ENVIRONMENTAL ASSESSMENT
NUKA RIVER DIVERSION; BRADLEY LAKE HYDROELECTRIC PROJECT

PREPARED BY:
NATIONAL PARK SERVICE, ALASKA REGIONAL OFFICE

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PURPOSE AND NEED FOR THE ACTION

The Alaska Power Authority, a public corporation of the State of Alaska within the Department of Commerce and Economic Development, has received a license from the Federal Energy Regulatory Commission (FERC) for a major unconstructed project henceforth referred to as the Bradley Lake Hydroelectric Water Power Project or the Bradley Lake Project.

The proposed Bradley Lake Project is located at the head of Kachemak Bay, on the Kenai Peninsula approximately 105 miles south of Anchorage, and 27 miles northeast of Homer, Alaska. The project entails the construction of a concrete faced rockfill dam at the outlet of Bradley Lake, which would raise the level of the lake, and construction of a power tunnel which would convey water to a powerhouse situated on the shore of Kachemak Bay. The proposal calls for the construction of diversion structures on both the Middle Fork Bradley River and at the Nuka River outlet of the Nuka Glacier terminal pool which would permanently divert Nuka Glacier flows into the upper Bradley River, the other outlet of the Nuka Pool. Also included is an outlet weir to the Bradley River from the Nuka pool.

Subsequent to the submission of a license application, a draft supplemental environmental impact statement (DSEIS) was prepared by the Federal Energy Regulatory Commission which supplemented and built upon the earlier environmental impact statement done by the U.S. Army Corps of Engineers (1982) for the project under federal authorization. A mitigation plan was also filed with FERC by the APA. This environmental assessment hereby incorporates by reference, the above mentioned environmental documents and is tiered upon them.

Concerns were raised by the National Park Service during the environmental analysis process as performed by the FERC, that while the construction and power generation activities occurred outside the boundaries of nearby Kenai Fjords National Park, the proposed diversion of Nuka Glacier flow could adversely affect park resources. Specifically mentioned were the ecological and aesthetic values of the area.

The purpose of this assessment is to evaluate, given information compiled to date, the potential impacts to the resources within the park, associated
with construction of a low gravel dike diverting Nuka Glacier flows. Alternatives 4 and 5 include the release at the diversion structure of flows into the Nuka River drainage resulting in minimum guaranteed flows into Kenai Fjords National Park.

The alternatives considered include: 1) no action (natural flow with no diversion structures); 2) 2 cubic feet per second (cfs) in the Nuka drainage as measured at the park boundary (APA proposal in Mitigation Plan); 3) 5 cfs in the Nuka River drainage as measured at the park boundary (APA proposal, May 20, 1986); 4) the release of 5 cfs at the diversion structure into the Nuka drainage; and, 5) the release of 5 cfs at the diversion structure into the Nuka drainage plus those excess waters which would otherwise be spilled into the Bradley drainage during periods of high flow or full storage capacity at the dam.

The project and impact descriptions which follow focus specifically upon the Nuka Glacier diversion alternatives and their potential to impact resources within the Kenai Fjords National Park. Other features and impacts associated with the construction of the power system and the provision of power to the region are not discussed.

PROJECT DESCRIPTION

The Nuka Diversion structure of the proposed Bradley Lake Project is within a 38,066 acre area around the Bradley River watershed which was placed into a Federal Power Withdrawal in 1962 pursuant to Public Land Orders 3953 and 4056. The entire hydropower project and its construction are proposed on lands near the terminus of the Nuka Glacier and will be entirely outside the boundary of the Kenai Fjords National Park.

Essentially, the Nuka Glacier terminates on the basin divide between the Upper Bradley River and the Nuka River. Flows available from the glacier are variable and are divided between the two drainages. For example, from 1958 to 1970 a large proportion of the Nuka Glacier outflow drained into the Nuka River. During this period the glacier retreated approximately 1,000 feet and by 1971 virtually all the runoff flowed into the Bradley River drainage. More recent observations indicate that some
partial switching has occurred with flows again being experienced in both drainages.

The Nuka Diversion proposed by the Alaska Power Authority would be constructed at an elevation of approximately 1300 feet, within Section 6 T6S, Range 8W, Seward Meridian. The Project would consist of: 1) a rock cut at the natural outlet that diverts flow into the Upper Bradley River system, 2) increasing the Upper Bradley River channel width to a minimum of 65 feet immediately downstream of the outlet, and 3) construction of a five-foot-high gravel dike in the Upper Nuka River drainage adjacent to the Nuka Pool plus an outlet weir to the Bradley River. The diversion will direct flows from the glacier into the upper Bradley River which flows into Bradley Lake. A dam will be built raising the level of the lake for hydropower generation. Discharged waters from the powerhouse will empty into the lower Bradley River.

Heavy equipment for construction of the Nuka diversion dam would be flown into the unvegetated site in this remote area to avoid impacts upon soils and vegetation. Blasting schedules within the immediate project area would be developed to minimize impacts to mountain goats which utilize the surrounding area. (See APA Mitigation Plan and the FERC Draft Supplemental Environmental Impact Statement for additional detail of project specifications and methods.)

EXISTING ENVIRONMENTAL SETTING

Nuka River Hydrology and Hydraulics

The meltwater and runoff from the Nuka Glacier have historically entered both the Nuka River and the Bradley River drainages. Over time, the location of subglacial channels and depositional material at the glacier terminus have determined the course of the runoff and meltwater and the proportions received by the two drainages. Recorded observations show that not only do the proportions of flow into the drainages vary, but there have been periods historically where essentially all of the flow has gone either to the Bradley or to the Nuka River. According to U.S. Geological Survey recorded information, approximately 75% of the flow went into the Nuka River between the years 1958 and 1970. From mid-1971 until the
summer of 1983 nearly all the glacial meltwater flowed into the Upper Bradley River drainage. This situation again began to change in 1983 as a result of natural subglacial channeling and the flow again became divided between the two drainages. As recently as July 1985, the percentage of Nuka glacier flow entering the Nuka River drainage was 57.8%. The average total May through November flow originating from the Nuka Glacier, as recorded by the U.S. Geological Survey was approximately 192 cfs, while average annual flows measured for 1985 were 115 cfs.

