NOTE:

At the time of the examination made by Mr. Howes, the equipment recommended by him was based on the requirements of the City of Anchorage and the Alaska Railroad as they existed at that time.

Due to the increased activities in and around Anchorage as well as to the widening of the field of activities of this corporation together with the normal growth to be expected, and the increase in business which will be brought about by the lowered rates, it is deemed not only advisable but necessary to equip the power plant with 2--1500 K W generators rather than the 2--1000 K W generators recommended by Mr. Howes.

This increased installation will adequately take care of all the business outlined in the statement herewith under Section 6. Article 1.

T O

FRANK I. REED

OF

ANCHORAGE, ALASKA

R E

EKLUTNA HYDRO ELECTRIC PROJECT

B Y

ROBERT HOWES

May 8, 1924.

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May 6, 1924

Mr. Frank I. Reed,
Anchorage, Alaska.

Dear Sir:

In accord with your request I have made an investigation of your proposed hydro electric project near Anchorage, Alaska, and report findings as follows.

The writer left Seattle Feb. 23rd last going to Anchorage, and made personal examination of the proposed power site and studied the market for power in Anchorage and vicinity, visited the coal mines on Moose Creek, and returned to Seattle March 25th. Very satisfactory information as to the market for power was readily obtained from the Alaska Railroad Commission; operating officials of the Light and Power Department in the City of Anchorage; and from the various mine operators. This information has been analyzed in the accompanying 10 page abstract entitled "Markets for Power".

The telephone system in Anchorage occupies the same poles and is now operated in conjunction with the light and power public service. As the system is rather small to warrant a separate installation, it has been included as a part of the project. A following page entitled "Telephone Public Service in Anchorage" gives the earning capacity for a recent period and estimates for the future.

The definite power market is composed of three principal items, the Public Service in the City of Anchorage; Power for pumping water for the City Water Supply; and Power to operate the shops and general requirements of the Alaska Railroad Commission in the Anchorage yards of the Alaska Railroad. The normal growth of this market will be proportional to the development of Northern Alaska and the usefulness of the Alaska Railroad.

A speculative further development of market largely hinges upon the gold lode mines of the Willow Creek district and the coal mines of the Moose Creek and Matanuska Fields.

The proposed hydro electric project contemplates development of the power of the Eklutna River to supply the requirements of the markets mentioned above.

The Alaska Railroad was built by the U.S.Government and is operated by the Alaska Railroad Commission. It extends from Seward through Anchorage and to Fairbanks, a distance of 470.3 miles with branch lines from Matanuska to Chickaloon, 37.7 miles, and from Happy to Chatinika, 31.9 miles.

There is also a branch from Sutton on the Chickaloon branch to the Evan Jones Mine 2.9 miles and a narrow gauge construction track extends from Moose Creek Station for about five miles up Moose Creek to the Premier and Baxter Mines.

Seward is a salt water port open to navigation all the year round. It is on the coat and subject to coat conditions and considerable snowfall. About two or three feet lay on the ground at the time of my visit. Leaving Seward the railroad goes through a mountain pass attaining an elevation of 1063 feet. At this point the snow in places was about level with the top of the cars. Continuing, the track descends to tide water on Turnagain Arm and follows along the shore line for a considerable distance; then across a comparatively level area to the city of Anchorage at a distance of 114.3 miles from Seward. Across the mountains between Seward and Turnagain Arm deep snow fall presents considerable obstacle to dependable railway traffic and along the shore of Turnagain Arm there are snow slides and opportunities for rock and dirt to fall upon the track which interferes to some extent with regular train schedules during the winter and early spring months.

Anchorage is located at tide water on Knik Arm of Cook Inlet. It is open to deep water navigation throughout the greater portion of the year. A heavy run of tide prevents the formation of solid ice but broken cakes of ice flow in and out with the tide and make navigation difficult, so that at present for a considerable period in the winter Anchorage is dependent upon the railroad for communication with regular navigation port.

The climate at Anchorage is quite different from that at Seward being protected from the coast by a range of high mountains and the ground was almost bare at the time of my visit and always there is very much less snow than at Seward. The town occupies a part of a level gravelly area, has been well laid out with rectangular blocks and wide streets, with ample elevation for drainage and plenty of space and opportunity for growth as a clean and well ordered city. The head

quarters of the Alaska Railroad, and the repair shops, storage yards and equipment aggregating in all many millions of dollars in value, are located immediately adjacent to the city of Anchorage, upon a level area close to the deep water dock, with ample room for level trackage. It is unquestionably the logical location for these important appurtenances to the railroad which constitutes a guarantee of the permanency of the city.

Anchorage is also the nearest salt water port to the Matanuska coal fields and to the many mining districts tributary to the Alaska Railroad north of Anchorage. Hence it seems certain that the major portion of all tonnage to be transported from these mines will be transferred from rail to water at the Anchorage docks and that the business center for this vast north country will remain at Anchorage.

