (triangulation station)	Kennebec	598
Ragged Mountain (triangulation station)	Knox	1,300
Randall Mountain	York	1,105
Rattlesnake Mountain	Cumberland	1,046
Rices Hill	Oxford	1,320
Ring Hill	Kennebec	400
Robinson Mountain	Hancock	680
Sabattus Mountain (triangulation station)	Androscoggin	802
Sawyer Mountain (triangulation station)	York	1,210
Schoodic Mountain	Hancock	437
Speckled Mountain (triangulation station)	Oxford	2,207
Springer Hill	Kennebec	555
Sprague Hill	Sagadahoc	200
Snow Mountain	Waldo	742
Stickney Hill (triangulation station)	Somerset	968
Streaked Mountain (triangulation station	Oxford	1,770
Stubb Hill (triangulation station)	Hancock	480
Summit Spring Hill	Cumberland	883
Sunset Rock	Somerset	364
Tate Hill	Sagadahoc	375
The White Cap	Hancock	925
Tiger Hill	Cumberland	723
Treat Hill	Waldo	370
Waldo Mountain (triangulation station)	Waldo	1,062
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APPENDIX.

DEPARTMENT OF COMMERCE
UNITED STATES COAST AND GEODETIC SURVEY
E. LESTER JONES, SUPERINTENDENT

PRELIMINARY RESULTS OF PRECISE LEVELING IN MAINE BETWEEN BOUNDARY AND VANCEBORO, ALONG THE CANADIAN PACIFIC RAILROAD AND THE MAINE CENTRAL RAILROAD FIELD WORK WAS DONE IN 1916

PRECISE LEVELING BETWEEN BOUNDARY AND VANCEBORO, ME.

This line of levels was run over the tracks of the Canadian Pacific Railroad between Boundary and Mattawamkeag and over the tracks of the Maine Central Railroad between Mattawamkeag and Vanceboro by a party of this Survey under the charge of Assistant John D. Powell during the season of 1916. The line has a length of 340 kilometers (211 miles) and serves as a connecting link between two points of the Canadian system of leveling. The elevations of 105 permanent bench marks and of the top of spike at the base of rail at 33 points were determined.

The leveling started on Canadian bench mark 23-A near Megantic, Quebec, and ended on Canadian bench mark 13-B near Vanceboro, Me. The elevation of bench mark 13-B, as given by the observed and unadjusted leveling, based upon the published elevation of bench mark 23-A (448.5778 meters equal 1471.709 feet[1]), was 118.3561 meters. The published elevation of 13-B is 118.3916 meters or 388.423 feet[2]. The difference between the observed and published elevations of bench mark 13-B is 0.0355 meter. This difference was distributed over the entire length of the line at the rate of about 0.1 millimeter per kilometer.

The elevations given for the bench marks and the top of spikes are not to be considered as standard or fixed but are the best available at this time. They are given out in this form to supply the immediate needs of engineers and others in a territory without leveling control. It is probable that the elevations will be changed by a small fraction of a meter when the precise level net of the United States is extended

[1]See page 76, Vol. 1, No. 3, Publications of the Dominion Observatory, Ottawa, Canada, 1913.

[2]See page 460, Vol. 1, Report of the Chief Astronomer (Canadian), 1910.

to the New England States and the level nets of this country and Canada, which join at many places, are adjusted to give standard elevations near the international boundary. As this is not a prospect of the near future the given elevations will probably be held for several years.

General Notes Describing Different Forms and Markings of Bench Marks[1].

Note 1.—This type of bench mark is the red metal disk designed by the Coast and Geodetic Survey, lettered "U. S. Coast and Geodetic Survey, B. M. $250 fine or imprisonment for disturbing this mark." The disk is 3 inches in diameter, with a 3-inch tenon upon the back for setting it, and is set in cement flush with a horizontal or vertical surface. In the latter case a horizontal mark cut on it, or the horizontal mark of a cross, is the bench mark.

Note 13.—The surface within an outlined square, 1 inch on each side, on a horizontal surface of masonry or metal, unlettered.

Note 17.—A 3-inch aluminum or bronze disk[1] lettered "U. S. Geological Survey B. M. $250 fine or imprisonment for disturbing this mark. Elevation above sea —— feet. Datum ——." Each disk is stamped with the approximate elevation in feet and a letter or letters to indicate the datum plane. This elevation and the datum letter or letters usually form the name by which the bench mark is designated in this publication.

