SUSITNA HYDROELECTRIC PROJECT

DEVELOPMENT SELECTION REPORT

APPENDICES A THROUGH J

TASK 6 - DESIGN DEVELOPMENT

DECEMBER 1981

Prepared by:

ACRES

ALASKA POWER AUTHORITY

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APPENDIX C

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APPENDIX C - ALTERNATIVE HYDRO GENERATING SOURCES

The analysis of alternative sites for non-Susitna hydropower development followed the plan formulation and selection methodology discussed in Section 1.4 of Volume I and Appendix A. The general application of the five-step methodology (Figure A.1) for the selection of non-Susitna plans is presented in Section 6 of this report. Additional data and explanation of the selection process are presented in more detail in this Appendix.

The first step in the plan formulation and selection process is to define the overall objective of the exercise. For step 2 of the process, all feasible sites are identified for inclusion into the subsequent screening process. The screening process (step 3) eliminates those sites which do not meet the screening criteria and yields candidates which could be refined to include into the formulation of Railbelt generation plans (step 4).

Details of each of the above planning steps are given below. The objective of the process is to determine the optimum Railbelt generation plan which incorporates the proposed non-Susitna hydroelectric alternatives.

C.1 - Assessment of Hydro Alternatives

Numerous studies of hydroelectric potential in Alaska have been undertaken. These date as far back as 1947, and were performed by various agencies including the then Federal Power Commission, the U.S. Army Corps of Engineers (COE), the United States Bureau of Reclamation (USBR), the United States Geological Survey (USGS) and the State of Alaska. A significant amount of the identified potential is located in the Railbelt region, including several sites in the Susitna River Basin.

Review of the above studies and in particular the inventories of potential sites published in the U.S. Army Corps of Engineers National Hydropower Study (1) and the Alaska Power Administration (APAd) "Hydroelectric Alternatives for the Alaska Railbelt" (2) identified a total of 91 potential sites (Figure C.1). All of these sites are technically feasible and, under step 2 of the planning process, were identified for inclusion in the subsequent screening exercise.

C.2 - Screening of Candidate Sites

The screening process for this analysis required the application of four iterations with progressively more stringent criteria.

(a) First Iteration

The first screen or iteration determined which sites were technically infeasible or not economically viable and rejected these sites. The standard for economic viability in this iteration was defined as energy production cost less than 50 mills per kWh, based on economic parameters. This value for energy production cost was considered to be a reasonable upper limit consistent with Susitna Basin alternatives for this phase of the selection process.

Cost data provided in published COE and APAd reports were updated to represent the current level of economics in hydropower development for a total of 91 sites inventoried within the Railbelt Region. As discussed in Section 8, annual costs were derived on the basis of a 3 percent cost of money, net of general inflation. Construction costs were developed by making uniform the field costs provided in the COE and APAd reports. This was necessary as the two agencies used different location factors in their estimates, to account for higher price levels in Alaska. Contingencies of 20 percent and engineering-administration adjustments of 12 to 14 percent were added to finally yield the project cost. Project costs were subsequently updated to a July 1, 1980 price level based on the "Handy-Whitman Cost Index for Hydropower Production in the Pacific Northwest" (3).

Using updated project costs as well as a series of plant size-dependent economic factors preliminarily selected for the rough economic screening, the average annual production costs in mills/kWh were estimated for the 91 sites. Typical factors considered were construction period, annual investment carrying charges, and operation and maintenance expenditures. Plant capacity factors ranged from 50 to 60 percent, based on source data. A range of average annual production costs resulted for most of the sites, similar to those initially estimated by both the COE and the APAd.

As a result of this screen, 26 sites were eliminated from the planning process. The sites rejected are given in Table C.1. The remaining 65 sites were subjected to a second iteration of screening which included additional criteria on environmental acceptability. The location of the 65 remaining sites are given in Figure C.1.

(b) Second Iteration

The inclusion of environmental criteria into the planning process required a significant data survey to obtain information on the location of existing and published sources of environmental data. The 27 reference sources used in preparing the evaluation matrix include publications and maps for which data were collected, prepared and/or adopted by the following agencies:

- University of Alaska, Arctic Environmental Information and Data Center
- Alaska Department of Fish and Game
- Alaska Division of Parks
- National Park Service
- Bureau of Land Management, U.S. Department of Interior
- U.S. Geological Survey
- Alaska District Corps of Engineers
- Joint Federal State Land Use Planning Commission

In addition, representatives of state and federal agencies (including AEIDC, ADNR, ADF&G, ADEC and Alaska Power Administration) were interviewed to provide subjective input to the planning process.

