U. S. GEOLOGICAL SURVEY

Conservation Division

Preliminary report on the water-power possibilities of the Seldovia River, Alaska

by

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Preliminary report on the water-power possibilities of the Seldovia River, Alaska

The purpose of this report is to give a rough appraisal of the power possibilities of the Seldovia River, Alaska, below Seldovia Lake. A survey of the river and lake made in 1953 constitutes a basis for computing the potential storage capacity at the lake, and for determining the power drop available downstream along the channel. The lake is at altitude 427 feet. There is a drop of 265 feet in a two-mile reach of channel below the lake, and an additional drop of 135 feet in a channel distance of about 3 miles to a point at altitude 27 feet, one mile from the mouth of the river at Seldovia Bay.

The available information does not justify more than a very rough estimate of the probable runoff from the Seldovia River basin. It is judged that the mean discharge in an average year would not be more than about 40 second-feet at the lake outlet, nor less than about 22 second-feet. The mean discharge in the drier years probably would be only two-thirds of that in the average years, and in extreme dry years perhaps less than half of the average.

The power that could be developed through a drop of 400 feet is 27 kilowatts per second-foot at an over-all efficiency of 80 percent. Thus the average power that might be developed is 1,080 kilowatts with a mean annual flow of 40 second-feet, and 595 kilowatts with a mean annual flow of 22 second-feet. Complete regulation for uniform month-to-month releases might require as much as 10,000 acre-feet of capacity, in years when the mean discharge is 40 second-feet. However, the seasonal distribution of runoff and the seasonal power demand may be such that a substantial part of the natural flow could be controlled with much less storage capacity.

The initial drop of 280 feet could be utilized with a relatively short conduit and penstock, but the additional facilities needed for the larger development would be limited mainly to conduit and penstock. The requirements for a storage reservoir and access roads would be about the same in either case; and the increased size of power-house facilities would be partly offset by the reduction in transmission distance from the point of generation to the potential market at the town of Seldovia.

The amount of construction needed for development seems large in relation to the probable output, and the possibilities are not considered to be very attractive even with a liberal estimate of the potential power. However, conditions not apparent from the scanty information that is now available might justify a modification of this opinion.

If the possibilities seem to warrant further investigation, one of the primary needs is for water-supply data. The estimates given herein are based mainly on qualitative judgments.

Acknowledgments: Information about some physical conditions in the basin, and the needs for power at Seldovia was furnished by F. L. Bush of Seldovia.

Maps and photographs: A topographic map of the Seldovia quadrangle; scale 1:250,000 with contour interval of 200 feet in the Seldovia River basin, has been published by the Geological Survey.

A plan and profile of Seldovia River and Seldovia Lake is in preparation for publication at scale of 1:24,000 and with contour intervals of 20 feet and 100 feet on land, and 5 feet on water surfaces.

A topographic map of the Seldovia B-5 quadrangles is in preparation, and is to be published on a scale of 1:63,360. A copy from the compilation manuscript, on a scale of 1:20,000, and with a contour interval of 100 feet on land and 50 feet on water, was used in connection with the river survey and in preparation of this report. It shows the Seldovia River basin from the headwaters to within about 2 miles of Seldovia Bay.

Aerial photographs of July 1951 are available at the office of the Topographic Division, Geological Survey, Denver, Colorado.

Description of the basin.

The Seldovia River is near the west end of the Kenai Peninsula, on a northwest slope of the Kenai Mountains. It is at about latitude 59°20', and longitude 151°40'. The basin extends 12 miles from the headwaters area to the mouth of the river at Seldovia Bay, and its area is 27 square miles. The drainage area at the outlet of Seldovia Lake is only 8.7 square miles. The lake has a surface area of 135 acres, and constitutes the only practicable storage site in the basin.

The Seldovia River flows northwest from the lake to tidewater at Seldovia Bay. This bay is formed by indentation of about 5 miles in the south shore of Kachemak Bay near its mouth at Cook Inlet. The town of

Seldovia is located on Seldovia Bay, about 3.8 miles north of the mouth of Seldovia River. The principal industry based at Seldovia is fishing, and canning of fish. Seldovia is the supply center for outlying points, and activities include some transport of freight by water. The town is reached by boat or by chartered air service. The population was recorded as 437 in the 1950 census.