Elevations and Descriptions of Permanent Bench Marks Between Boundary and Vanceboro, Me., 1916.

23-A.—In the west face of an irregular, partly broken mass of rock, 12 feet (4 meters) south of the Canadian Pacific Railroad tracks and 25 feet (8 meters) east of the thirteenth telegraph pole east of Ditchfield station, Quebec. (448.5778 meters equal 1471.709 feet.)

D.—About 1/16 mile east of Boundary, Franklin County, Me., on a large bowlder, about 20 meters (66 feet) north of the Canadian Pacific Railroad tracks. Note 1. (560.881 meters equal 1840.157 feet.)

E.—About 1/8 mile east of Boundary, Franklin County, Me., on the south parapet of concrete culvert under the Canadian Pacific Railroad tracks. Note 1. (556.941 meters equal 1827.231 feet.)

F.—About 1.6 miles east of Boundary, Franklin County, Me., on the south parapet of concrete culvert under the Canadian Pacific Railroad tracks at a point about 50 meters (164 feet) west of mile pole 100. Note 13. (529.323 meters equal 1736.621 feet.)

G.—About 2 miles east of Boundary, Franklin County, Me., on a low, flat, ledge rock, about 15 meters (49 feet) north of the Canadian Pacific

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[1]Any person who finds that one of the bench marks here described is disturbed, or that the description is not in accordance with the facts, is requested to notify the Superintendent of the Coast and Geodetic Survey, Washington, D. C.

Railroad tracks at a point midway between mile poles 99 and 100. Note 1. (518.340 meters equal 1700.587 feet.)

H.—At Lowelltown, Franklin County, Me., on the south side of the concrete foundation of the Canadian Pacific Railroad water tank. Note 1. (486.380 meters equal 1595.732 feet.)

I.—About 0.2 mile east of Lowelltown, Franklin County, Me., on a medium-sized bowlder, about 50 meters (164 feet) south of the Canadian Pacific Railroad tracks. Note 1. (482.707 meters equal 1583.681 feet.)

J. About 0.9 mile west of Skinner, Franklin County, Me., on a flat ledge rock, about 20 meters (66 feet) north of the Canadian Pacific Railroad tracks at a point 500 meters (1640 feet) east of mile pole 96. Note 1. (447.530 meters equal 1468.271 feet.)

K. At Skinner, Franklin County, Me., on a low, flat rock, about 20 meters (66 feet) south of the Canadian Pacific Railroad tracks at a point about 1/8 mile east of the railroad depot. Note 1. (433.686 meters equal 1422.851 feet.)

L.—At Franklin, Franklin County, Me., on a large pointed rock about 1 meter outside of the Canadian Pacific Railroad right of way, 25 meters (82 feet) south of the tracks and about 150 meters (492 feet) west of the depot. Note 1. (405.645 meters equal 1330.854 feet.)

M.—About 2.1 miles east of Franklin, Franklin County, Me., on a flat ledge rock, about 420 meters (1378 feet) west of mile pole 90 and about 15 meters (49 feet) north of the Canadian Pacific Railroad tracks. Note 1. (390.339 meters equal 1280.637 feet.)

N.—About 1.8 miles west of Holeb, Somerset County, Me., on a low, granite bowlder, about 500 meters (1640 feet) west of mile pole 88 and about 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (386.391 meters equal 1267.684 feet.)

O.—About 0.2 mile west of Holeb, Somerset County, Me., on a large mass of ledge rock, 250 meters (820 feet) west of the water tank and about 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (383.216 meters equal 1257,268 feet.)

P. About 1 mile east of Holeb, Somerset County, Me., north of the tracks on the east abutment of the Canadian Pacific Railroad bridge at mile pole 85.40. Note 1. (379.722 meters equal 1245.805 feet.)

Q.—About 2.8 miles west of Attean, Somerset County, Me., on a large granite bowlder about 300 meters (984 feet) east of mile pole 82 and 15 meters (49 feet) south of the Canadian Pacific Railroad tracks. Note 1. (381.236 meters equal 1250.772 feet.)