The basic data collected identified two levels of detail of environmental screening. The purpose of the first level of screening was to eliminate those sites which were unquestionably unacceptable from an environmental standpoint. Rejection of sites occurred if:

(i) They would cause significant impacts within the boundaries of an existing National Park or a proclaimed National Monument area;

(ii) They were located on a river in which:

- Anadromous fish are known to exist;
- The annual passage of fish at the site exceeds 50,000;
- Upstream of the site, a confluence with a tributary occurs in which a major spawning or fishing area is located.

The definition of the above exclusion criteria was made only after a review of the possible impacts of hydropower development on the natural environment and the effects of land issues on particular site development.

The first exclusion criterion reflects the existing restrictions to the development of hydropower in certain classified land areas. Information regarding the interpretations of land use regulations was gathered in discussions with state and federal officials, including representatives of the Federal Regulatory Commission (FERC) who are responsible for the licensing of hydropower projects affecting federal lands. Many land classifications were identified, such as national and state parks, forests, game refuge or habitat areas, wild and scenic rivers, and wilderness areas. Additionally, the land ownership question in Alaska was further complicated by federal land withdrawals (under the Federal Land Policy and Management Act) and Administration National Monument Proclamations.

After the various restrictions were evaluated, it became clear that the only lands where hydropower development is strictly prohibited are National Parks and Monuments, Wild and Scenic Rivers and National Wilderness Areas. At this time, many lands were still protected by the National Monument Proclamations, pending the passage of the Alaska National Interest Lands Bill in Congress. Other land classifications allow for monitoring and regulation of development by the controlling agency and, in some cases, veto power if the development is not consistent with the purposes of the land designation. Note that no sites coincided with either Wild and Scenic Rivers or Wilderness Areas; these were not included as exclusion criteria.

At the time of evaluation, the Alaska Lands Bill had not yet been passed by the U.S. Congress. Thus, the determination of impacts of restricted land use was based on the existing legislation, which included the

Administration National Monument Proclamation of December 1, 1978, and the Federal Land Policy and Management Act of 1976. The Lands Bill became Public Law 96-487 on December 2, 1980. The resulting land status changes have been evaluated to the extent that they affected the chosen hydropower sites.

Many significant sensitivities were identified in the Alaskan setting. However, only one of these was determined to be so highly sensitive to hydro development and so important to the state that it alone could prohibit the development of a site. Thus, sites located on a stretch of river used as a major artery for anadromous fish passage were excluded. It was believed that the potential for mitigation of adverse affects of such sites was limited, and that even a relatively small percentage loss of fish could have a devastating result for the fishery.

Of the 65 sites remaining after the preliminary economic screening, 19 sites were unable to meet the requirements set for the second screen. These sites are given in Table C.1, and the reason for their rejection in Table C.2

(c) Third Iteration

The reduction in the number of sites to 46 allowed a reasonable reassessment of the capital and energy production costs for each of the remaining sites to be made. Adjustments were made to take into account transmission line costs necessary to link each site to the proposed Anchorage-Fairbanks intertie. This iteration resulted in the rejection of 18 sites based on judgemental elimination of the more obvious uneconomic or less environmentally acceptable sites. The remaining 28 sites were subjected to a fourth iteration which entailed a more detailed numerical environmental assessment. The 18 sites rejected in the third iteration are given in Table C.1.

(d) Fourth Iteration

To facilitate analysis, the sites were categorized into sizes as follows:

- Less than 25 MW: 5 sites;
- 25 MW to 100 MW: 15 sites
- Greater than 100 MW: 8 sites.

The fourth and final screen was performed using detailed numerical environmental assessment which considered eight criteria chosen to represent the sensitivity of the natural and human environments at each of the sites. Three main aspects were incorporated into the selection of these criteria:

- Criteria must represent the important components of the environmental setting that may be impacted by the development of a hydroelectric project.
- Criteria must include components that represent existing and potential land use and management plans.

- Information relating to these criteria must be reasonably available and easily incorporated into a screening/evaluation process.

The eight evaluation criteria are listed in Table C.3. Each criterion was defined to identify the objectives used for investigating that criterion. Following the selection of the evaluation criteria, it was necessary to define the significance of a variety of factors within each set of criteria. Under the category of anadromous fisheries, for example, it is necessary to differentiate between a site which would adversely affect a major spawning area and a site which is used only for passage by a relatively small number of fish.

For each of the evaluation criteria, therefore, a system of sensitivity scaling was used to rate the relative sensitivity of each site. A letter (A, B, C or D) was assigned to each site for each of the eight criteria to represent this sensitivity. The scale rating system is defined in Table C.4.