The Nuka River follows a course of 12 miles in a southerly direction from the terminus of Nuka Glacier into Beauty Bay, an arm of Nuka Bay on the south coast of the Kenai Peninsula. The river course varies from a flat, meandering single channel with sparsely vegetated banks in the upper four miles, to a steeper, narrowly confined channel in the middle four miles, to a wide and braided system in the lower four miles. Several rapids and small falls exist throughout the middle section and a falls occurs at mile 4.1 which acts as a natural block to the upstream movement of fish. Alluvial sediments are the river substrates found in the upper and lower sections and a bedrock substrate is found in the middle section.

Substantial flows occur in the Nuka River system from sources other than the Nuka Glacier. The upper third of the river receives runoff and glacial meltwater from a 10.9 square mile area of which 3.6 are glacier-covered. Appendix 1 includes APA estimates of monthly flows in the upper Nuka River drainage, without the addition of Nuka Glacier flows. During most years, 10 to 22+ cfs are received during the period from June through September at the park boundary as a sole result of snowmelt, rainfall, and from groundwater flow through pervious gravels. Mean annual precipitation at the upper drainage of the river is more than 60 inches annually.

Monthly flows in cfs peak in the upper third of the drainage in July and August and are lowest in March and April. The lower two thirds of the drainage receive additional runoff and meltwaters which are not from the Nuka Glacier. Channel configuration in the middle section of the river is confined by bedrock to a narrow channel, while the lower section is characterized by a broader and braided stream channel.
Vegetation

The upper Nuka River flows through a subalpine valley with vegetation common to much of southcentral Alaska on the Kenai Peninsula. Willow shrubs cover 75% or more of the area interspersed with shrub tundra, herbaceous vegetation (including horsetail, graminoids, burnet, bluejoint sedge, shield fern, yarrow, fireweed, and others). Other groundcover consists of feathermoss, nagoon berry, sphagnum moss, club moss, lousewort, bog orchid, wintergreen, primrose, and marsh violet.

At the lower portions of the river after it traverses a bedrock canyon is a vegetated broad valley which includes typical forms of riparian vegetation including willow and alder with some dense stands of spruce along the west side of the valley.

Wildlife

Species of wildlife observed within the Nuka River valley include moose, bear, mountain goat, wolverine, beaver, and various small mammals. Moose and beaver are found year round within the upper Nuka drainage. Groups of mountain goats have been observed at the Nuka Glacier. Generally, the diversity of species is somewhat greater in the more diverse habitat of the lower Nuka River than in the upper reaches. Vegetation on the broad valley floor forms a prime habitat for moose, black bear, furbearers, and small mammals.

Bird diversity within the valley is considered to be low. Several species of passerine birds in addition to willow ptarmigan have been observed. No eagles, falcons, or waterfowl have been recorded within the upper Nuka River valley.

The Nuka River supports relatively low numbers of salmon due to unsuitable habitat. It is a glacial system with a braided portion downstream of the barrier (a falls) located at river mile 4.1. The NPS is currently unaware of any fish present above the falls. Most use in the lower drainage occurs in clearwater tributaries or side channels which appear to function independently of the mainstem. Fish studies conducted during the months of August and November of 1984 revealed pink salmon adults in a side channel to the Nuka River at mile 2.6 and both coho and
chum salmon adults in a tributary at mile 3.6. Both juvenile coho salmon and Dolly Varden were observed in several locations in side channels and within sloughs along the rivercourse and may also be present in the mainstem.

Visitor Use and Aesthetics

The Nuka River drainage is within a remote area of the Kenai Fjords National Park which is relatively inaccessible to most potential visitors. Access is by floatplane, by boat into Beauty Bay, or by foot into the Nuka Pass Area. Cross country travel on foot is difficult due to the presence of dense alder thickets, cold and swift river waters, and steep canyons. As a result, most recreational use of the Kenai Fjords is on the adjacent coastal waters of the Gulf of Alaska or along the immediate shoreline. No established trails are designated in the western portion of the park and none are anticipated with the possible exception of a trail which was mentioned in the General Management Plan for Kenai Fjords (1983). That document states that "a trail into the Nuka Bay area of the fjords could be constructed following completion of the Bradley Lake hydroelectric project." The document goes on to say, "If a road is provided for public access from Homer to the reservoir and if sufficient public interest is expressed, a trail could be constructed from the end of the road, over Nuka Pass, and down into Beauty Bay."

Current visitation into this localized area of the park is estimated at 15 or less annually. This visitation could increase substantially with the construction of the hydropower project nearby, and particularly if road access from a barge landing to Bradley Lake and the trail were developed, as described. Additional planning and environmental compliance would be required before the NPS could construct a trail to Beauty Bay.

The Nuka River drainage possesses a virtually untouched and aesthetically pleasing experience to the few visitors who have had the opportunity to see it. Natural fluctuations in runoff from the Nuka Glacier and downstream tributaries have created a system of dynamic change evidenced in the aquatic characteristics, as well as the changing vegetation and in the wildlife species which inhabit the area.
ALTERNATIVES

Alternative 1: No Action (Natural Flow With No Diversion Structures)

The no action alternative assumes that no construction of a water diversion structure would occur to divert water flow from the Nuka River drainage. The existing natural processes which govern the volume and direction of waters from the Nuka Glacier would prevail. Other tributaries and sources of water into the Nuka drainage below the glacier would also remain unaltered.