R.—About 1.3 miles west of Attean, Somerset County, Me., on a large ledge rock overlooking Attean Pond, 3 1/2 telegraph poles west of mile pole 80 and about 15 meters (49 feet) south of the Canadian Pacific Railroad tracks. Note 1. (371.840 meters equal 1219.945 feet.)

S.—About 0.9 mile east of Attean, Somerset County, Me., on a large bowlder, 75 meters (246 feet) east of mile pole 78 and 10 meters (33 feet) north of the Canadian Pacific Railroad tracks. Note 1. 368.436 meters equal 1208.777 feet.)

T.—About 2 miles west of Jackman, Somerset County, Me., on the west abutment of the Canadian Pacific Railroad bridge over the Moose River at mile pole 75.5. Note 1. (356.838 meters equal 1170.726 feet.)

U. S. G. S. No. 6.—About 2 miles west of Jackman, Somerset County, Me., on the east abutment of the Canadian Pacific Railroad bridge over the Moose River at mile pole 75.5. Note 17. (356.742 meters equal 1170.411 feet.)

U.—About 0.4 mile west of Jackman, Somerset County, Me., on the north parapet of the concrete culvert under the Canadian Pacific Railroad tracks, 2 telegraph poles east of mile pole 74, 20 meters (66 feet) east of a road crossing entering the Newcastle Lumber Co.'s yard. Note 1. (367.091 meters equal 1204.364 feet.)

V.—At Jackman, Somerset County, Me., on the northwest corner of the south wing of the Roman Catholic Convent which is 1/4 mile south of the depot. Note 1. (381.077 meters equal 1250.250 feet.)

W.—At Jackman, Somerset County, Me., on a large bowlder about 30 meters (98 feet) east of the railroad depot and about 10 meters (33 feet) south of the Canadian Pacific Railroad tracks. Note 13. (372.327 meters or 1221. 543 feet.)

X.—About 0.9 mile east of Jackman, Somerset County, Me., on a flat ledge rock, 13 telegraph poles east of mile pole 73, and about 20 meters (66 feet) north of the Canadian Pacific Railroad tracks. Note 1. (357.824 meters equal 1173. 961 feet.)

Y.—About 0.3 mile west of Blair, Somerset County, Me., over the central pier of a double, flat-slab culvert, 8 1-2 telegraph poles east of mile pole 70, on the north side of the Canadian Pacific Railroad tracks. Note 1. (355.297 meters equal 1165.670 feet.)

Z.—About 1.6 miles east of Blair, Somerset County, Me., in a large mass of shale rock, 2 telegraph poles west of mile pole 68, and about 15 meters (49 feet) north of the Canadian Pacific Railroad tracks. Note 1. (358.243 meters equal 1175.336 feet.)

A_1.—At Long Pond, Somerset County, Me., on a large granite bowlder about 20 meters (66 feet) north of the Canadian Pacific Railroad tracks and just in the rear of the building used as the post office and the general store of the Kellogg Lumber Co. Note 1. (363.292 meters equal 1191.900 feet.)

B_1.—About 1.5 miles east of Long Pond, Somerset County, Me., on the east abutment of the Canadian Pacific Railroad bridge over Parlin stream, near mile pole 63.5. Note 1. (356.310 meters equal 1168.994 feet.)

C_1.—About 1 mile west of Mackamp, Somerset County, Me., on a large, flat, moss-covered rock, 1-3 mile west of mile pole 61 and about 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (362.177 meters equal 1188.242 feet.)

D_1.—At Mackamp, Somerset County Me., on the south parapet of the granite culvert under the Canadian Pacific Railroad tracks, 20 meters (66 feet) east of the east switch of the sidetrack, near mile pole 60. Note 1. (357.039 meters equal 1171.385 feet.)

E_1.—About 1.9 miles west of Brassua, Somerset County, Me., in a bowlder about 12 telegraph poles east of mile pole 58 and 15 meters (49 feet) south of the Canadian Pacific Railroad tracks. Note 1. (354.962 meters equal 1164.571 feet.)

F_1.—About 0.2 mile west of Brassua, Somerset County, Me., on the south parapet of the concrete culvert under the Canadian Pacific Railroad tracks at a point 3 telegraph poles west of mile pole 56. Note 1. (339.909 meters equal 1115.185 feet.)

U.S.G.S. 3.—About 0.2 mile west of Tarratine, Somerset County, Me., on the south side of the east abutment of the Canadian Pacific Railroad bridge over Misery Stream at mile pole 52. Note 17. (338.244 meters equal 1109.722 feet.)