There is a moderate cover of spruce trees along the river and on the lower slopes in the Seldovia River basin. On higher slopes and ridges, the vegetation is limited to low shrubs and grasses, or is entirely lacking.

Climate

A summary of climatological data to 1921, published by the Weather Bureau, includes a map of annual mean temperature and precipitation. This indicates that the mean temperature in the Seldovia River basin may be between 35°F and 40°F, and that the mean annual precipitation possibly is not more than 50 inches. Since the precipitation stations were mostly at distant points and near sea level, the basis for estimating the amount in the small Seldovia River basin, which is at altitudes generally from 500 to 2500 feet above sea level, necessarily is very uncertain.

A climatic atlas for Alaska, was prepared by the Weather Bureau and published by the Weather Information Branch, Army Air Forces, September 1943. The charts of this report show about the same estimated distribution of precipitation and temperatures on the Kenai Peninsula as were shown in the earlier climatological summary. The mean annual precipitation near

Table 1

Annual precipitation recorded at Seward, Alaska

Calendar year	Precipitation, inches	Calendar year	Precipitation, inches
1909	46.8	1934	93.0
1910	38.8	1935	73.9
1913	55.9	1936	65.9
1914	61.0	1940	92.1
1915	71.4	1941	78.5
1916	73.2	1942	66.4
1918	78.4	1943	91.5
1919	59.2	1944	79.4
1920	50.1	1945	71.4
1921	61.0	1946	54.3
1922	63.1	1947	64.0
1923	55.6	1948	58.4[a]
1924	70.3	1949	82.4
1930	66.9	1950	63.3[a]
1931	85.4	1951	49.1
1933	50.1	1952	86.2

Figures as recorded in climatic summaries are listed here to the nearest tenth of an inch.

a - Partly estimated

the Seldovia River basin is shown as about 40 inches, and further inland at Kenai Lake as between 40 and 60 inches. Runoff as recorded in recent years has exceeded 60 inches from several basins near Kenai Lake. It was pointed out that the climatic charts were based on data at low-level stations and should be used with caution.

The precipitation recorded at Seward may serve as a guide to the relative amount of variation from year to year on the Kenai Peninsula. Figures for 32 years of record are listed in Table 1. The mean monthly precipitation at Seward for the periods of record to 1952 is listed as follows to show the expected seasonal distribution:

Monthly mean precipitation, inches

J	F	M	A	M	J	J	A	S	O	N	D	Year
5.27	5.37	3.80	4.33	3.49	2.41	2.89	6.09	9.79	10.70	7.03	6.72	67.89

The mean annual temperature at Seward is 39.4°F whereas at Kenai on the north side of the peninsula it is 34.9°F. The temperature in the upper Seldovia River basin, at average altitude of 1,150 feet, perhaps would be as low as at Kenai or lower. The mean monthly temperatures probably are below freezing from December to April, and about 50°F in the warmest months, July and August.

Glaciers on both the northwest and southeast slopes of the Kenai Mountains are a common feature from a point about 20 miles northeast of the Seldovia River basin further inland. There are none in the immediate vicinity of the basin, where the crests of the divides generally are 2,000 feet lower than to the northeast. The absence of glaciers here may be attributed to higher temperatures to be expected in the lower mountains, and possibly to lesser precipitation. Since temperature is a substantial factor in the formation of glaciers, their absence does not necessarily indicate a deficiency in precipitation.

Water Supply

Since there are no streamflow records for the Seldovia River or nearby streams the probable order of magnitude of the runoff must be judged indirectly.

Complete records of precipitation were obtained at the town of Seldovia during the calendar years 1918, 1919, and 1920. The annual amounts were 49.0, 39.4, and 37.0 inches, or an average for the three years of 41.8 inches. During the same years the amounts recorded 85 miles northeast at Seward were 78.4, 59.2, and 50.1 inches, with an average of 62.6 inches. The mean annual precipitation at Seward for the period of record to 1952 is about 68 inches, so the 3-year comparison indicates that the corresponding amount at Seldovia might be roughly 45 inches.

