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ALASKA POWER AUTHORITY

SUSITNA HYDROELECTRIC PROJECT

POSITION PAPER

FISHERIES ISSUE F-12

EXECUTIVE SUMMARY

Issue

Formulation and implementation of a post-construction plan to monitor significant impacts and the efficacy of specific mitigation measures.

Position

The Alaska Power Authority proposes formulation and implementation of a monitoring plan to detect changes in the aquatic environment that may result from the Project. The Power Authority also endorses development of plans to monitor the efficacy of specific aquatic mitigation measures. A construction monitoring program is endorsed (and described) by the Power Authority in this position paper.

Present Knowledge

Aquatic monitoring for this project is divided into two broad categories:

- Construction monitoring
- Long-term monitoring

Construction monitoring encompasses regulatory monitoring and compliance enforcement. Construction monitoring activities will cover all project facilities including access road construction and maintenance, camp and

village construction, material removal, washing operations for dam construction, reservoir clearing, and rehabilitation needed due to construction activities. Monitoring will be done to ensure that proper construction practices are being followed and that project facilities are being properly maintained. The Power Authority has prepared Best Management Practices Manuals, which are compendiums of typical practices that can be used to avoid or minimize environmental impacts from construction, operation, and maintenance of Power Authority energy projects. The Power Authority intends that applicable guidelines from the manuals be incorporated where appropriate into the contract documents for the Susitna project. During construction, the Power Authority plans to consult with regulatory agencies to ensure that construction methods are consistent with regulatory requirements. In addition, the Power Authority intends to have, prior to construction, a member of its staff on-site as an Environmental Field Officer (EFO). It will be the EFO's responsibility to ensure that construction practices are consistent with the contract documents. The regulatory requirements will be incorporated into the contract documents.

Long-term aquatic monitoring will be conducted primarily to:

- Assess salmon population and production levels to ensure that these levels are maintained
- Evaluate the effectiveness of the project mitigation measures for areas downstream of the project and within the impoundment zone.

The long-term monitoring plan focuses on:

- Water quality upstream and downstream of the project
- Critical life history stages of fish
- Fluvial geomorphology

- Structural alteration of habitat such as slough modifications.

The overall plan will incorporate additional details where appropriate for monitoring potential impoundment zone impacts when mitigation plans for this project area are finalized by the Power Authority and the resource agencies.

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INTRODUCTION

Issue

Formulation and implementation of a post-construction plan to monitor significant impacts and the efficacy of specific mitigation measures.

Position

The Alaska Power Authority proposes formulation and implementation of a monitoring plan to detect changes in the aquatic environment that may result from the Project. The Power Authority also endorses development of plans to monitor the efficacy of specific aquatic mitigation measures. A construction monitoring program is endorsed (and described) by the Power Authority in this position paper.

DISCUSSION

Present Knowledge

Aquatic monitoring for this Project can be divided into two broad categories:

- Contruction monitoring
- Long-term monitoring

Construction monitoring will encompass regulatory monitoring and compliance enforcement. Long-term monitoring will be conducted primarily to:

- Assess salmon population and production levels to ensure that these levels are maintained.

- Evaluate the effectiveness of project mitigation measures for areas downstream of the project and within the impoundment zones.

The Power Authority presented an initial aquatic monitoring plan for the Susitna Project in the License Application (APA 1983, Exhibit E, page E-3-180). This plan included both construction and long-term monitoring. In response to resource agency requests, the Power Authority is presently revising that plan by adding more details and by expanding the original scope of the plan to incorporate additional monitoring that will be needed.

The following sections summarize the key components of the construction and long-term monitoring plans. Because monitoring procedures for these two plans are fairly distinct, separate procedures and implementation methods are described for each.

Construction Monitoring. Construction monitoring activities will cover all project facilities, including access road construction and maintenance, camp and village construction, material removal, material washing operations, reservoir clearing, and rehabilitation needed due to construction activities. Monitoring will be done to ensure that proper construction practices are being followed and that project facilities are being properly maintained.