G_1.—About 0.2 mile east of Somerset Junction, Somerset County, Me., on the top of the bridge over the west outlet of Moosehead Lake at mile pole 48.72. The mark is in the center of the stone arch span which forms part of this bridge. Note 1. (313.399 meters equal 1028.210 feet.)

U.S.G.S. 2.—About 0.2 mile east of Somerset Junction, Somerset County, Me., on the north side of the east abutement of the Canadian Pacific Railroad bridge over the west outlet of Moosehead Lake at mile pole 48.72. Note 17. (313.347 meters equal 1028.039 feet.)

H_1.—About 1.7 miles east of Somerset Junction, Somerset County, Me., on a large granite bowlder 3 telegraph poles east of mile pole 47 and about 10 meters (33 feet) south of the Canadian Pacific Railroad tracks. Note 13. (309.587 meters equal 1015.703 feet.)

U.S.G.S. 1.—At Moosehead, Piscataquis County, Me., on the south side of the east abutment of the Canadian Pacific Railroad bridge over the Kennebec River. Note 17. (313.363 meters equal 1028.092 feet.)

I_1.—About 1.6 miles east of Moosehead, Piscataquis County, Me., on a bowlder 12 telegraph poles east of mile pole 43 and about 20 meters (66 feet) north of the Canadian Pacific Railroad tracks. Note 1. (321.156 meters equal 1053.659 feet.)

J_1.—About 2.8 miles west of Squaw Brook, Piscataquis County, Me., on a bowlder 4 1-2 telegraph poles east of mile pole 41 and 20 meters (66 feet) north of the Canadian Pacific Railroad tracks. Note 1. (315.960 meters equal 1036.612 feet.)

K_1.—About 0.8 mile west of Squaw Brook, Piscataquis County, Maine, on the south parapet of the concrete culvert under the Canadian Pacific Railroad tracks at a point about 3 telegraph poles west of mile pole 39. Note 1. (317.309 meters equal 1041.038 feet.)

L_1.—At Squaw Brook, Piscataquis County, Me., in a large outcrop of ledge rock 8 1-2 telegraph poles west of mile pole 38 and about 20 meters (66) feet) north of the Canadian Pacific Railroad tracks. Note 1. (316.832 meters equal 1039.473 feet.)

M_1.—About 2 miles west of Greenville Junction, Piscataquis County, Me., in the north parapet of the concrete culvert 14 1-2 telegraph poles west of mile pole 35. Note 1. (316.571 meters equal 1038.617 feet.)

N_1.—At Greenville Junction, Piscataquis County, Me., on the south side of the top course of stone on the west abutement of the Canadian

Pacific Railroad bridge over the highway just east of the depot. Note 1. (322.660 meters equal 1058.594 feet.)

O_1.—At Greenville Junction, Piscataquis County, Me., in the stone work on the northwest corner of the Y. M. C. A. Building. Note 1. (315.878 meters equal 1036.343 feet.)

P_1.—About 2.3 miles east of Greenville Junction, Piscataquis County, Me., on a large bowlder 1-2 telegraph pole west of mile pole 31 and 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (341.727 meters equal 1121.149 feet.)

Q_1.—About 2.5 miles west of Morkill, Piscataquis County, Me., on a large rock 1 telegraph pole east of mile pole 29 and about 15 meters (49 feet) south of the Canadian Pacific Railroad tracks. Note 1. (319.832 meters equal 1049.315 feet.)

R_1.—About 1.9 miles west of Morkill, Piscataquis County, Me., in the north side of the west abutement of the Canadian Pacific Railroad trestle at mile pole 28.29. Note 13. (309.583 meters equal 1015.690 feet.)

S_1.—About 0.6 mile west of Morkill, Piscataquis County, Me., in the south parapet of the Canadian Pacific Railroad culvert 3 1-2 telegraph poles west of mile pole 27. Note 1. (304.397 meters equal 998.676 feet.)

T_1.—About 1.7 miles east of Morkill, Piscataquis County, Me., on the north side of the east abutment of the Canadian Pacific Railroad bridge at mile pole 24.89. Note 1. (293.558 meters equal 963.115 feet.)