Seldovia is near sea level on the northwest side of the Kenai Mountains, whereas Seward is near sea level on the southeast side. Although the distance between the stations makes comparison uncertain, it appears that part of the deficiency at Seldovia may be due to its location, which is on the leeward side of the mountains during the spring and summer season when prevailing winds are from the south over the Gulf of Alaska.

It would be expected, therefore, that precipitation on the upper part of the Seldovia River basin would be greater than at Seldovia at least during this season; in view of the probable increase in precipitation with increase in altitude on the windward slope. The peaks and ridges enclosing the basin are at about the same altitude as the crest of the divide. The highest points are at altitudes about 3,100 feet.

Precipitation decreases abruptly to the north of the Kenai Mountains, and at Homer, 16 miles northeast of Seldovia across Kachemak Bay, the mean annual amount is recorded as only about 26 inches.

The foregoing considerations make it seem very likely that the mean annual precipitation on the drainage basin of Seldovia Lake is more than at the town of Seldovia. It is judged accordingly that the mean precipitation would exceed that at Seldovia by several inches at the least, making 50 inches roughly the lower limit of the expected mean annual precipitation. The natural water losses are assumed to be 15 inches a year. This estimate is based on the consideration that an annual loss in the order of 10 inches may be expected in basins practically bare of vegetation and soil cover and with annual mean temperatures less than 40°F. On the other hand, losses of 20 inches have been estimated for basins having average conditions of soil and vegetation, and with mean temperatures from 40° to 46°. The conditions in the upper Seldovia River basin seem to be intermediate.

An annual runoff of 35 inches corresponds to a mean discharge of a little more than 22 second-feet from 8.7 square miles of drainage area. Precipitation about 75 percent of the mean annual amount is not very unusual, according to the Seward record. (See table 1). Thus if the mean on the Seldovia River basin is 50 inches, annual amounts of about 37 inches are to be expected in drier years; and on the average, perhaps 1 year in 10. With a loss of 15 inches this would correspond to a runoff of 22 inches, or 63 percent of that estimated with precipitation of 50 inches.

Since there are no records of precipitation on the windward side of the Kenai Mountains opposite the Seldovia basin, there is little basis for judging a reasonable upper limit for its precipitation in an average year. However, the climatic charts suggest that the precipitation at sea level southeast of the basin is considerably less than at Seward. Thus it would not be expected that the Seldovia River runoff would be greater than that from mountain basins near Seward. There are some streamflow records for several of these basins, which are summarized in Table 2. The records are for the 12-month periods ending September 30 of the designated years.

Table 2

Water year	Station	Drainage area sq. miles	Runoff, inches	Ratio of minimum monthly discharge to mean annual discharge
1948	Kenai River	613	64.1	.076
1949	"	613	57.6	.096
1950	"	613	65.6	.107
1951	"	613	50.5	.099
1948	Trail Creek	175	64.6	.115
1948	Russian River	56	32.6	.266
1950	Cooper Creek	32	37.3	.104
1951	Cooper Creek	32	27.6	.230
1952	Cooper Creek	32	26.2	.212
1948	Ptarmigan Creek	33	53.6	.101
1949	Ptarmigan Creek	33	51.8	.091
1948	Grant Creek	44	55.2	.082
1949	Grant Creek	44	57.4	.067
1950	Grant Creek	44	63.7	.088
1949	Lost Creek	10.4	37.5	.011

The figures listed in this table were computed from provisional records, subject to revision.

The complete station names are: Kenai River at Cooper Landing; Trail Creek near Moose Pass; Russian River below Lower Russian Lake near Moose Pass; Cooper Creek near Cooper Landing; Ptarmigan Creek near Lawing; Grant Creek near Moose Pass; and Lost Creek near Seward.