The Power Authority has prepared five Best Management Practices (BMP) Manuals to be used in the design, construction and maintenance of Alaska Power Authority projects:

- o Oil Spill Contingency Planning
- o Erosion and Sedimentation Control
- o Liquid and Solid Waste
- o Fuel and Hazardous Materials
- o Water Withdrawal and Storage

These manuals are the result of a coordinated effort involving Federal, state and local government agencies, and special interest groups. The manuals are compendiums of typical practices that can be used to avoid or minimize environmental impacts from construction, operation, and maintenance of Power Authority energy projects. In addition, a report entitled "Drainage Structure and Waterway Design Guidelines" is being prepared.

The BMP manuals will be provided to the design engineer, who will utilize them in the preparation of both design and construction documents. The Power Authority intends that applicable guidelines contained in these Best Management Practices Manuals be incorporated where appropriate into the contractual documents for the Project.

During construction, the Power Authority and its construction manager will consult with regulatory agencies to insure that construction practices are consistent with regulatory requirements. Another goal of the Power Authority will be to apply for and receive as many permits as possible prior to the bidding of the job. The remaining permits will be obtained by the Power Authority's contractors as part of their contractual requirements under the close supervision of the Power Authority, or by the Power Authority directly.

In addition to consultation with individual agencies, the Power Authority will continue the practice of meeting with the established interdisciplinary/inter-agency groups. The Power Authority envisions that these meetings may be held once every two months and will be the forum in which agencies will be apprised of the current work status. These meetings will also provide for interactive discussion between resource agencies, as well as an opportunity for the group to resolve differences of opinion and

provide consistent direction to the Power Authority and its design contractors.

The Power Authority is committed to working with an inter-agency team and will support its effort by providing data, analysis, technical support, and periodic field support. However, it does not support the concept of funding a full-time intraagency team for monitoring or consultation.

The Power Authority has, and will continue, to work with the agencies to develop an acceptable construction monitoring plan. The Power Authority anticipates that the Federal Energy Regulatory Commission (FERC) will include a License Article which will require implementation of the plan, and believes that this is a prudent approach since both the Power Authority and the agencies will need flexibility to resolve the day-to-day implementation and monitoring problems in an expeditious and cost effective manner. Regardless of how many contingency plans are developed, most of the field problems that occur during implementation typically are resolved as they occur. Some procedural flexibility is necessary in order to develop workable solutions. The Power Authority intends to have at least one member of its staff designated as an on-site Environmental Field Officer (EFO). The EFO will be required to be thoroughly familiar with plans and specifications, as well as with special regulatory permit stipulations and general environmental statutes and regulations. It will be the EFO's responsibility to enforce those portions of the construction contract documents, that incorporate the environmental stipulations specified in the permits and licenses. By incorporating the environmental concerns in the contract documents the Federal, state and local agencies can be assured that these concerns will be enforced in the field. The EFO will directly interface with the Power Authority's resident engineer and construction manager. The on-site construction manager will be thoroughly familar with the regulatory requirements and plans and specifications. These quality control assurance personnel will give equal weight to technical and environmental concerns in carrying out their field inspection responsibilities. The EFO through the Director of Environment and Licensing

(DEL), will be the Power Authority's field liaison with resource/regulatory agencies. The DEL will contact the appropriate agencies prior to the contractor beginning a scheduled major work item, in order that the regulatory agency may have the opportunity to request a site inspection.

The DEL also will contact regulatory agencies regarding amendments to permits, to report permit violations or to obtain variances. It will be the resident engineer's responsibility to ensure that contractors comply with federal and state oil spill reporting requirements and have control plans developed and approved. The Power Authority expects that resource/regulatory agencies will recognize the DEL as their contact and deal directly with him rather than with other entities. Monthly status reports are to be provided to the resource agencies by the DEL.