U_1.—About 2.4 miles west of Bodfish, Piscataquis County, Me., in the south parapet of the concrete culvert under the Canadian Pacific Railroad tracks 18 telegraph poles east of mile pole 23. Note 1. (258.986 meters equal 849.690 feet.)

V_1.—About 1.1 miles east of Bodfish, Piscataquis County, Me., in the north parapet of the Canadian Pacific Railroad culvert 2 telegraph poles west of mile pole 20. Note 1. (218.922 meters equal 718.247 feet.)

W_1.—About 0.2 mile west of Onawa, Piscataquis County, Me., in a large granite bowlder 4 telegraph poles east of mile pole 18 and about 20 meters (66 feet) north of the Canadian Pacific Railroad tracks. Note 1. (192.987 meters equal 633.158 feet.)

X_1.—About 0.6 mile east of Onawa, Piscataquis County, Me., on the north side of the west abutment of the Canadian Pacific Railroad trestle over Ship Pond Stream at mile pole 17.20. Note 1. (195.820 meters equal 642.453 feet.)

Y_1.—About 2.7 miles west of Benson, Piscataquis County, Me., in the north parapet of the concrete culvert under the Canadian Pacific Railroad tracks 19 telegraph poles east of mile pole 16. Note 1. (219.528 meters equal 720.235 feet.)

Z_1.—About 0.2 mile east of Benson, Piscataquis County, Me., in a granite bowlder 18 meters (59 feet) south of the Canadian Pacific Railroad tracks at mile pole 13. Note 1. (222.253 meters equal 729.175 feet.)

A_2.—About 0.3 mile west of Ray, Piscataquis County, Me., in the north parapet of a large concrete culvert which is about 11 1-2 miles west of Brownville Junction. Note 13. (215.436 meters equal 706.810 feet.)

B_2.—About 0.6 mile east of Ray, Piscataquis County, Me., in a granite bowlder 16 telegraph poles east of mile pole 11 and about 25 meters (82 feet) north of the Canadian Pacific Railroad tracks. Note 1. (226.631 meters equal 743.539 feet.)

C_2.—About 0.6 mile east of Barnard, Piscataquis County, Me., in a large granite bowlder 1 1-2 telegraph poles west of mile pole 8 and 20 meters (66 feet) north of Canadian Pacific Railroad tracks. Note 1. (227.164 meters equal 745.287 feet.)

D_2.—About 1 1-2 miles west of Williamsburg, Piscataquis County, Me., in a granite bowlder 20 telegraph poles east of mile pole 6 and 25 meters (82 feet) south of the Canadian Pacific Railroad tracks. Note 1. (206.876 meters equal 678.726 feet.)

E_2.—About 2.3 miles west of Brownville Junction, Piscataquis County, Me., in a bowlder 17 telegraph poles west of mile pole 2 and 20 meters (66 feet) north of the Canadian Pacific Railroad tracks. Note 1. (155.386 meters equal 509.796 feet.)

F_2.—At Brownville Junction, Piscataquis County, Me., on the cement porch of Wilkinson's store on Main Street. Note 1. (119.084 meters equal 390.695 feet.)

G_2.—About 1.7 miles west of Knights, Piscataquis County, Me., in a bowlder 3 1-2 telegraph poles west of mile pole 102 and 15 meters (49 feet) south of the Canadian Pacific Railroad tracks. Note 1. (152.906 meters equal 501.659 feet.)

H_2.—About 0.4 mile east of Knights, Piscataquis County, Me., on a bowlder 1 telegraph pole east of mile pole 100 and south of the Canadian Pacific Railroad tracks. Note 1. (156.937 meters equal 514.884 feet.)

I_2.—About 1.9 miles west of Lake View, Piscataquis County, Me., on a bowlder 16 telegraph poles west of mile pole 97 and about 15 meters (49 feet) north of the Canadian Pacific Railroad tracks. Note 1. (141.528 meters equal 464.330 feet.)

J_2.—About 0.5 mile east of Lake View, Piscataquis County, Me., on a granite bowlder 1 telegraph pole west of mile pole 95, at edge of right of way south of the Canadian Pacific Railroad tracks. Note 1. (140.782 meters equal 461.882 feet.)

K_2.—About 3 miles west of Hardy Pond, Piscataquis County, Me., on the north parapet of the concrete culvert 17 1-2 telegraph poles east of mile pole 93. Note 1. (107.485 meters equal 352.640 feet.)