The light and power distribution system in Anchorage was constructed by the Alaska Railroad Commission and is at present operated by the City of Anchorage under a temporary agreement with the Commission, the same being true of the telephone system. Apparently the wires and equipment are of good quality and sufficient for the present size of the city; however the poles although of good appearance and dimensions are of spruce and may be expected to require reconstruction or resetting in the comparatively near future, and this item for poles appears as the most prominent early expenditure in connection with the distribution system. I was advised that an appraisal dated Sept. 4, 1923, by representatives of the Railroad Commission and city, placed the value of the light, power and telephone system in Anchorage as $41,171.55, and presumably this valuation will be somewhat further reduced by depreciation as time goes on.

The Eklutna River empties into Knik Arm from the south and is crossed by the main line of the Alaska Railroad at a distance of about 27 miles from Anchorage towards Fairbanks.

A careful current meter measurement of the natural flow of the Eklutna River at the mouth of the canyon, which is a little more than half a mile from the railroad track, was made by the writer on March 12, 1924, when the water was believed to be at a very low stage, and the flow computed to be 69.3 cubic feet per second. Gauge heights at this station were also observed by the writer as follows:

March 5, 1924 at 1.13 P.M. gauge height 0.41

March 12,1924 at 2.33 P.M. gauge height 0.375
(Measurement started)

March 12,1924 current meter measurement, discharge 69.3 c.f.s.

March 12,1924 at 3.50 P.M. gauge height 0.395
(Measurement finished)

March 13,1924 at 8.25 A.M. gauge height 0.38.

The writer also observed but did not measure the flow of the stream at various points in the course of his examination of the project as follows.

March 4, 1924 at outlet of lake, estimated 50 to 60 c.f.s.

March 6, 1924 at 150 ft dam site.

March 7, 1924 at 150 ft dam site.

From all of which it is concluded that the low natural winter flow of the river at the point of proposed use is probably about 65 c.f.s. which may be easily increased by storage. The total annual discharge of the river is unknown but is unquestionably greatly in excess of the requirements of the initial plant as herewith proposed.

The river is the natural outlet of Eklutna Lake; a body of water about eight miles in length and having an area of 5.2 square miles and an elevation of about 670 feet above sea level, as derived from a single line stadia survey run by engineers of the Alaska Railroad Commission. On March 4, 1924, the writer went by dog sled on the ice over the surface of the lake to a point estimated to be about the middle of the lake and four miles from the outlet, and was able to view the entire lake, satisfying himself that the above statements as to area and elevation are substantially correct.

The outlet of the lake was open water at the time of this visit and the stage of water was presumably at a minimum and the discharge of the outlet was estimated to be from 50 to 60 c.f.s.

Eklutna Lake is fed by streams having their source in glaciers located on the northerly slopes of the high range of mountains which lies between the head of Knik Arm and Prince William Sound. Little definite data is available as to the size of these glaciers or the area drained by the streams flowing into the lake, but judging from what the writer could see at a distance and information obtained from guides and hunters who had been in these valleys, the drainage area is of considerable extent and the principal streams between ten and twenty miles in length. From the appearance of the mountains and the location relative to the moisture bearing winds it is presumed that heavy snow fall occurs on the head waters and is the source of the glaciers.

The bed of the stream at the outlet of the lake is composed of gravel and clay and the banks presumably of the same composition. Even at this period of the year the water contained a plainly visible glacial discoloration indicating that there were living glaciers of such size as to continue their motion to some extent at least very late in the season and producing silt so fine that it did not settle out entirely in the quiet waters of the lake where the velocity must have been almost imperceptible and the surface protected from wind by a continuous ice sheet.

The outlet of the lake is comparatively narrow, having a water surface width of from 30 to 50 feet and at an elevation of 20 feet above the surface of the lake a width of 150 feet. Above this elevation the bank continues to rise rather abruptly on one side but on the other side is a very gradual slope for a considerable distance to the foot of the hill.

It appears feasible to obtain a storage depth of 15 feet and a volume of 50,000 acre feet at reasonable cost if required and presumably a still larger storage would be practical if the demand was urgent. However for the sake of initial economy and because there appears no visible need in the immediate present for so much storage the writer has estimated on the basis of an initial development of 5 feet depth of storage, or 17,000 acre feet, which can evidently be created at a very moderate cost and be sufficient to increase the normal flow of the stream by 90 c.f.s. continuous flow for a period of three months or the equivalent in any desired manner. This feature eliminates all question as to the sufficiency of the water supply for the project.

From the outlet of Eklutna Lake down the channel of the river to the railroad track near the mouth of the river the distance as shown by the stadia survey made by the Alaska Railroad Commission is about 10.5 miles and the fall about 825 feet. The straight line distance being about eight and three quarters miles.