Long Term Monitoring. The long-term plan will address monitoring for areas downstream of the Project and in the impoundment zones. The purposes of this plan will be to:

- Determine if significant impacts to the aquatic system have occurred during operation of the project
- Evaluate the effectiveness of mitigation measures
- Provide input to refine operation and mitigation measures
- Provide supplemental baseline information

The general approach to monitoring will be to monitor natural conditions for a number of years (in many cases, monitoring natural conditions is complete). The length of time needed and the data requirements will depend on the parameter or situation to be monitored. Conditions will then be monitored after Watana construction begins and will continue through the initial years of Devil Canyon operation. The natural and with-project information will then be compared to determine if significant impacts have occurred and to evaluate the effectiveness of mitigation measures.

Major parameters that will be monitored will only be those that are considered good indicators of change (for the system) and are readily measured and analyzed.

The Power Authority proposes to initiate the field program during the 1985 field season. This will not preclude the possible analysis and use of previously collected data. The Power Authority will, on an annual basis, submit a report on aquatic monitoring to the FERC and resource agencies for review and comment. This report will describe the results of monitoring for the year and provide an analysis of whether or not impacts are apparent and significant.

The need for continued monitoring will be reviewed periodically. If significant impacts are found, recommendations will be made to mitigate them. It is envisioned that as the project matures, any significant impacts will be mitigated and the need for field studies/monitoring will decrease, i.e., portions of the aquatic monitoring program will be terminated when the need for further mitigation is considered unnecessary. Consequently, the need for reports on an annual basis may also decrease.

The major efforts for the program will be focused on monitoring:

- Water quality upstream and downstream of the project including:
  - Dissolved gas supersaturation
  - Temperature/ice studies
  - Turbidity
  - Mercury concentrations in fish
- Critical life history stages of fish including:
  - Adult salmon

- Egg incubation, juvenile rearing, and outmigration

o Fluvial geomorphology, including geomorphological changes downstream of the project

o Structural alteration of habitat such as slough modifications

Most efforts in the proposed plan concentrate on areas downstream of the project. A monitoring plan will be developed to evaluate the efficacy of the proposed impoundment area mitigation program. This will be done following finalization of mitigation plans for this area as proposed by the Power Authority (Woodward-Clyde Consultants 1984).

The following briefly describes the monitoring studies that will be proposed in the revised plan. Table 1 shows the schedule for each study element.

Dissolved Gas Supersaturation. Dissolved gas supersaturation can potentially result in fish mortalities downstream of dams, particularly at high head dams such as those proposed for the Susitna Project. Supersaturation primarily occurs when water, released over a spillway, plunges into a pool, while entraining air. This carries the air to depth and the hydrostatic head forces it into solution. At shallower depths, however, the gas comes out of solution, thus causing bubbles to form. If the gas comes out of solution within a fish (whose pressure is identical to that of the surrounding water), it may cause mortality.

To avoid potential impacts from supersaturation (and minimize the need to release water over the spillway), the Power Authority has provided means for storing and releasing all floods with recurrence intervals of 50 years or less without the need for spillway discharges. One of the means will be to provide a separate outlet equipped with cone valves. Releases from these valves would be dispersed as a spray and, therefore