The purpose of this alternative is not to determine the feasibility of the Bradley Lake Project without controlled flow from the Nuka Glacier source. The purpose is to provide a feasible alternative and a baseline of natural events against which the impacts of the succeeding alternatives for diverting water can be contrasted. The impacts to Kenai Fjords National Park resources as a result of the construction of a diversion structure on the Nuka River are the subject of this assessment.

Alternative 2: Two Cubic Feet Per Second in the Nuka Drainage as Measured at the Park Boundary (APA Proposal from Supplemental EIS and Mitigation Plan)

This alternative guarantees the flow of the Nuka River at a minimum of 2 cubic feet per second (cfs) past the Kenai Fjords National Park boundary. This flow requirement would be valid only for the annual period between May 15 through September 30 as discussed in the APA proposal. During the winter months (December through March) most water in the region is frozen in the form of ice and snow. During this period the combined flow of the glacier and the flow below the glacier is so slight that the exclusion of winter glacier flow from the Nuka drainage is not anticipated to make a significant reduction in overall flow levels (average combined flow for this period during 1985 was 3.25 cfs). Therefore, the minimum 2 cfs agreement does not apply to this period.
The park boundary is located about 2,000 feet downstream of the proposed diversion and this reach has a 0.9 square mile drainage area. The APA estimates that an average annual flow of 6 cfs would reach the park boundary from this drainage area without any flow from the Nuka Glacier itself. The average flow during the period from June through September without Nuka Glacier flow would be 14.4 cfs. This flow would result from sources including rainfall, snowmelt, and tributaries to the Nuka River below the terminus of Nuka Glacier.

Thus, it is unlikely that the establishment of a minimum flow of 2 cfs within the Nuka drainage as measured at the park boundary would require the release of any water from the proposed diversion structure into the Nuka drainage for the annual period from May 15 to September 30 annually. Flows in excess of this minimum level are already experienced from sources other than meltwater from the Nuka Glacier.

**Alternative 3: Five Cubic Feet Per Second As Measured At the Park Boundary (APA Proposal, May 20, 1986)**

This alternative guarantees the flow of the Nuka River at a minimum daily average of 5 cubic feet per second (cfs) at the Kenai Fjords National Park boundary. This flow requirement would be valid only for the annual period between May 15 through September 30. As discussed in Alternative 2, during the winter months, the combined flow of the glacier and the flow below the glacier is so slight that the exclusion of winter glacier flow from the Nuka drainage is not anticipated to make a significant reduction in overall flow levels.

As discussed under Alternative 2, the APA estimates that an average annual flow of 6 cfs would reach the park boundary from this drainage area without any flow from the Nuka Glacier itself. Therefore, it is unlikely that the establishment of a minimum flow of 5 cfs within the Nuka drainage as measured at the park boundary would require the release of any water from the proposed diversion structure into the Nuka drainage for the annual period from May 15 to September 30 annually.
Alternative 4: Release of 5 Cubic Feet Per Second of Flow at the Nuka River Diversion Structure

This alternative requires the release of a minimum of 5 cfs of water at the diversion structure into the Nuka River drainage. The water release would serve to augment that flow which would naturally pass the park boundary from sources below the terminus of the glacier.

This alternative would guarantee the park a portion of the Nuka Glacier flow during the period from May 15 to September 30 annually. Nuka River flows under this alternative would remain within a range of flows which have been historically experienced during this annual time period. Under this alternative, however, the Nuka River drainage within the park would not experience substantial variations in flow as high as would have been experienced naturally during this annual period. In addition, the Nuka River drainage would not experience cycles of great abundance or lack of appreciable flow over the course of several years as have historically been the result of morainal deposition and consequent "switching" in flow between the Nuka and Bradley drainages.

Alternative 5: Release of Five Cubic Feet Per Second at the Diversion Structure into the Nuka Drainage, Plus Excess Waters

This alternative calls for the release of 5 cfs of water at the Nuka River diversion structure and the additional release of those excess waters which would otherwise be spilled at the Bradley Lake dam during periods of high flow and/or full storage capacity at the dam. As with the previous alternatives, this alternative would be valid for the period from May 15 through September 30 annually.

This alternative assumes that there will exist excess flows from the glacier in some years which are not required to generate electricity or to fill capacity behind the Bradley Lake Dam, and which would otherwise be spilled at the dam and into the lower Bradley River under Alternatives 2, 3, and 4. Thus, the alternative is, whenever all of the combined flow of the upper Bradley River and the Nuka River are not needed at the dam site,
then diversion of those unneeded waters could be allowed to pass into the Nuka River drainage, rather than being diverted into the Bradley Lake.

The alternative may not be viable for a considerable period of time following project construction because excess flows in the interim would likely be required behind the dam to raise the pool to desired operating standards.

In a limited sense, the delivery of such excess flows would follow approximate flow patterns which would be naturally experienced within the Nuka River drainage, albeit at a much reduced flow volume. These natural flow patterns could be obscured, however, by the changing volume requirements at the hydropower site which are based upon regional electricity needs, maintenance and repair requirements at the dam, and other factors. In addition, patterns of "natural flow" would be further obscured by the fact that this excess flow may not have been naturally experienced in the Nuka drainage because of the process of natural "switching" of flow between the Nuka and Bradley drainages.

In essence, if the amount of excess flow does not rise and fall with natural supply of waters from the Nuka Glacier into the Nuka River drainage, but instead with requirements at the dam site, then the flow diversion into the Nuka drainage could be highly artificial and erratic. It seems clear that implementation of this alternative would require close coordination and an agreement between the NPS and the APA to refine a method or set of circumstances which would govern when and how excess waters would be released into the Nuka drainage.