For about three miles on the lower section of its course the river flows in the bottom of a precipitous canyon, the channel being remarkably narrow and deep and the walls of hard igneous rock. At one point the canyon is only some twelve or fifteen feet wide at the water level and scarcely more than forty feet in width at an elevation of eighty feet above the water, making an excellent location for a dam 100 feet high, which is the site originally contemplated by you and by the Railroad Commission. A short distance down stream an excellent site was observed for a dam 150 feet high and about half a mile downstream is a remarkable site for a dam over 300 feet in height having a top width less than the height above the water. All of these sites would however involve the location of the power house in a narrow and inaccessible canyon and involve considerable expense in transportation of materials and machinery to the site. Although the construction of a dam and power house at any of the above locations would be entirely feasible they have been given only this passing notice because of possibilities not heretofore observed which appeal to the writer as even more practical and desirable with at least equal economy and greater possibilities for the future. This plan is briefly as follows.

It is found that the canyon of the Eklutna River makes a horse-shoe turn at a point near the center of its length which point is so located that by driving a tunnel through the rock wall to the north and 2400 feet in length, the waters of the river may be diverted at their present elevation and conveyed to an outlet on a steep rock hillside immediately above a level area which has the elevation of extreme high tide, and the power house can be located at the foot of this hill only 1000 feet distant on level ground from the main line of the Alaska Railroad. The length of tunnel and penstock from the proposed diversion to the power house so located will be only 2830 feet, in which distance a fall of approximately 180 feet will be available without the construction of any dam except a simple diversion.

The cost of driving this tunnel is estimated to be not more than that of building a dam 100 feet in height and the location of the power house will be much more desirable. The difficulty of transporting materials and machinery will be greatly reduced and the increase in available head obtained, compensates for the loss of the service reservoir which would be created by a dam resulting in continuous power, in quantity approximately equal to the peak lode capacity that would be derived from a 100 foot dam. Hence there seems no question as to the desirability of this method in preference to the building of a dam as before contemplated for the initial development.

By the proposed method maximum provision is made for future extensions for at a point just below the proposed tunnel diversion there is a narrow place in the canyon where an arch dam can be built between solid walls of massive igneous rock and to any height desired up to about 270 feet above the present water level, at which elevation a separate spillway of ample proportions can be constructed so as to enable the building of a dam of this height without overflow. With the construction of this dam the water may be diverted through a tunnel as before to the power house located as described and the power developed under a gross head of about 450 feet. Above this dam a large service reservoir would be formed extending a mile or more up the canyon and completely flooding the dam site which you originally contemplated. The plan would enable a most advantageous utilization of the flow of the stream under an effective head of 430 feet or more than half of the total fall between the lake and high tide; after which a second development could be made by constructing a pipe line from the storage dam at the lake to a power house located at the upper end of the backwater created by the high dam thus affording a complete utilization of the hydraulic capacity of the stress with only two power plants as the ultimate plan of development.

While the construction of the high dam appeals to the writer as the probable sequence and a large step in the plan for ultimate development to be carried out when the market has become sufficient to justify a plant of the capacity that can be so created, it is pointed out that as an intermediate step a dam of some 50 feet in height to be a part of the base of the ultimate structure can be constructed as a second step in the development of this project, creating an additional pressure head of 50 feet on the proposed initial tunnel, thus making the gross available head

at the power house about 230 feet and creating a small service reservoir for use in carrying peak loads, and that the construction of this dam will be greatly facilitated by diversion of the stream flow away from the dam site through the tunnel, the surplus waters being allowed to discharge down the hillside from an overflow at the tunnel outlet.

The combined effect of adding 50 feet to the available head and creation of the small service reservoir will produce a power capacity available for public utility purposes nearly double that of the first installation assuming the same amount of water to be available and this additional head can be utilized with reasonable efficiency up to the rated capacity in machinery suitable for the initial installation, hence avoiding the necessity of discarding such initial machines should the demand require this extension at an early date. However in order to make all this possible it would be necessary to construct the tunnel and penstocks and design the water wheels in such manner as to enable their use under the added head and this will involve some additional expenditure over what would otherwise be the case at the time of the initial installation.

In view of all the conditions the writer has deemed it advisable to present as a plan for your consideration the assumption of an initial development including such features as will enable the later construction of a 50 foot dam as described and the addition of penstocks and machinery at that time so as to utilize the hydraulic power which would become available. This plan requires that all features of the tunnel and pipe line from the diversion intake to the standpipe near the tunnel outlet shall be designed and constructed to sustain the pressure of some 75 feet of head which will be required after the 50 foot dam is completed. This is necessary because of continuous service preventing any interference with the continuous flow of water through the tunnel to the stand pipe where connection can be made to the various penstocks leading to the power house.