Table 1

SUSITNA HYDROELECTRIC PROJECT

SCHEDULE FOR LONG-TERM AQUATIC MONITORING PLAN

Study Element	Prior Data Avail.	1985 W S S F	1986 W S S F	1987 W S S F	1988 W S S F	1989 W S S F	1990 W S S F	Watana Complete	Devil Canyon Complete	Both Dams + 5 years
Water Quality										
1. Dissolved Gas Supersaturation	yes	-----						-----	-----	----->
2. Temperature/Ice	yes	--------			----------					-----
Turbidity/Sediment	yes									
3. Mercury/Heavy Metals	no	-----						-----	-----	-----
4. Dissolved Oxygen, pH, Organic Nitrogen, and Phosphorus	yes	--------						-----	-----	-----
Water Quantity	yes	----------								----->
Fish Resources										
1. Adult Salmon	yes	---	---	---	---	---	---	-----	-----	------->
2. Young Salmon	yes	-----	-----	-----	-----	-----	-----	-----	-----	------->
Structural Habitat Modifications		(If incorporated as part of mitigation)						-----	-----	------->
Aquatic Habitat	yes							-----	-----	-->
Special Monitoring Studies		(Performed on an as-needed basis)								
Project Schedule (milestones)										
License Granted				*						
Watana Construction Begins					*					
Watana Construction Complete								*		
Devil Canyon Construction Begins									*	
Devil Canyon Complete										*

W S S F - Winter, Spring, Summer, Fall

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850125

would not plunge to depth nor be expected to cause gas saturations in excess of 110 percent downstream.

Six cone valves are planned for Watana Dam. These valves will have a discharge capacity of 24,000 cubic feet per second (cfs). Devil Canyon will have seven cone valves with a 38,500 cfs-discharge capacity.

In addition to the cone valves in Watana Dam, there will be a flood storage pool between elevations (el) 2,185, the normal maximum operating level, and el 2,193, the normal maximum flood surcharge level. Floods which occur in the late summer when the reservoir is at maximum operation level would be released through the cone valves and turbines. Inflows in excess of the combined capacities of the cone valves and turbines would be stored in the flood storage pool and released later. Additionally, as reservoir operation policies are refined and as Railbelt electrical demand increases, the amount of power generated by the Susitna Project powerhouses will increase. Thus, with time, increasingly greater amounts of inflow to the project will be utilized for power, reducing the possibility that flood inflows will fill the flood storage pool and cause spillway operation.

Natural turbulence in Devil Canyon causes supersaturation, with higher discharges resulting in higher dissolved gas concentrations. These natural concentrations may exceed the State of Alaska maximum allowable standard of 110 percent total gas saturation when flows in the river are greater than about 15,000 to 20,000 cfs.

The main objectives of the dissolved gas saturation studies will be to:

1. Establish the relationship between flows and natural dissolved gas concentrations

2. Monitor gas concentrations resulting from cone valve operation

3. Evaluate the effect of spillway discharge.

The primary means of achieving these objectives will be to collect preproject baseline data and compare it with data collected during operation of the powerhouses, cone valves and spillways of the two dams. The results of the comparisons would be used to determine if the mitigation measures are operating as designed.

Temperature/Ice. The Watana and Devil Canyon Reservoirs will cause temperatures in the river downstream from the dams to differ from natural conditions. Water temperatures in the spring will be below natural by a few degrees Celsius. In mid-summer, they will be near natural. In the fall, water temperatures will be above natural by a few degrees C. In the winter, due to "warm" releases[1/] from the reservoir, a large portion of the river downstream of the dams may remain free of ice. Under Watana only operation, this ice-free area (at maximum upstream progression of the ice-front) would extend approximately 40 to 60 miles downstream from the dam. With Devil Canyon Dam in place and operating, the open water would be about 15 to 35 miles downstream from the dam. In this ice-free area, temperatures may remain above natural (0°C) by up to 3°C throughout the winter. The variation from natural conditions will be greatest near the dam, and will decrease with distance downstream. Under the ice cover, temperatures will be 0°C, the same as for natural conditions (Arctic Environmental Information and Data Center 1984). During the winter, warmer releases will cause the ice front progression up the middle reach to be delayed by two to six weeks. Higher than natural winter discharges will result in elevated water levels downstream of the ice front. Upstream of the with-project ice front, water levels will be lower than natural because the natural staging due to ice cover will be eliminated.

1/ Warmth is relative; water released in winter will be at 4°C (39°F).