ENVIRONMENTAL CONSEQUENCES

The environmental consequences of the proposed action and the alternatives are discussed in the following paragraphs and tables. The primary areas of potential impact under the alternatives which include the construction of a diversion dam, are primarily related to: water quantity, stream morphology, sediment transport, visitor use, and aesthetics. Very minor changes in vegetation and habitat are also foreseen.
Impacts of Alternative 1

There would be no known impacts to natural, cultural, scenic, or other resources within the Nuka River drainage of Kenai Fjords National Park as a result of the implementation of the No Action Alternative. If, according to APA estimates, the economic feasibility of the Bradley Lake Project is contingent upon the utilization of a minimum of 50% of the Nuka Glacier runoff (Anchorage Daily News; May 22, 1986), then it can be assumed that this alternative would preclude implementation of the project. If the Bradley Lake Project did not go forward, impacts resulting from increased access to, and use of the area encompassing the Nuka River drainage within the Kenai Fjords National Park would also be precluded.

Impacts of Alternative 2: Two CFS at the Park Boundary

The impacts associated with the 2 cfs guaranteed minimum flow as measured at the park boundary for the period of May 15 through September follow. This alternative would result in the diversion of all potential natural flow from the Nuka Glacier into the Bradley River drainage. This is because flows in excess of 2 cfs from sources other than the glacier currently pass the park boundary during the period from May 15 through September 30 as discussed. The average flow from rainfall, snowmelt, and tributaries below the Nuka Glacier and upstream of the park boundary contribute an average flow of 14.4 cfs at the park boundary for this time period (see Appendix 1). Approximately 6 cfs are contributed on an average annual basis.

The loss of any potential Nuka glacier flow would have the effect of lowering the flow received at the park boundary. This flow has reached to peaks at the park boundary as high as 261 cfs or more (of which as much as 200 cfs is attributable to glacier flow). In past years, the flow has been less than one fourth this amount. The high variability is due to the switching of the flow between the Bradley River and the Nuka River under natural conditions.
TABLE 1

<table>
<thead>
<tr>
<th>PARK ATTRIBUTE</th>
<th>REMARKS</th>
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<tbody>
<tr>
<td>Climate</td>
<td>Climate would not be affected other than specific limited microenvironments at the diversion structure itself.</td>
</tr>
<tr>
<td>Air Quality</td>
<td>The only air quality impacts would be from fugitive dust, machinery emissions, and/or burning. All would occur at the project site outside the park boundary. Both of these activities will be strictly controlled and not allowed to cause adverse impact upon air quality.</td>
</tr>
<tr>
<td>Noise</td>
<td>Dam construction will occur seven miles from the boundary of the park. Noise from the site will be inaudible at the park. While the Nuka Diversion is less than one mile from the park boundary, little noise will be generated during construction, and is not expected at levels which would be disruptive to natural systems or visitors. The noise of construction occurring outside the park will be both temporary and seasonal.</td>
</tr>
<tr>
<td>Water Quantity</td>
<td>The water quantity received at the park boundary could be substantially reduced from flows which would have been naturally received. It is difficult to project the precise level in reduction in cfs because of the natural switching of the flow from the glacier between the Nuka and Bradley drainages. Flow reductions could be reduced by as little as 0 cfs in low flow periods or as much as 300+ cfs at peak flow periods depending upon which drainage would have received this flow under natural conditions. At present, the total flow from the Nuka Glacier into the Nuka River exceeds 94 cfs during peak flow in July, 90% of the time. This flow would be reduced to 0 cfs under this alternative. During other months the reduction would not be as great. For example, the present flow which is 23 cfs or more off the glacier into the Nuka River in June (90% of the time) would be reduced to 0 cfs under this alternative (see Appx. 3). Flow levels would occur within the range of flows which have historically been experienced. However, there would no longer be a dynamic system over time in which some years the park received virtually no glacier flow, and in others a great proportion of the glacier flow. The level of flow from sources below the glacier terminus along the twelve mile reach of the river (rainfall, snowmelt, tributaries), would continue to contribute natural levels of flow to the river. These levels of flow will continue to vary at the park boundary from an average 1.0 cfs in January to as much as an average 22.3 cfs during June (see Appendix 1).</td>
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Stream Morphology

The flow (or the energy available to transport material) within a river or stream is essential in forming and maintaining the active channel. When the flow regime is altered, the channel conforms to a new flow regime which holds the potential to cause changes in the pattern and/or location of the stream.

Stream morphology under this alternative will no longer be controlled by a dynamic combination of natural cyclic flow events from Nuka Glacier (as well as runoff events from side drainages). Naturally high runoff events from side drainages will now likely be the dominant force in determining stream morphology changes in the lowest river sections. In the upper Nuka River, permanently reduced flows will likely stabilize the channel, possibly in a different configuration and/or location. This will be caused by the reduction in flow or energy affecting sediment transport. Probable changes cannot be fully defined with current available data.

Sediment Transport

A consistent reduction of flow or energy in the drainage system can be expected to result in a systematic, long term decrease in the transport of sediment. In other words, both the volume and the capacity of the river system to carry sediment loads will be permanently reduced and stabilized at a lower level than at present. Glacial sediment levels in the upper Nuka drainage will be reduced and stabilized. The braided channel system on the lower Nuka River could be sensitive to changes in sediment size and load, as well as flow volume and velocity. The full extent of change cannot be developed without additional field study.

Turbidity

On a percentage basis, the amount of glacial silt within waters in the Nuka River system will be permanently reduced with a lesser proportion of streamflow from the glacier. This will permanently reduce and stabilize stream turbidity at a level lower than now present and will be most evident within the upper Nuka River.

Water Temperature

Most water within the system is from glaciers, snowmelt, and percolation through the ground. Permanent diversion of Nuka Glacier flows could cause a temperature increase in the upper Nuka River because a larger proportion of flows, at times, will be non-glacial in origin.