Each evaluation criterion has a definitive significance to the Alaskan environment and degree of sensitivity to impact. A discussion of each criterion is appropriate to determine the importance of that criterion in the continued study or rejection of the hydroelectric sites.

(i) Big Game

The presence of big game is especially significant in the Alaskan environment. Special protection and management techniques are employed to ensure propagation of the species and continued abundance for subsistance and commercial harvesting as well as recreation uses. This criterion has a very high importance in the life style and economic well being of the Alaskan people.

Site specific information was extracted from a series of map overlays which identified types of big game habitats with varying importance to survival of the species considered. For example, a map may have a large area designated as "moose present" or "moose distribution". Within that large distribution area, smaller areas were identified as seasonal concentration areas or calving areas. These smaller areas were considered to be more sensitive to development than the large areas because they satisfy specific needs within the life cycle of the moose, and because the availability of appropriate land is limited.

Of the references inspected, "Alaska's Wildlife Atlas, Vol 1" was regarded as the most authoritative source, and took precedence in the case of conflicting information. References "Musk Oxen and Caribou" and "Large Mammals" generally added to the body of knowledge. References "Bear Denning and Goat Range", "Dall Sheep, Deer and Moose Concentrations" and "Distribution of Caribou Herds in Alaska" were reviewed, but had little input which corresponded with the sites surveyed.

(ii) Argicultural Potential

Agricultural potential was assigned a relatively high importance. This is because it is an indicaton of the potential for the self sufficiency of any area, and the avenues towards self sufficiency require special consideration in the economic climate of Alaska.

The best agricultural resources identified in the Railbelt region are located in the lowlands adjacent to the lower Susitna basin. These include the Yentna/Skwentna system and the northern and eastern shores of Cook Inlet as well as the Tanana and Nenana River valleys and the upper part of the Copper River basin. The latter was identified as climatically marginal.

The amount of land identified with suitable farming soils is relatively small and was assigned a higher sensitivity than land with marginal farming soils. Lands with no suitable soils identified were assigned the lowest sensitivity.

Map reference "Cultivatable Soils" and "Alaska Resources Inventory, Agricultural and Range Resources" were used to identify lands with agricultural potential in the Railbelt.

(iii) Waterfowl, Raptors and Endangered Species

The Railbelt provides extensive habitats for many species of waterfowl as well as habitats for some threatened and endangered bird species. The protection of these habitats in the face of development is a concern of many environmentalists and ecologists. As an evaluation criterion, this was considered to be slightly less important than the big game or fisheries criteria because of the combined ecological and economic importance of those two criteria.

In evaluating the sensitivity of the various factors providing input to these criteria, three reference maps were surveyed: "Alaska's Wildlife Atlas Vol II" provided information regarding waterfowl and seabirds; "Migratory Birds: Seabirds, Raptors & Endangered Species" had information regarding seabirds and raptor habitats; and "Birds" identified endangered and threatened species habitats. Generally, raptor and endangered species' habitats were considered most sensitive. High density and key waterfowl areas were considered to be moderately sensitive.

(iv) Anadromous Fisheries

The anadromous fisheries resource is an essential component of Alaska's economy and life style as well as its natural environment. It is the single resource most affected by hydropower development due to the nature of the development itself which not only hampers the passage of fish but may also alter flow conditions essential to the anadromous life cycle. Because of its sensitivity to hydropower development, the anadromous fisheries resource was very highly considered in this evaluation.

The comparative sensitivity of the sites was based on the number of species identified as present or spawning in the vicinity. Particular emphasis was placed on the river upstream of proposed dam sites and, when information was available, on the estimated number of fish identified passing certain points. Some sites were excluded in preliminary screening because they were identified as major locations for fish passage (greater than 50,000 annually.) The most sensitive of the remaining sites were those with the largest number of species present and with the most extensive spawning areas upsteam of the dam site. Lowest sensitivity corresponded with the absence of anadromous fish in the area.

Several compiled references were available for determining the extent of fisheries' presence at each of the hydro sites considered. The most comprehensive reference was "Alaska Fisheries Atlas" Volume I, which indicated on USGS topographical maps the presence of each of five species of salmon and their spawning areas for all areas of interest. Two map overlays were used to determine more generally the presence of anadromous fisheries: "Fisheries" and "Marine Mammals and Fish". This information was also checked against the Ch_2M-Hill report "Review of South Central Alaska Hydropower Potential" for some of the sites.