The Power Authority has included multilevel intakes in the designs for both the Watana and Devil Canyon developments to mitigate these potential temperate impacts. These intakes will be operated to provide as near natural temperatures as possible. Ongoing studies are examining the potential benefits of different modes of operation. It may be possible to release the warmest water available throughout the year, thus minimizing potential growth reductions in fish during the open water season.

The main objective of the temperature/ice monitoring studies will be to determine whether the dam and reservoirs have altered the existing temperature regime of the Susitna River downstream of the project dams. This will include monitoring of natural and with-project conditions.

The data collected will be analyzed to:

- Determine the effectiveness of the multilevel intake in controlling temperatures
- Compare predicted and measured warming and cooling rates
- Estimate the impact of project operation on potential overwintering mortality of young salmon

Finally, all this information will be considered in the refinement of project operating procedures to optimize temperatures for the fishery resources to the extent possible.

Turbidity/Sediment. During the ice-cover season, the natural turbidity and suspended sediment concentrations of the Susitna River are near zero. During much of the open water season, the river is highly turbid and carries large volumes of suspended sediments. Open water suspended sediments average approximately 700 mg/l (Harza-Ebasco 1984). Peak

turbidity values may be as high as several hundred nephelometric turbidity units (NTU's).

Most sediments that presently depend on the river's tractive force for downstream transport are expected to be trapped upstream of the dams. The suspended sediment and turbidity regimes should be less variable under with-project conditions. Enhancement of biological productivity is possible if sufficiently clear water can be combined with regulated river temperatures and flows which protect critical aquatic habitats during appropriate seasons.

The purpose for monitoring turbidity and suspended sediment concentrations under natural and with-project conditions will be to use this data to determine whether or not changes in these parameters significantly affect fishery resources downstream of the Project.

The main objectives of these studies will be to:

- Determine the seasonal changes in turbidity and suspended sediments that occur due to the Project
- To the extent possible, determine how these changes have affected the fishery resources downstream of the Project.

Information concerning changes in turbidity that occur will be used in conjunction with fish monitoring studies to better understand any changes that may occur in the fish resources. If these resources are affected, any changes will be addressed through the mitigation planning process (Woodward-Clyde Consultants 1984).

Mercury Concentrations in Fish. A number of metals naturally exist in the Susitna River. The most biologically important of these metals are

mercury, copper, cadmium, and zinc. Post-impoundment water quality studies in existing reservoirs have shown that only one of these metals, mercury (Hg), consistently concentrates to relatively high levels as a direct result of impoundment (Abernathy and Cumbie 1977; Bodaly et al. in press; Meister et al. 1979). These concentrations in fish tissues might exceed those that are considered safe for human consumption (greater than 70.5 mg/kg of fish tissue). After impoundment, microbial methylation of mercury from organic matter in soils and newly inundated detritus of Watana and Devil Canyon Reservoirs may result in mercury levels in reservoir fish higher than current concentrations. Certain environmental conditions in the reservoirs will tend to minimize mercury biomethylation and subsequent concentration notably:

- Low year-round water temperature
- Low rates of benthic microbiological activity
- Blanketing of inundated organic matter with a layer of inorganic sediments
- Relatively limited fish populations

Any potential impact of the Project on mercury in downstream fishes will be a function of two things: mercury exported from the reservoirs and in situ methylation and uptake of mercury in downstream habitats. Methylmercury leaving the reservoirs is not predictable. Mercury accumulation in fish downstream may be largely due to in situ methylation and uptake, and will likely be influenced by project-induced changes in biological productivity at all levels of the food chain.

The main goal for monitoring mercury concentrations in fish will be to analyze sufficient numbers of preproject and with-project fish tissue

samples to determine if mercury bioconcentration has occurred and to what extent. Other metals such as copper, cadmium, and zinc will also be measured to determine if bioconcentration has occurred.

Sufficient samples will be collected at each sampling location so that a range of preproject values can be established. To a large degree, the number of samples will depend on the variance found in the initial sampling.

With-project values will be used to determine the extent of any increase and whether or not it is important.