Vegetation

A zone of riparian vegetation along the Nuka River corridor between the high and low water flow lines is distinct from vegetation types on higher and drier slopes. The location and extent of riparian vegetation in the upper Nuka River will no longer be a dynamic changing process dependent upon natural cyclic events from glacier flow. After a new channel stabilizes, formerly inundated areas within the upper reach of the drainage will become covered with riparian vegetation.
The stabilization of an increased level of riparian vegetation will cause minor habitat changes which will be more favorable to some wildlife and may hinder others. For example, moose and other species which favor riparian habitat would be benefited. Such change will be more pronounced in the upper Nuka River drainage than in the lower reach, although the reduced flow rate may also cause a more meandering stream in the lower drainage with slight increases in riparian vegetation.

Benthos and Water Column Production
Primary and secondary production is presently very low in the upper river due to cold temperatures, high turbidity, and high sediment load from the Nuka Glacier. Past natural cyclic flow events from the glacier have likely resulted in dynamic changes in production in the upper river. With permanent loss of turbid glacier flow, the upper Nuka River production per unit area and per unit volume, will likely increase and stabilize at a higher level.

Wildlife and Fish
No significant displacement of fish or wildlife species is anticipated. Moose or goats utilizing the drainage will not be displaced, nor will small mammal species. Short term construction at the diversion site outside the boundary could displace some mammals from the immediate area on a seasonal basis. The falls at river mile 4.1 currently acts as a barrier to upstream fish passage. Use of the clearwater tributaries and the braided mainstem below this point by salmon and Dolly Varden is expected to continue.

Visitor Use and Aesthetics
Visitor use could increase with the construction of the diversion dam and hydro project. Current use at approximately 15 visits per year into the remote western section of the park would increase during the period of construction of the hydro project. No permanent access road would be built to the diversion structure and long term increases in visitation are expected to be minimal. Access by boat to the Bradley Lake construction road or into Beauty Bay would be required to use the area. Thus, it is likely that visitors from Homer and the Kenai Peninsula would prefer to use more accessible and comparable environments in Kachemak Bay and at other nearby locations.

No established trails are designated in the western portion of the park and none are anticipated with the possible exception of a trail which was mentioned in the General Management Plan for Kenai Fjords (1983). Additional NPS planning and environmental compliance would be required before a trail could be constructed from Bradley Lake, over Nuka Pass, and into the Beauty Bay area.

The park staff will lose the opportunity to interpret the natural dynamic
processes which occurred within the Nuka drainage prior to the construction of the diversion. The park, however, does not currently have an active interpretive program within the western portion of the park. The aesthetics of the Nuka drainage are not expected to be appreciably disrupted or resources destroyed. Some visitors may question the need to divert Nuka River water and the impact on park resources. These visitors could be disappointed that totally pristine conditions have not been maintained. Most would be unaware of any change in the environment unless those changes were interpreted to them by park staff.

Cultural Resources
No impacts upon historical or archeological resources within the Nuka River drainage have been identified by APA and none are anticipated. No structures listed on the National Register of Historic Places have been identified within the drainage and none eligible are known to exist there.

Impacts of Alternative 3: Five CFS at the Park Boundary

The impacts of this alternative would be identical to those described under alternative 2. This is because flows in excess of 5 cfs already pass the park boundary during the annual period from May 15 through September 30 and such flow levels are expected to continue during successive seasons without any contribution from Nuka Glacier flow. Refer to Table 1 under “Impacts of Alternative 2” for specific impacts of this alternative.

Impacts of Alternative 4: Five CFS at the Diversion Structure

The impacts resulting from this alternative would primarily involve water quantity in the Nuka drainage, sediment transport, stream morphology, visitor use, and aesthetics. The impacts are comparable to those in alternatives 2 and 3, although they would be realized to a lesser degree than in these alternatives. This is because the delivery of a base flow of 5 cfs from the diversion structure brings the flows within the Nuka drainage closer to levels which have historically been experienced during that period of higher flow. Diversion of water from the Nuka River drainage will, however, preclude natural levels of flow (or energy in the system)
and the variability which has historically been experienced due to
"switching" between the Bradley and Nuka drainages. Total natural and
undisturbed conditions in this remote and localized portion of the park
will not be maintained. The dynamic hydrologic processes within the
drainage will be replaced with a more regulated level of flow from the
Nuka Glacier source. All tributary sources below the diversion structure
will continue to provide natural inflow to the Nuka drainage. No
substantial adverse impairment to the natural resources within the
drainage is anticipated. Minor increases in riparian vegetation species
would be realized with overall reduced water flow. This condition could
favor some wildlife species and hinder use of the area by others. Those
dependent upon riparian vegetation could be benefited.

The construction of the Bradley Lake Project holds the potential to cause
moderate increases in access and recreational use within the western
portion of the Kenai Fjords National Park. The General Management Plan
prepared for the park in 1983, recognized this potential and recommended
the creation of a trail from the access road at the project site, over Nuka
Pass, and into Beauty Bay. While current visitation to the Nuka drainage
and shoreline of Beauty Bay is extremely low, such trail access could draw
more visitors into the park annually. Dramatic increases are not expected
because boat or floatplane access would still be required to reach the
project access road and trailhead outside the park boundary. The General
Management Plan further provides for the future construction of a ranger
cabin/cache facility somewhere along the shoreline of Nuka Bay. The
construction of a trail and the consequent need for ranger patrols and
visitor contact in this area could dictate the optimum site for this
presently unbuilt structure.

See the following table for additional detail of impacts:

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the park boundary. Both of these activities will be strictly controlled and not allowed to cause adverse impact upon air quality.