L_2.—At Hardy Pond, Piscataquis County, Me., on a large granite bowlder 8 3-4 telegraph poles east of mile pole 90 and 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (121.599 meters equal 398.946 feet.)

M_2.—About 0.3 mile west of Russell's siding, Penobscot County, Me., on a large granite bowlder 19 telegraph poles west of mile pole 87 and about 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (97.181 meters equal 318.835 feet.)

N_2.—About 1.5 miles west of Seboois, Penobscot County, Me., on a large granite bowlder 6 telegraph poles east of mile pole 85 and 15 meters

(49 feet) north of the Canadian Pacific Railroad tracks. Note 1. (73.268 meters equal 240.380 feet.)

U.S.G.S. 223.—About 0.6 mile east of Seboois, Penobscot County, Me., on a bowlder 11 telegraph poles east of mile pole 83 and about 15 meters (49 feet) north of the Canadian Pacific Railroad tracks. Note 17. (68.176 meters equal 223.674 feet.)

O_2.—About 1 mile east of Seboois, Penobscot County, Me., on a granite bowlder 22 1-2 telegraph poles east of mile pole 83 and 18 meters (59 feet) north of the Canadian Pacific Railroad tracks. Note. 1. (75.822 meters equal 248.759 feet.)

P_2.—About 1 mile west of Gilford, Penobscot County, Me., on the north side of the east abutment of the Canadian Pacific Railroad bridge at mill pole 80.41. Note 1. (69.057 meters equal 226.565 feet.)

U.S.G.S. 225.—About 0.4 mile west of Gilford, Penobscot County, Me., on the south side of the east abutment of the Canadian Pacific Railroad bridge at mile pole 70.94. Note 17. (68.590 meters equal 225.032 feet.)

Q_2.—About 0.4 mile west of Woodard, Penobscot County, Me., on a large bowlder 2 1-2 telegraph poles west of mile pole 76 and about 10 meters (33 feet) north of the Canadian Pacific Railroad tracks. Note 1. (84.948 meters equal 278.700 feet.)

R_2.—About 1.9 miles east of Woodard, Penobscot County, Me., on a bowlder 5 telegraph poles east of mile pole 74 and 18 meters (59 feet) north of the Canadian Pacific Railroad tracks. Note 1. (86.904 meters equal 285.118 feet.)

U.S.G.S. 217.—About 2.5 miles west of Chester, Penobscot County, Me., on the north side of the west abutment of the Canadian Pacific Railroad bridge over Madunkieunk Stream at mile pole 72.29. Note 17. (66.050 meters equal 216.699 feet.)

S_2.—About 0.8 mile west of Chester, Penobscot County, Me., on a granite bowlder 17 3-4 telegraph poles east of mile pole 71 and 20 meters (66 feet) south of the Canadian Pacific Railroad tracks. Note 1. (77.687 meters equal 254.878 feet.)

T_2.—At Craigvale, Penobscot County, Me., on the south side of the Canadian Pacific Railroad culvert 20 1-2 telegraph poles west of mile pole 66. Note 1. (70.173 meters equal 230.226 feet.)

U_2.—About 2 miles west of Mattawamkeag, Penobscot County, Me., in a granite bowlder at mile pole 64 about 15 meters (49 feet) north of the Canadian Pacific Railroad tracks. Note 1. (64.699 meters equal 212.267 feet.)

V_2.—At Mattawamkeag, Penobscot County, Me., in the north parapet of the concrete culvert in the Maine Central yards about 300 meters (984 feet) west of the depot. Note 1. (66.065 meters equal 216.748 feet.)

W_2.—At Mattawamkeag, Penobscot County, Me., in the foundation just south of the west entrance to the Methodist Episcopal Church. Note 1. (66.661 meters equal 218.704 feet.)

Y_2.—About 1.2 miles west of Gordon, Penobscot County, Me., on a large granite bowlder 6 telegraph poles west of the sign "Gordon One

Mile" and about 10 meters (33 feet) north of the Maine Central Railroad tracks. Note 1. (105.037 meters equal 344.609 feet.)

Z_2.—About 2.9 miles west of Kingman, Penobscot County, Me., on a bowlder 8 telegraph poles east of mile pole 51 and about 20 meters (66 feet) north of the Maine Central Railroad. Note 1. (100.302 meters equal 329.074 feet.)