The precipitation at Seward during the period of the runoff records and in 1953, was as follows:

Water-year	Precipitation, inches
1948	67.9[a]
49	58.3
50	63.3[b]
51	47.0
52	42.6
53	100.6

a Includes estimated precipitation for June
b Includes estimated precipitation for April

The precipitation recorded at Seward during the water year 1948 was about the same as the long-time average; and it is reasonable to suppose that the runoff from nearby basins in that year also was representative of the average. The precipitation measured during the two water years 1951 and 1952 was notably deficient, but was somewhat more than was measured in the calendar years 1909 and 1910. The water years 1951 and 1952, or ones like the calendar years 1909 and 1910, perhaps represent about the most adverse conditions to be expected for a system dependent solely on water-power.

Although the climatic charts suggest that there is less precipitation in the mountains near Seldovia than near Seward they may not be a reliable guide to the amounts that occur on small mountain areas. It therefore seems possible that precipitation and unit runoff of the upper Seldovia River basin may be as much as for the basins between Seward and Kenai Lake; but very unlikely that it is much more. Of these basins Lost Creek is the only one on the southeast side of the Kenai Mountains. The others drain to the north, but their basins are enclosed by high ridges and peaks beyond the divide, as is the Seldovia River basin.

The records listed in Table 2, and corresponding precipitation records for Seward, indicate that runoff from several of the basins may be between 55 and 65 inches in an average year. The lesser amounts for Russian River and nearby Cooper Creek possibly are due to a generally higher barrier of mountains and glaciers to the south.

A mean annual runoff of about 63 inches therefore was taken as a probable upper limit for the Seldovia River basin; and this corresponds to a mean discharge of about 40 second-feet from 8.7 square miles. Both this estimated limit and the estimated minimum of 22 second-feet in an average year are somewhat arbitrary, and are intended only as guides for a very rough appraisal of the power possibilities.

There is little basis for estimating the seasonal distribution of runoff from the Seldovia River basin. The ratios of minimum to average flows given herein in Table 2 show that the relative amount of flow during the low-water period may differ considerably in different basins. In the low month, which usually is February, March or April, the average flow was roughly a tenth of the mean annual flow in several of the basins. The unusually large flow of Russian River in the winter period may be due to a considerable amount of ground-water storage. The minimum flows also probably are affected considerably by temperatures and by replenishment of ground-water by fall rains.

The monthly flows of Grant Creek during the water-years 1948, 1949 and 1950 are listed here as an example:

Monthly mean discharge, second-feet

Water-year	O	N	D	J	F	M	A	M	J	J	A	S	Year
1948	265	200	116	32.5	24.1	17.4	27.6	247	489	549	388	165	211
1949	259	89.8	26.9	15.0	12.4	14.8	17.1	137	408	473	325	446	186
1950	194	197	71.3	37.2	21.1	18.3	26.1	117	446	521	491	338	207

The heaviest runoff occurs in July as a result of snow melt, but

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(October 1949)