Noise

Dam construction will occur seven miles from the boundary of the park. Noise from the site will be inaudible at the park. While the Nuka Diversion is less than one mile from the park boundary, little noise will be generated during construction, and is not expected at levels which would be disruptive to natural systems or visitors. The noise of construction occurring outside the park will be both temporary and seasonal.

Water Quantity

The Nuka River drainage will receive a guaranteed minimum 5 cfs flow from the diversion structure which will augment other tributary sources to the drainage below the glacier terminus. The water quantity received at the park boundary could be substantially reduced from flows which would have been naturally received. It is difficult to project the precise level of change in cfs because of the natural switching of the flow from the glacier between the Nuka and Bradley drainages. In some years 5 cfs could be more than would have been naturally experienced. (For example, virtually all of the Nuka Glacier flow from mid-1971 to 1983 naturally flowed into the Bradley drainage.)

At present, the total flow from the Nuka Glacier into the Nuka River exceeds 94 cfs during peak flow in July, 90% of the time. This flow would be reduced to minimum 5 cfs under this alternative. During other months the reduction would not be as great. For example, the present flow (90% of the time) would be reduced to minimum 5 cfs under this alternative (see Appx. 3).

Flow levels would occur within the range of flows which have historically been experienced. However, there would no longer be as dynamic a system over time in which some years the park received virtually no glacier flow, and in others a great proportion of the glacier flow. The level of flow from sources below the glacier terminus along the twelve mile reach of the river (rainfall, snowmelt, tributaries), would continue to contribute natural levels of flow to the river. These levels of flow will continue to vary at the park boundary from an average 1.0 cfs in January to as much as an average 22.3 cfs during June (see Appendix 1). Thus, overall river flow would occur within a narrower range than in the past.

Stream Morphology

The flow (or the energy available to transport material) within a river or stream is essential in forming and maintaining the active channel. When the flow regime is altered, the channel conforms to a new flow regime which holds the potential to cause changes in the pattern and/or location of the stream.

Stream morphology under this alternative will no longer be controlled by
a dynamic combination of natural cyclic flow events from Nuka Glacier (as well as runoff events from side drainages). The guaranteed release of a minimum of 5 cfs from the diversion structure into the drainage during the annual high flow season would serve to reduce the potential for change in stream morphology which would have been experienced if all flow were diverted (as in alternatives 2 and 3). It is difficult to project the level of change in stream configuration and location as a result of 5 cfs flow plus tributary flow. With reduced energy or flow in the system from present levels, a new equilibrium will be achieved requiring some alteration.

Naturally high runoff events from side drainages will now likely be the dominant force in determining stream morphology changes in the lowest river sections.

Sediment Transport

A consistent change in flow or energy in the drainage system can be expected to result in a systematic, long term change in the transport of sediment. Both the volume and the capacity of the river system to carry sediment loads will be permanently changed and stabilized at a lower level than now present. Glacial sediment levels in the upper Nuka drainage will be reduced and stabilized. The braided channel system on the lower Nuka River could be sensitive to changes in sediment size and load, as well as flow volume and velocity.

The level of reduction in sediment transport from current levels, and its effects will be lower than in alternatives 2 and 3 because of release of 5 cfs into the Nuka drainage during high flow seasons. The level of sediment transport at 5 cfs may actually be greater than would have occurred naturally in future years because of the switching of glacier flow between the Nuka and Bradley drainages.

Turbidity

On a percentage basis, the amount of glacial silt within waters in the Nuka River system will be permanently reduced from present levels due to a lesser proportion of streamflow from the glacier. This will permanently reduce and stabilize stream turbidity at a level lower than now present and will be most evident within the upper Nuka River. The level of reduction in turbidity, however, will not be as great as that which would occur under alternatives 2 or 3, because of the guarantee of 5 cfs of glacial water past the diversion structure.

Water Temperature

Most water within the system is from glaciers, snowmelt, and percolation through the ground. Permanent diversion of Nuka Glacier flows could cause a temperature increase in the upper Nuka River from present condition, because a larger proportion of flows will be non-glacial in origin. Temperature increases in the upper Nuka are not expected to be as great as under alternatives 2 and 3 because of the guaranteed release of 5 cfs of glacier water past the diversion structure. In some years, temperatures in the upper drainage may actually be lower.
than would have been experienced because less than 5 cfs of glacier melt would have originated at the glacier.

Vegetation

A zone of riparian vegetation along the Nuka River corridor between the high and low water flow lines is distinct from vegetation types on higher and drier slopes. The location and extent of riparian vegetation in the upper Nuka River will no longer be a dynamic changing process dependent upon natural cyclic events from glacier flow. After a new channel stabilizes, formerly inundated areas within the upper reach of the drainage will become covered with riparian vegetation.

The stabilization of an increased level of riparian vegetation will cause minor habitat changes which will be more favorable to some wildlife and may hinder others. Such minor habitat change will be more pronounced in the upper Nuka River drainage than in the lower reach, although the reduced flow rate may also cause a more meandering stream in the lower drainage with slight increases in riparian vegetation.

Increases in riparian vegetation are not expected to be as great as under alternatives 2 and 3 because of the guaranteed release of 5 cfs of glacier water past the diversion structure, and the consequent lessening in changes in drainage characteristics.

Benthos and Water Column Production

Primary and secondary production is presently very low in the upper river due to cold temperatures, high turbidity, and high sediment load from the Nuka Glacier. Past natural cyclic flow events from the glacier have likely resulted in dynamic changes in production in the upper river. With permanent loss of turbid glacier flow, the upper Nuka River production per unit area and per unit volume will likely increase and stabilize at a higher level.

Increases in production are not expected to be as great as under alternatives 2 and 3 because of the guaranteed release of 5 cfs of glacier water past the diversion structure, and thus a less dramatic change in sediment, temperature, and turbidity characteristics.