(v) Wilderness Consideration

National and state interest in the preservation of natural aesthetic qualities in Alaska continue to be the impetus for studies and land use legislation. Substantial amounts of land have been identified and protected under state and federal law. However, other lands have been identified for their unique wilderness, scenic, natural and primitive qualities but have received no particular protection. This factor was considered to the extent that any of the potential hydro sites would impact the aesthetic quality of these unprotected lands.

Two map overlays prepared by the Joint Federal State Land Use Planning Commission were used: "Selected Primitive Areas in Alaska for Consideration for Wilderness Designation" and "Scenic, Natural and Primitive Values".

(vi) Cultural, Recreation and Scientific Features

These criteria reflect the importance placed on the historical, cultural and recreational values of certain landmarks, as well as the values of scientific resources at identified locations. Areas of varying significance were identified by the reference sources and comparative sensitivities were assigned accordingly if potential hydro sites corresponded with identified areas.

Three map overlays were used to substantiate these criteria: "Recreation, Cultural and Scientific Features", "Nationally Significant Cultural Features", and "Proposed Ecological Reserve System for Alaska".

(vii) Restricted Land Use

A significant amount of land in Alaska is classified as national or state parks, wildlife areas, monuments, etc. These classifications afford varying levels of protection from complete exclusion of any development activity to a monitoring or regulation of development occurring on the protected lands. Using this criterion as an indication of the legal restrictions that might hinder the implementation of a hydroelectric development, the comparative sensitivities were defined. If a potential hydro site was located within a national park or monument, the site was excluded during preliminary screening from further consideration. Other land classifications were less severe. This criterion, although it may be more of an indication of institutional factors than the actual sensitivity of the site area, represents real issues that would affect development.

Land status was identified using maps and reference materials prepared by state sources: "Generalized State Land Activity", "Game Refuges, Critical Habitat Areas and Sanctuaries", and federal sources, USGS Alaska Map E and Quadrangle Maps, "Administration National Monument Proclamation and FLDMA Withdrawals", "Alaska Illustrated Land Status". It should be noted that this evaluation was performed before the passing of the Alaska National Interest Lands Conservation Act (PL 96-487). The results of the application of this criterion were subsequently compared against the mandates of this federal act. No substantial effects on the screening results were found.

(viii) Access

The main purpose of this criterion was to indicate how the potential hydro sites fit into the existing infrastructure. In other words, the concern was to identify those areas which would be most and least affected or changed by the introduction of roads, transmission lines and other facilities. The highest sensitivity was assigned to the sites which were the farthest from the existing infrastructure, indicating areas with the greatest potential for impacts. Lower sensitivities were assigned to areas where roads, transmission lines and settlements already exist.

Although this was an important criterion to consider, it was not given a high weighting when compared to other criteria due to the subjective nature of the interpretations made. It could be, for example, that an existing small settlement would be more adamantly opposed to development in an area where nobody has presently settled.

Information was garnered from notes in "Review of the Southcentral Hydropower Potential" and road maps of the area.

(ix) Summary of Criteria Weighting

The first four criteria - big game, agricultural potential, birds and anadromous fisheries, were chosen to represent the most significant features of the natural environment. These resources require

protection and careful management due to their position in the Alaskan environment, their roles in the existing patterns of life of the state residents and their importance in the future growth and economic independence of the state. These four criteria were viewed as more important than the following four criteria due to their quantifiable and significant position in the lives of the Alaskan people.

The remaining four criteria - wilderness, cultural, recreation and scientific features, restricted land use, and access were chosen to represent the institutional factors to be considered in determining any future land use. These are special features which have been identified or protected by governmental laws or programs and may have varying degrees of protected status, or the criteria represent existing land status which may be subject to change by the potential developments.

It must be noted that the interpretations placed on these criteria are subjective, although care was taken to ensure that the many viewpoints which make up Alaska's sociopolitical climate were represented in the evaluation. The latter four criteria were considered less important in the comparative weighting of criteria mainly because of the subjective nature and lower degree of reliability of the facts collected.

Data relating to each of these criteria were complied separately and recorded for each site, forming a data-base matrix. Then, based on these data, a system of sensitivity scaling was developed to represent the relative sensitivity of each environmental resource (by criterion) at each site.

The scale ratings used are summarized below. A detailed explanation of the scale rating may be found in Table C.5.

A - Exclusion (used for sites excluded in preliminary screening)

B - High Sensitivity

C - Moderate Sensitivity

D - Low Sensitivity

The scale ratings for the criteria at each site were recorded in the evaluation matrix. Site evaluations of the 28 sites under consideration are given in Table C.6. Preliminary data regarding technical factors were also recorded for each potential development. Parameters included installed capacity, development type (dam or diversion), dam height, and new land flooded by impoundment. The complete evaluation matrix may be found in Table C.7.