A_3.—At Kingman, Penobscot County, Me., on the south side of the west abutment of the Maine Central Railroad bridge 1 1-2 telegraph poles east of mile pole 48. Note 1. (103.972 meters equal 341.115 feet.)

B_3.—At Drew, Penobscot County, Me., on a bowlder 20 meters (66 feet) south of the Maine Central Railroad tracks at mile pole 45. Note 1. (99.080 meters equal 325.065 feet.)

C_3.—About 3.7 miles west of Wytopitlock, Aroostook County, Me., on the south side of the west abutment of the Maine Central Railroad bridge about 10 telegraph poles west of mile pole 42. Note 1. (99.047 meters equal 324. 957 feet.)

CX_3 (U.S.G.S.).—About 3.7 miles west of Wytopitlock, Aroostook County, Me., on the south side of the east abutment of the Maine Central Railroad bridge about 10 telegraph poles west of mile pole 42. Note 17. (98.651 meters equal 323. 657 feet.)

D_3.—About 1.3 miles west of Wytopitlock, Aroostook County, Me., on the north side of the east abutment of the Maine Central Railroad bridge 8 1-2 telegraph poles east of mile pole 40. Note 1. (99.837 meters equals 327.549 feet.)

DX_3. (U.S.G.S.).—About 1-2 mile east of Wytopitlock, Aroostook County, Me, on the south side of the west abutment of the Maine Central Railroad bridge 9 1-2 telegraph poles west of mile pole 38. Note 17. (103.401 meters equal 339.421 feet.)

E_3.—About 1 mile west of Bancroft, Aroostook County, Me., on the south parapet of the concrete culvert on the Maine Central Railroad 2 telegraph poles west of mile pole 37. Note 1. (102.605 meters equal 336.630 feet.)

F_3.— About 1.6 miles east of Bancroft, Aroostook County, Me., on the south side of the east abutment of the Maine Central Railroad bridge 24 telegraph poles east of mile pole 35. Note 1. (105.413 meters equal 345.842 feet.)

G_3.—About 3.9 miles east of Bancroft, Aroostook County, Me., on the south parapet of the concrete culvert under the Maine Central Railroad 3 1-2 telegraph poles west of mile pole 32. Note 1. (127.647 meters equal 418.789 feet.)

H_3.—About 4.4 miles east of Bancroft, Aroostook County, Me., in the top of the south parapet of the concrete culvert under the Maine Central Railroad 5 telegraph poles west of the sign "Cherokee One Mile" and 15 telegraph poles east of mile pole 32. Note 13. (128.594 meters equal 421.895 feet.)

I_3.—About 2.2 miles west of Danforth, Washington County, Me., on a bowlder 9 telegraph poles east of mile pole 29 and 15 meters (49 feet) south of the Maine Central Railroad. Note 1. (121.523 meters equal 398.697 feet.)

J_3.—At Danforth, Washington County, Me., on the granite foundation of the south side of the west entrance to the town hall. Note 1. (119.353 meters equal 391.577 feet.)

K_3.—About 1 mile east of Danforth, Washington County, Me., on a large granite bowlder 15 telegraph poles east of mile pole 26 and 18 meters (59 feet) south of the Maine Central Railroad tracks. Note 1. (120.517 meters equal 395.396 feet.)

L_3.—About 1 mile west of Eaton, Washington County, Me., on a large bowlder at mile pole 23 and 20 meters (66 feet) north of the Maine Central Railroad tracks. Note 1. (127.130 meters equal 417.092 feet.)

M_3.—About 1.6 miles east of Eaton, Washington County, Me., on a large granite bowlder 26 telegraph poles east of mile pole 21 and 20 meters (66 feet) north of the Maine Central Railroad tracks. Note 1. (124.870 meters equal 409.678 feet.)

N_3.—About 0.7 mile west of Forest, Washington County, Me., on a large flat bowlder 12 telegraph poles east of mile pole 18 and 15 meters (49 feet) north of the Maine Central Railroad tracks. Note 1. (134.119 meters equal 440.022 feet.)

O_3.—About 1 mile east of Forest, Washington County, Me., on the north parapet of the Maine Central Railroad culvert 1 telegraph pole west of mile pole 16. Note 1. (125.046 meters equal 410.255 feet.)