Wildlife and Fish

No significant displacement of fish or wildlife species is anticipated. Moose or goats utilizing the drainage will not be displaced, nor will small mammal species. Short term construction at the diversion site outside the boundary could displace some mammals from the immediate area on a seasonal basis. The falls at river mile 4.1 currently acts as a barrier to upstream fish passage. Use of the clearwater tributaries and the braided mainstem below this point by salmon and Dolly Varden is expected to continue.
Visitor Use and Aesthetics

Visitor use could increase with the construction of the diversion dam and hydro project. Current use at approximately 15 visits per year into the remote western section of the park would increase during the period of construction of the hydro project. No permanent access road would be built to the diversion structure and long term increases in visitation are therefore expected to be minimal. Access by boat to the Bradley Lake construction road or into Beauty Bay would be required to use the area. Thus, it is likely that visitors from Homer and the Kenai Peninsula would prefer to use more accessible and comparable environments in Kachemak Bay and at other nearby locations.

No established trails are designated in the western portion of the park and none are anticipated with the possible exception of a trail which was mentioned in the General Management Plan for Kenai Fjords (1983). Additional NPS planning and environmental compliance would be required before a trail could be constructed from Bradley Lake, over Nuka Pass, and into the Beauty Bay area.

The park staff will lose the opportunity to interpret the natural dynamic processes which occurred within the Nuka drainage prior to the construction of the diversion. The park, however, does not currently have an active interpretive program within the western portion of the park. The aesthetics of the Nuka drainage are not expected to be appreciably disrupted or resources destroyed. Some visitors may question the need to divert Nuka River water and the impact on park resources. The modification of totally pristine conditions within the drainage may be a disappointment to some visitors. Most would be unaware of any change in the environment unless these changes were interpreted to them by park staff.

Cultural Resources

No impacts upon historical or archeological resources within the Nuka River drainage have been identified by APA and none are anticipated. No structures listed on the National Register of Historic Places have been identified within the drainage and none eligible are known to exist there.

Impacts of Alternative 5: Five CFS at the Diversion Structure and Excess Flow

For reasons illustrated in the description of this alternative, the nature of excess flows and therefore their consequences are difficult to project. Assuming that use of water at the Bradley Lake Hydropower facility is
constant after the dam is filled, then patterns of excess flow spillage into
the Nuka River drainage could possibly follow or "mimic" natural high
flow events from the glacier. The delivery of this flow into the Nuka
drainage, however, could not take into consideration the natural
"switching" which occur between the Nuka and Upper Bradley drainages.

Furthermore, as previously described, excess flow may result more from
varying man-induced requirements at the power facility than from natural
events. Such decisions could cause sudden, high volume releases into the
Nuka drainage from the diversion.

For these reasons, the diversion of excess flow into the Nuka drainage
could cause flow characteristics which are highly artificial, erratic, and
potentially highly disruptive to natural processes and resources.

As discussed, conditions which dictate when and how such releases are
made into the Nuka drainage would need to be examined and mutually
agreed upon by the APA and the National Park Service.

Impacts of this alternative would be the same as found in alternative 4
but with potential additional adverse effects. The following paragraphs
illustrate the potential impacts of excess releases from all possible
events.

The quantity of water within the Nuka drainage would be a guaranteed 5
cfs plus flow from below glacier sources from May 15 through September
30. The release of excess flow into the Nuka River from the Nuka pool
could cause the sudden and disruptive changes in additional flow of up to
300 cfs (if all Nuka Glacier waters are diverted in a peak period). The
time and seasons, the rate, and the levels at which these flows were
released at the diversion would likely not be entirely in response to
natural events, as discussed.

The result could be sudden and erratic changes in stream morphology with
substantial changes of the energy within the system. Unless releases are
gradual and in response to natural events (as opposed to man-induced
situations) substantial changes in stream pattern and configuration could
result. Sudden increase in energy in the system could radically increase
sediment transport and turbidity within the drainage. The vastly
increased proportion of glacial water in the system could create sudden
decreases in water temperatures, particularly in the upper Nuka River.

Responses in vegetation along the river could be substantial with new riparian zones being formed, and then abandoned by the river channel when it changes in response to subsequent spills of excess flow. Alder and willow along abandoned stream channels (particularly along the lower third of the river) could lack the water necessary to sustain them and would be replaced by drier slope species. New areas of riparian vegetation would form, although not in response to natural events. If spills are sudden releases of high volume, some vegetation would be swept downstream creating a higher potential for streambank erosion.

Pulses in the spillage of excess waters would create conditions which are not conducive to the production of benthic organisms, due to sudden regular changes in temperature, turbidity, and sediment loading. Sudden releases in excess water at the diversion could endanger small mammals utilizing habitat along the stream channel, and potentially fish using the waters below the 41 mile falls.

Sudden high volume increases in flow could conceivably endanger visitors camped adjacent to, or attempting to cross the streamcourse.
CONSULTATION AND COORDINATION

The following agencies and individuals were contacted during the process of review of the APA proposal for Bradley Lake and during the preparation of the environmental assessment for Nuka River diversion:

Stanley Ponce, NPS, Water Resources Division
Richard Stenmark, NPS, WASO
Alan Lovaas, NPS, Alaska Regional Office
Ross Kavanagh, NPS Alaska Regional Office
Larry Wright, NPS, Alaska Regional Office
Jonathan Halpern, NPS, Alaska Regional Office
Tom Lucke, NPS, Water Resources Division
Gerry Verstraete, NPS, Washington Office
Hank Hasking, U.S. Fish and Wildlife Service, Office of Ecological Services
Bob Bowker, U.S. Fish and Wildlife Service, Office of Ecological Services
APPENDIX 1: Estimates of Monthly Streamflow in the Upper Nuka River Drainage Without the Addition of Nuka Glacier