Dissolved Oxygen, pH, Organic Nitrogen, and Phosphorus. Collection of data on these parameters is inherent to understanding changes that may occur in fish resources as a result of the project. Sampling of both natural and with-project conditions will take place coincidentally with turbidity sampling. Winter sampling will be needed for natural conditions.

Water Quantity. As part of normal project operation, mainstem discharges will be continuously monitored at several locations, including:

- Upstream of the Watana impoundment zone
- Watana Dam
- Devil Canyon Dam
- Gold Creek
- Sunshine Station

This information is needed to assure that minimum and maximum flow constraints are met.

Fish Resources. The Susitna River supports spawning populations of five species of salmon. Operation of the Susitna Project may alter these populations by causing changes in production and survival rates of both juvenile and adult fish. Long-term effects from project operations will be reflected in the spawner populations. Changes in the population due to project effects on juvenile fish would also be observed immediately in production and survival rates of young and later in the number of adults returning to spawn.

Although there are important resident fish such as rainbow trout (Salmo gairdneri) and burbot (Lota lota) present in the Middle River, no specific monitoring studies are proposed for these species. The reasons for this are that their population numbers appear to be low compared with the salmon species and they are difficult to sample in sufficient quantities. Some resident fish may, however, be taken incidentally to the sampling for salmon. These specimens will be recorded and analyzed to the extent practical.

The primary study region for the monitoring program is the middle portion of the Susitna River (from the Watana Dam site downstream to the confluence with the Talkeetna and Chulitna Rivers). The salmon populations in this area of the river are the most likely to change if significant impact occurs. Therefore, concentrating study efforts on the middle reach of the river will provide the best opportunity to detect changes due to the project. Chances of detecting changes in the Lower River due to operation of the project are greatly reduced because the Lower River is influenced to a much greater extent by non-project related instream and tributary conditions.

It is felt that the best indicator for detecting potential impacts on salmon will be the number of young salmon produced from a given escapement. As such, the program will concentrate on enumeration of adults and juvenile salmon.

The Alaska Department of Fish and Game has performed spawner escapement studies on the Susitna River since 1974. Escapement estimates were derived from survey data for the years 1974, 1975, 1977, and 1981-1984. The escapement estimates were determined from tag-recovery data and spawning ground surveys conducted by helicopter, fixed wing aircraft, and ground surveys. Survey techniques and sampling designs were revised periodically over the years, taking advantage of the increased understanding gained with each year of study. Emphasis has gradually changed from a general coverage of the entire system to more concentrated coverage of the middle reach.

A study program has been conducted over the past several years to provide information on the habitat and seasonal distribution and abundance of juvenile salmon in the Middle Susitna River. In 1983, the SuHydro Study Team (part of ADF&G) initiated a program to provide estimates of fry-smolt production. The program entailed marking juvenile salmon in tributary creeks and sloughs and recovering them downstream at the Talkeetna Station (River Mile 103). Methodology and statistical considerations have been developed to the point where reasonably good estimates can be obtained from a nominal survey effort.

The objective of the adult salmon monitoring program will be to provide spawning population estimates (escapement estimates) of the five salmon species over a period of years encompassing natural and with-project conditions. The estimates will be used to assess the effect of the project on the populations. The extended number of years is necessary to detect "real" trends in escapement patterns that naturally vary considerably. Determining what factor or factors are affecting or controlling population levels will be difficult. The level of detectability will depend on the "natural" variability in the population, the degree of change induced by the various factors controlling the population, the variability inherent in the sampling program, and the number of years of study.

Subobjectives of the adult salmon monitoring program include the following:

1. Monitoring the long-term trend in catch at fixed fishwheel stations.

2. Monitoring the long-term trend in spawning ground counts.

3. Monitoring the long-term trend in age and size composition of spawners.

4. Relating trends to physical, chemical, and biological changes in the system, including changes induced by the project.