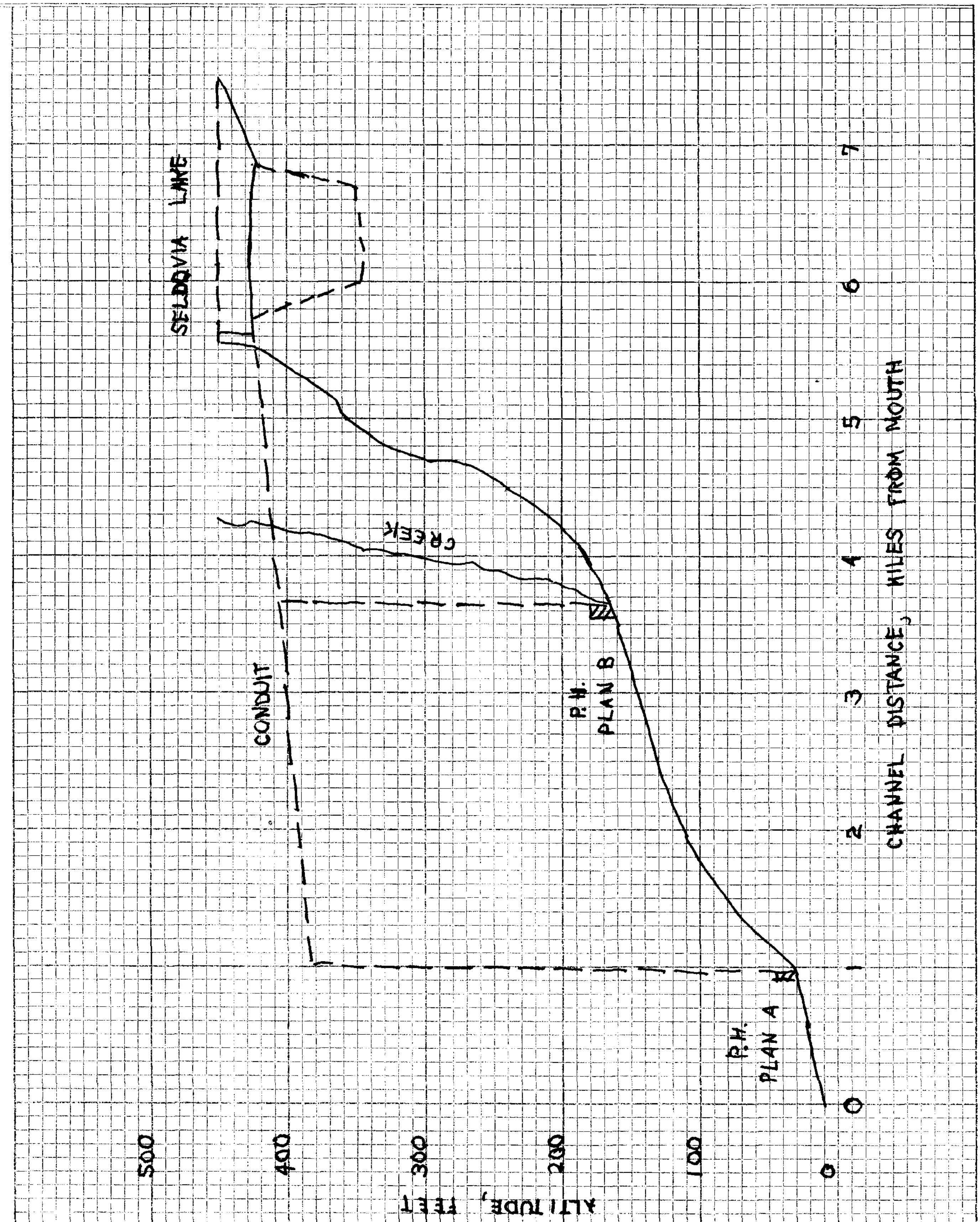
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

File Number
Washington
District

PROFILE OF SELDOVIA RIVER AND ILLUSTRATIVE PLAN OF DEVELOPMENT

16—13468-2 GPO

(DO NOT USE THIS SPACE EXCEPT FOR BINDING PURPOSES)



Sheet No. of sheets. Prepared by Date Checked by Date there are secondary peaks in September or October due to rain. These are the wettest months of the year, and the usual wet period starting in August serves to extend the high flow from the snow-runoff period through October or November. The Seldovia Creek basin is lower than the Grant Creek basin so it would be expected that there would be proportionately more rain runoff there in October and November.

<u>Undeveloped storage capacity</u>

Seldovia Lake constitutes the only site in the basin having substantial potential capacity for storage. With a dam near the lake outlet, the capacities at different altitudes would be as follows:

Altitude, feet	Surface area, acres	Capacity, acre-feet
427	136	0
440	260	2,210
450	-	5,000 (interpolated)
460	333	8,540
470	-	13,000 (interpolated)
480	477	17,140

There is a site on Seldovia River 1,400 feet downstream from the outlet that appears topographically suitable for a low dam. The altitude on the stream there was 420 feet at the time of the survey, and depths to the gravel bottom along the reach upstream were not over 2 feet. Rock is exposed on both sides of the channel and across the channel at and downstream from the 420-foot crossing.

The width of the section at the 440-foot altitude is about 170 feet, and at the 450-foot altitude, about 220 feet; but it is more than 500 feet at the 460-foot altitude. A geologic examination has not been made.