For the ultimate development of the high head dam it is believed that the importance of the power plant will be such as to justify the construction of a second tunnel after the completion of which it would be possible to reconstruct the original penstocks and tunnel to such an extent as might be necessary in order to provide for the complete utilization of the possibilities.

Accompanying is an estimate of the cost of an initial development of the Eklutna River upon the assumption as above of diverting the water at its natural level through a tunnel and utilizing it in a power house located at extreme high tide elevation and about 1000 feet from and practically level with the Alaska Railroad. The estimate contemplates that the tunnel shall be lined with concrete near the portals and in such places as it may be anticipated will require lining in order that the tunnel may be reasonably water tight when sustaining a pressure head of 70 feet. It is assumed that the outlet of the tunnel will connect with a creosoted wood stave pipe 6 feet in diameter which would lead to and terminate in a steel stand pipe having a top height to correspond with the initial development but of such strength as to sustain 50 feet of additional height to be obtained by adding courses of steel plate when the proposed 50 foot dam is constructed. This stand pipe would have two outlet connections, one to supply the initial requirements and the second for connection to a future penstock. A single penstock of creosoted wood stave pipe would lead from the stand pipe to a branch Y at the power house and connections of steel from this branch Y would lead to two separate water wheel units each suitable to carry a load of 1000 kilovolt amperes, or about 1250 horsepower at the power station.

It is estimated that this capacity will be such that a single unit can carry the normal requirements to be expected in the City of Anchorage and its immediate vicinity for two or three years after the plant is put in service while the second unit will be spare equipment for alternate and emergency use but also available to supply current for mining purposes should that market appear as an early demand.

The estimate described above contemplates as much expenditure in preparation for future requirements as appears justifiable in the mind of the writer at the present time and should it be necessary to exercise initial economy to the extent of designing the plant for capacity only sufficient to meet the requirements at Anchorage it would be feasible to eliminate some of the features included in the estimate just described and reduce the cost of others making the capacity of the water power units and initial development half that contemplated in the estimate described above and omitting provision for future growth, which means that increase in capacity will necessitate a second tunnel.

In order that you may be advised as to the costs of such a restricted development a second estimate has been prepared and accompanies this report. This second

estimate provides only for two hydro electric units of 500 kilovolt amperes capacity or about 650 horsepower each with tunnel and penstock to correspond.

A statement of the estimated annual receipts and disbursements based on revenue from the market at Anchorage and a 2000kva installation including suggested provisions for further increase in capacity accompanies this report. These revenues are based upon rates and gross business all as described in detail in an appendix accompanying herewith under the caption "Markets for Power".

I feel that the analysis indicates the project to be one of decided merit, presuming that you can conclude contracts to supply the requirements of the vicinity of Anchorage as outlined, and that with local residents providing $100,000 in preferred stock, as I understand to be the condition, an underlying bond issue to provide additional funds to the extent of $300,000 at an attractive rate of interest should prove a conservative investment.

My recommendations are to proceed with plans providing for an initial installation of two 1000 kva units and provisions agreeable with the suggested later construction of a 50 foot dam and a doubling of the initial capacity rating of equipment. But before the closing of any contract involving the definite expenditure of any considerable amount of money for these extra provisions for the future, that an endeavor be made to ascertain the attitude of the Willow Creek operators, and their willingness to enter into definite contracts for power at satisfactory rates. If satisfactory indication of a profitable load from Willow Creek and the coal mines cannot be obtained by the time contracts of moment should be let, then I suggest the adoption of the plan of the second estimate providing the two 500 kva generators as an initial installation.

The following appendices accompany and are a part of this report.

A 10 page discussion entitled "MARKETS FOR POWER"

A 1 page discussion entitled "TELEPHONE PUBLIC SERVICE IN ANCHORAGE"

A 3 page estimate amounting to $392,200 gross expenditure and providing for an initial development with two 1000 kva units and other provisions for future enlargements to provide for growth.

A 1 page estimate showing gross Revenues and Expenditures during the first year of hydro-electric operation.

A 3 page estimate amounting to $319,316 gross expenditure and providing for an initial development with two 500 kva units and no extra expenditures on account of future enlargements.

3 photographs showing Eklutna Lake.

3 photographs showing outlet of Eklutna Lake and site for proposed storage dam.

1 composite photograph showing Eklutna Canyon at the proposed point of diversion and the ridge through which the tunnel will be driven.

1 photograph showing site of proposed power house and ridge through which tunnel will emerge.

1 photograph showing Eklutna River where it emerges from the canyon.

1 blueprint showing cross-section profile of proposed development diversion, tunnel, power house, etc. Also cross-section of canyon at site of proposed high dam for ultimate development.

Frontispiece; Photograph showing Eklutna Canyon at point of proposed tunnel diversion and site for high dam suggested for ultimate development.

Respectfully submitted

ROBERT HOWES