The objective of the juvenile salmon monitoring program is to provide estimates of fry and smolt production in the Middle River over a period of years encompassing natural and with-project conditions. Production estimates and changes in production patterns over the years can be compared directly with changes in physical conditions due to project operation. In addition to production estimates, survival rates obtained from the ratio of egg deposition to fry-smolt production can be monitored over the pre- and with-project period.

Subobjectives of the juvenile monitoring program include the following:

1. Monitoring long-term trends in the timing of emergence and outmigration of juvenile salmon by use of tagging of young fish and recapture in outmigrant traps

2. Monitoring long-term trends in the development, growth and relative condition of young salmon.

Preproject data will be compared to with-project data to determine whether substantial changes are occurring as a result of the project.

In addition, the data collected from the above studies, data from the commercial fish harvest, sportfish harvest surveys, and subsistence fishing will be considered in the overall evaluation of the salmon resources.

Monitoring of Structural Habitat Modifications. The Power Authority has proposed plans for specific structural habitat modifications to protect Middle River fish resources (Woodward-Clyde Consultants 1984). These measures are in addition to the proposed flow constraints. Final agreement has not been reached on details of these plans, but when the plans are finalized, there will be a need to evaluate whether an adequate level of mitigation is being achieved. To some degree, this will be accomplished by the monitoring of adult escapement and juvenile outmigration.

One of the higher priority mitigation measures will be to structurally modify slough habitats so that they continue to provide fish habitat at existing levels. Although this measure is still under consideration, the Power Authority proposes the following draft monitoring plan for slough modifications. If slough modification proceeds, this plan can be implemented.

The various features incorporated for slough habitat enhancement will be monitored to determine whether they are meeting their intended function and are operating properly. Mitigation features designed to allow adult salmon access into the sloughs will be inspected annually after breakup to identify and implement any needed repairs prior to the adult's return. Annual monitoring of returning adults will identify access problems or passage delays and appropriate corrective actions will be taken.

Slough modification designed to maintain spawning areas will be inspected annually prior to the spawning season to verify that the area contains suitable spawning conditions such as adequate flow (depth and

velocity) and suitable substrate. If flows diminish so that spawning is no longer possible, appropriate corrective action will be taken. The annual slough monitoring program will include an evaluation of general slough conditions including beaver occupation and general condition of the spawning and rearing areas. Appropriate remedial actions will be performed to maintain slough productivity.

The number of spawning adults returning to the modified sloughs will be monitored annually to measure run size as an indicator of whether the combination of flow control and slough modifications is maintaining natural levels of production. This monitoring will also serve to determine whether the capacity of the modified areas is being exceeded. Appropriate remedial actions will be taken when run sizes are either too low or too high.

Fry production will be monitored annually to verify incubation success. Fry monitoring will include an assessment of out-migration timing and success.

Following initiation of river flow regulation by Watana Dam, representative sloughs will be instrumented with temperature and flow recording instruments to monitor physical characteristics of the sloughs throughout the year. Monitoring of the physical processes will be continued until slough conditions stabilize under the regulated flow regime. This physical process monitoring will be used in part to determine whether further modifications to the physical habitat can be made to assist in maintaining slough productivity.

Fluvial Geomorphology. The Susitna River is a dynamic system that is undergoing continual morphological changes due to physical processes such as ice and floods. The processes by which these changes occur will be altered by with-project flow regulation. Therefore, it is important to document these changes on a periodic basis.

The primary means of providing this documentation will be through detailed air photography of the river from the upper end of the Watana Reservoir to Cook Inlet. Numerous photo series of the basin are already available.

Existing photos of the Middle and Lower River will be used as a baseline. For comparison, additional photos will be taken periodically. This will be performed in conjunction with air photography for wildlife studies.

Special Monitoring Studies. It is anticipated that there may be a need for other additional monitoring studies. During the annual review process, proposals for these studies will be considered. If approved, these proposals will be implemented during following years.

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