The altitude of the bottom of Seldovia Lake was determined at a few places, roughly along a center line from the outlet to the upstream end. It is about 350 feet from a point a quarter of a mile from the outlet to a mile upstream. (See figure 1). This information is not adequate for determining the capacity below lake level, but it does not appear that this can be very great and it seems doubtful that a tunnel for draw-down would be justified. A draw-down of 10 feet possibly could be obtained by excavating the channel from the lake to the dam site; and this might provide additional capacity in the order of 1,000 acre-feet.

Storage requirements:

The capacity required for control would depend on the seasonal distribution of runoff and the seasonal demand. In view of the small population in the potential market area it does not appear that present needs for domestic power would exceed 500,000 kilowatt-hours annually, even with a relatively high consumption in each home. Since this is equivalent to an average output of less than 60 kilowatts, a considerable part of the market for power that might be developed on the Seldovia River would have to be found in industries. If used for such purposes as canning, cold storage and freezing of fish products, the demand probably would be heaviest in the summer season when runoff is highest. Relatively small storage capacity would be required to supply a power demand of that kind.

The storage requirement may be estimated roughly on the basis of the seasonal distribution of runoff from some of the basins near Seward and Kenai Lake. An operation schedule based on the runoff distribution of Grant Creek near Moose Pass for the water-year 1948, without allowance for reservoir or conduit losses, is shown as an example:

Operation schedule for uniform draft

All quantities in percent of annual runoff

Month	Inflow	Draft	Change in Contents	Contents
Oct.	10.65	8.5	+2.15	33.12
Nov.	7.80	8.2	-0.40	32.78
Dec.	4.66	8.5	-3.84	28.94
Jan.	1.31	8.5	-7.19	21.75
Feb.	0.88	7.7	-6.82	14.93
Mar.	0.70	8.5	-7.80	7.13
Apr.	1.07	8.2	-7.13	0.00
May	9.90	8.5	+1.40	1.40
June	19.00	8.2	+10.80	12.20
July	22.00	8.5	+13.50	25.70
Aug.	15.60	8.5	+ 7.10	32.80
Sept.	6.43	8.2	-1.77	31.03
Total	100.00	100.0	-	-

The requirement according to this schedule is for active storage capacity of about a third the annual runoff. For a mean discharge of 40 second-feet the storage requirement would be about 9,700 acre-feet or for a discharge of 22 second-feet, about 5,300 acre-feet.

A schedule based on 150 percent of the average demand from May to October and 50 percent of average from November to April, is as follows:

Operation schedule for non-uniform draft as indicated

All quantities in percent of annual runoff

Month	Inflow	Draft	Change in contents	Contents
Oct	10.65	12.7	-2.05	10.98
Nov.	7.80	4.1	+3.70	14.68
Dec.	4.66	4.2	+0.46	15.14
Jan.	1.31	4.2	-2.89	12.25
Feb.	0.88	3.8	-2.92	9.33
Mar.	0.70	4.2	-3.50	5.83
Apr.	1.07	4.1	-3.03	2.80
May	9.90	12.7	-2.80	0.00
June	19.00	12.3	+6.70	6.70
July	22.00	12.7	+9.30	16.00
Aug.	15.60	12.7	+2.90	18.90
Sept.	6.43	12.3	-5.87	13.03
Total	100.00	100.0		

The capacity used in this schedule is about 19 percent of the annual runoff, or 5,500 acre-feet and 3,000 acre-feet respectively for the two assumed conditions of mean annual runoff.

It was judged from studies of some other runoff records that capacity requirements on the Seldovia River would not differ greatly from the illustrative amounts unless the winter flows per unit area are considerably higher than from most basins near Kenai Lake; or unless the winter power demand is very small.

<u>Undeveloped power</u>

On the basis of available information it appears that development of the water power on a dependable year-to-year basis would be limited to a utilization of about two-thirds of the average annual runoff. AA liberal estimate of the mean annual runoff is 29,000 acre-feet, corresponding to a dependable yield of 19,000 acre-feet in 90 percent of the years. The average flow equivalent to this runoff is 26 second-feet.