P_3.—About 1.6 miles east of Forest, Washington County, Me., on a bowlder 25 telegraph poles east of mile pole 16 and 18 meters (59 feet) south of the Maine Central Railroad tracks. Note 1. (118.517 meters equal 388.835 feet.)

Q_3.—About 4.1 miles east of Forest, Washington County, Me., on a bowlder 4 telegraph poles east of mile pole 13 and 10 meters (33 feet) south of the Maine Central Railroad. Note 1. (114.652 meters equal 376.154 feet.)

R_3.—About 7.5 miles east of Forest, Washington County, Me., on a bowlder 18 telegraph poles west of mile pole 9 and about 20 meters (66 feet) south of the Maine Central Railroad tracks. Note 1. (152.591 meters equal 500.626 feet.)

S_3.—About 6.7 miles west of Vanceboro, Washington County, Me., on a bowlder 12 telegraph poles east of mile pole 7 and 18 meters (59 feet) south of the Maine Central Railroad tracks. Note 1. (140.305 meters equal 460.317 feet.)

T_3.—At Lambert Lake, Washington County, Me., south of the tracks on the parapet of the Maine Central Railroad culvert over the outlet of Lambert Lake 6 telegraph poles west of the depot. Note 13. (130.645 meters equal 428.624 feet.)

U_3.—About 4 miles west of Vanceboro, Washington County, Me., on a bowlder 1 1-2 telegraph poles west of mile pole 4 and about 30 meters (98 feet) south of the Maine Central Railroad tracks. Note 1. (125.059 meters equal 410.298 feet.)

V_3.—At Vanceboro, Washington County, Me., south of the tracks on the west abutment of the Canadian Pacific Railroad bridge over the St. Croix River about 1-4 mile east of the railway station. Note 1. (119.358 meters equal 391.594 feet.)

W_3.—At Vanceboro, Washington County, Me., a Coast and Geodetic Survey triangulation station on the north side of the west abutment of the Canadian Pacific Railroad bridge over the St. Croix River. Marked by a brass disk. (119.348 meters equal 391.561 feet.)

13-B.—A bench mark of the Canadian Geodetic Survey in the third course of stonework below top in face of southeast retaining wall of the Canadian Pacific Railroad bridge over the St. Croix River near Vanceboro, Washington County, Me. (118.392 meters equal 388.423 feet.)

12-B.—A bench mark of the Canadian Geodetic Survey in the sixth course of stonework below bridge seat in second stone from north end in face of east abutment wall of subway on the Canadian Pacific Railroad 330 feet (100 meters) east of the St. Croix River Bridge. (116.628 meters equal 382.637 feet.)

ELEVATION OF TOP OF SPIKE AT BASE OF RAIL IN FRONT OF RAILROAD STATIONS.

Place.	Elevation. Meters.	Feet.
Boundary, Me	563.97	1850.29
Blair, Me	356.90	1170.93
Long Pond, Me	363.02	1191.01
Mackamp, Me	357.46	1172.77
Brassua, Me	342.54	1123.82
Tarratine, Me	338.90	1111.87
Somerset Junction, Me	315.82	1036.15
Moosehead, Me	315.60	1035.43
Squaw Brook, Me	318.24	1044.09
Morkill, Me	307.83	1009.94
Bodfish, Me	235.24	771.78
Onawa, Me	193.79	635.79
Benson, Me	226.16	741.99
Ray, Me	217.70	714.24
Barnard, Me	226.76	743.96
Williamsburg, Me	179.61	589.27
Canadian Pacific and Bangor and Aroostook Railroad crossing	118.89	390.06
Lake View, Me	136.21	446.88
Hardy Pond, Me	120.15	394.19
Seboois, Me	60.79	199.44
Gilford, Me	67.32	220.87
Woodard, Me	81.85	268.54
Chester, Me	67.52	221.52
Kingman, Me	101.99	334.61
Drew, Me	99.63	326.87
Wytopitlock, Me	108.26	355.18
Bancroft, Me	104.18	341.80
Danforth, Me	118.08	387.40
Eaton, Me	124.14	407.28
Forest, Me	135.24	443.70
Tomah, Me	116.34	.381.69
Lambert, Me	130.06	426.71
Vanceboro, Me	122.72	402.62