<table>
<thead>
<tr>
<th>Drainage Area (sq. mi.)</th>
<th>Park Boundary</th>
<th>Upper One Mile</th>
<th>Upper Third</th>
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<th>Upper Third</th>
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<td>March</td>
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<td>April</td>
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<td>May</td>
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Source: Alaska Power Authority, Attachment to letter to National Park Service, September 27, 1986
### Table 1

**Comparison of Mean Monthly Recorded Streamflows at Upper Nuka River and Upper Bradley River Streamgaging Sites, 1985 Water Year**

<table>
<thead>
<tr>
<th>MONTH</th>
<th>Q&lt;sub&gt;NUKA&lt;/sub&gt; (cfs)</th>
<th>Q&lt;sub&gt;BRADLEY&lt;/sub&gt; (cfs)</th>
<th>Percentage</th>
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<td>Jan 1985</td>
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<td>55.1</td>
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**Notes:**
1. Provisional data from USGS.
2. Upper Nuka River flow as a percentage of Upper Nuka River and Upper Bradley River combined flows:

\[
\% = \frac{Q_{NUKA}}{(Q_{NUKA} + Q_{BRADLEY})}
\]
### Table 2

**MONTHLY MEAN FLOWS AND EXCEEDANCE VALUES, NUKA RIVER NEAR HOMER**

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<th>DEC</th>
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</table>
| **SITE 1 - AT DIVIDE**
  **(PRESENT CONDITIONS)** |
| 90% Exceedance | 0   | 0   | 0   | 0   | 1   | 23  | 94  | 86  | 35  | 5   | 1   | 1   |
| 50% Exceedance | 1   | 1   | 0   | 1   | 4   | 51  | 136 | 147 | 74  | 12  | 3   | 1   |
| 10% Exceedance | 1   | 1   | 1   | 1   | 26  | 122 | 200 | 252 | 159 | 31  | 6   | 2   |
| **SITE 1 - AT DIVIDE**
  **(NUKA GLACIER FLOW TO BRADLEY LAKE)** |
| 90% Exceedance | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 50% Exceedance | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| 10% Exceedance | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
| **SITE 2 - AT BOUNDARY OF KENAI FJORDS N.M.**
  **(PRESENT CONDITIONS)** |
| 90% Exceedance | 1   | 0   | 0   | 0   | 1   | 30  | 122 | 113 | 46  | 6   | 2   | 1   |
| 50% Exceedance | 1   | 1   | 1   | 1   | 5   | 67  | 178 | 192 | 97  | 15  | 4   | 2   |
| 10% Exceedance | 2   | 1   | 1   | 2   | 34  | 159 | 261 | 329 | 207 | 41  | 7   | 2   |
| **SITE 2 - AT BOUNDARY OF KENAI FJORDS N.M.**
  **(NUKA GLACIER FLOW TO BRADLEY LAKE)** |
<p>| 90% Exceedance | 0   | 0   | 0   | 2   | 10  | 13  | 7   | 4   | 3   | 4   | 1   | 1   |
| 50% Exceedance | 2   | 2   | 2   | 5   | 16  | 20  | 14  | 9   | 10  | 12  | 5   | 3   |
| 10% Exceedance | 10  | 9   | 7   | 14  | 26  | 30  | 26  | 22  | 37  | 35  | 20  | 9   |</p>
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</table>
| SITE 5 - AT FISH BLOCK IN CANYON  
(PRESENT CONDITIONS)  |     |     |     |     |     |     |     |     |     |     |     |     |
| 90% Exceedance         | 30  | 23  | 21  | 26  | 120 | 357 | 401 | 308 | 188 | 128 | 60  | 40  |
| 50% Exceedance         | 66  | 54  | 44  | 54  | 221 | 509 | 605 | 531 | 444 | 300 | 150 | 79  |
| 10% Exceedance         | 148 | 128 | 93  | 114 | 414 | 728 | 922 | 922 | 1062| 706 | 377 | 157 |
| SITE 5 - AT FISH BLOCK IN CANYON  
(NUKA GLACIER FLOW TO BRADLEY LAKE)  |     |     |     |     |     |     |     |     |     |     |     |     |
| 90% Exceedance         | 25  | 20  | 17  | 22  | 101 | 300 | 337 | 258 | 158 | 108 | 51  | 34  |
| 50% Exceedance         | 56  | 46  | 37  | 45  | 185 | 428 | 508 | 446 | 373 | 252 | 126 | 66  |
| 10% Exceedance         | 124 | 108 | 78  | 96  | 348 | 612 | 775 | 775 | 893 | 593 | 316 | 132 |
| SITE 6 - AT MOUTH  
(PRESENT CONDITIONS)  |     |     |     |     |     |     |     |     |     |     |     |     |
| 90% Exceedance         | 57  | 44  | 40  | 49  | 230 | 681 | 764 | 587 | 359 | 245 | 116 | 77  |
| 50% Exceedance         | 126 | 104 | 83  | 103 | 421 | 971 | 1154| 1012| 847 | 572 | 286 | 151 |
| 10% Exceedance         | 282 | 244 | 177 | 218 | 790 | 1388| 1760| 1760| 2027| 1346| 719 | 300 |
| SITE 6 - AT MOUTH  
(NUKA GLACIER FLOW TO BRADLEY LAKE)  |     |     |     |     |     |     |     |     |     |     |     |     |
| 90% Exceedance         | 52  | 41  | 36  | 45  | 212 | 627 | 704 | 540 | 331 | 226 | 106 | 70  |
| 50% Exceedance         | 116 | 96  | 77  | 95  | 387 | 894 | 1062| 932 | 780 | 526 | 263 | 139 |
| 10% Exceedance         | 260 | 225 | 163 | 200 | 727 | 1278| 1620| 1619| 1866| 1239| 662 | 276 |