If developed according to Plan A of Figure 1, through a head of 400 feet, this would correspond to an average output of 700 kilowatts, or an annual production of roughly 6 million kilowatt-hours. Under the assumed condition this should be available about 9 years in 10; but with possible deficiency of 30 percent in extreme dry years.

However, if the average runoff from the Seldovia River Basin is the minimum that might be expected, the dependable runoff in 90 percent of the years would be only about 10,000 acre-feet. The dependable output for 90 percent of the time then might be only about 400 kilowatts; and the corresponding output 100 percent of the time, only 280 kilowatts.

Any plan of development, with or without storage regulation, probably would require access roads from Seldovia to the lake; a diversion or storage dam there; several miles of waterway; a power house; and several miles of transmission line.

For the partial development indicated as Plan B in Figure 1, the potential power would be figured according to the ratio of the available heads; 265 to 400, or 65 percent of the foregoing estimates. This partial development would require about 1.8 miles of conduit and penstock to convey water from the dam to a power house at altitude 162 feet at the Seldovia River. The conduit route was measured along the 400-foot contour of the 1:20,000 scale map, and on the southeast side of the river, as the topography there appears to be more favorable than the other side.

For the more complete development of Plan A it would be necessary to extend the conduit nearly 4 miles farther along the left bank. The topographic map indicates that there is supporting ground for a conduit at least that far, and within half a mile of the river. If such development were made, unregulated water could be captured from 2 creeks draining an area of about 3 square miles. This would increase the water supply by about a third, and with adequate storage capacity for increased regulation at the lake, would make it possible to increase the power output accordingly.

Conclusions

The utilization of the Seldovia River for power does not seem attractive, as judged from the available information and the foregoing considerations. The amount of construction required for any kind of development probably would be disproportionate to the output unless conditions of load demand, runoff, and structure locations are extremely favorable. A primary need for a better appraisal of the possibilities is quantitative information about the runoff from, or the precipitation on the upper Seldovia River basin. Justification for establishment of a stream-gaging station probably would depend on a more favorable outlook for development than is now apparent.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Conservation Division
244 Federal Building
Tacoma 2, Washington

March 22, 1954

Memorandum

To: Chief, Water and Power Branch

From: Regional Hydraulic Engineer, Northwest Region

Subject: Seldovia River report

Last fall I made a tentative arrangement with Mr. Slaughter to obtain a low-water measurement of the Seldovia River at Seldovia Lake. As it was then uncertain whether a trip could be made to the lake by plane during the winter the preparation of my preliminary report was not delayed for the possible results.

Now we have a report on the trip that shows that there was no flow in the channel on March 6, 1954. This fact may not be of considerable importance in weighing the feasibility of power development; but is additional evidence that the possibilities should be viewed with caution. Also it is the only definite piece of streamflow data that has significance. (A measurement was made last October but it was during runoff from rain and could not be used for comparison).

Enclosed is a report of the low-water findings, which if approved might be furnished to offices that have copies of the report as an "addendum". Please let me know whether this would be appropriate.

F. A. Johnson

Encls.

Addendum

Preliminary report on the water-power possibilities of the Seldovia River, Alaska

On March 6, 1954 the channel of the Seldovia River was thoroughly investigated from the outlet of the lake to about a mile downstream, and no flow was found in that reach. Several feet of wet snow was cleared out of the channel at several sites in the reach, and it was found that there was no flow and no ice. From air reconnaissance, the flow of the Seldovia River near the mouth was estimated as about ½ second-foot.

This investigation was made by personnel of the Surface Water Branch, Water Resources Division, Geological Survey. Marvin J. Slaughter, Engineer in Charge, Palmer, Alaska, reported that the field trip was made immediately following an extended period of extreme low temperatures.

The occurrence of zero flow below Seldovia Lake may indicate that the discharge during the several winter months usually is a smaller part of the total than shown in the illustrative schedules on page 14 of this report. This deficiency would increase the storage required for regulation, but the increase would be small in relation to the storage capacity needed for a substantial utilization of the annual water supplies for power development on a dependable schedule. The characteristics of winter flow would be of considerable importance, however, if a minor development with little or no storage capacity should be contemplated.