In this manner, the environmental data were reduced to a form from which a relative comparison of sites could be made. The comparison was carried out by means of a ranking process.

(x) Rank Weighting and Scoring

For the purpose of evaluating the environmental criteria, the following relative weights were assigned to the criteria. A higher value indicates greater importance or sensitivity than a lower value.

Big Game	8
Agricultural Potential	7
Birds	8
Anadromous Fisheries	10
Wilderness Values	4
Cultural Values	4
Land Use	5
Access	4

The criteria weights for the first four criteria were then adjusted down, depending on related technical factors of the development scheme.

Dam height was assumed to be the factor having the greatest impact on anadromous fisheries. All the sites were ranked in terms of their dam heights as follows:

- Height $\leq$150': Rank +

- Height 150' - 350': Rank ++

- Height $\geq$350': Rank +++

A dam with the lowest height ranking (+) would have least impact, and would therefore result in the fisheries weight to be adjusted down by two points. Similarly, a dam of height (++) was adjusted down by one point. A dam of height (+++) would have the greatest impact and the weight remained at its designated value.

The amount of new land flooded by creation of a reservoir was considered to be the one factor with greatest impact on agriculture, bird habitat, and big game habitat. Sites were ranked in terms of their new reservoir area as follows:

- Area $\leq$5000 acres: Rank +

- Area 5000 - 100,000 acres: Rank ++

- Area $\geq$100,000 acres: Rank +++

The same adjustments were made for the big game, agricultural potentials, and bird habitat weights based on this flooded area impact (see Table C.8).

Note that for developments which utilized an existing lake for storage, the new area flooded was assumed to be minimal (+).

The scale indicators were also given a weighted value as follows:

- B = 5
- C = 3
- D = 1

To compute the ranking score, the scale weights were multiplied by the adjusted criteria weights for each criteria and the resulting products were added.

Two scores were then computed. The total score is the sum of all eight criteria. The partial score is the sum of the first four criteria only, which gives an indication of the relative importance of the existing natural resources in comparison to the total score.

(xi) Evaluation

The evaluation of sites took place in the following manner: sites were first divided into three groups in terms of their capacity.

Based on the economics, the best sites were chosen for environmental evaluation. Table C.10 lists the number of sites evaluated in each of the capacity groups. The sites were then evaluated as described above. They were listed in ascending order according to their total scores for each of the groups. The partial score was also compared. The sites were then grouped as better, acceptable, questionable, or unacceptable, based on the scores. The same general standards (e.g, cut-off points) were used for all groups.

(xii) Analysis

The partial and total scores for each of the sites, grouped according to capacity, are given in Table C.10.

- 0 - 25 MW

  Of the five sites evaluated, all five were determined to be acceptable, based on the overall standards. Three of these sites were judged as a group to be better than the other two which had higher partial and total scores.

- 25 - 100 MW

  A cutoff point of approximately 134 for the total score and approximately 100 for the partial score was used. Sites scoring higher were eliminated. The seven sites scoring lower were re-examined.

  Three developments at Bruskasna, Bradley Lake, and Snow were the best sites identified.

Of the remaining four, Coffee and Seetna were identified as questionable because of anticipated salmon fisheries problems. Lowe and Cache scored only slightly better, but Lowe has minimal fisheries problems, and the Cache site is farthest upstream on the Talkeetna River, beyond which the salmon migrate only about five miles.

- >100 MW

Again, the same cutoff point for acceptable sites with total scores of 134 and partial scores of 100 used. The sites fell easily into the two groupings of acceptable and unacceptable.

(xiii) Results

Sixteen sites were chosen for further consideration. Three constraints were used to identify these 16 sites. First, the most economical sites which had passed the environmental screening were chosen. Secondly, sites with a very good environmental impact rating which had passed the economic screening were chosen. And finally, a representative number of sites in each capacity group were to be chosen, Table C.10.

From the list of 16 sites, 10 were selected for detailed development and cost estimates required as input to the generation planning. The ten sites chosen are underlined in Table C.1.

Three sites, Strandline Lake, Hicks, and Browne were identified by the Ch$_2$M-Hill Report to COE as being environmentally very good. These sites were included, even though their associated economics were not as good as many of the other sites which had also passed the economic screening.

The Chakachamna site had both a very high economic ranking and a good environmental rating in terms of the sensitivity of its natural resources to development. Chakachamna was also identified by the Ch$_2$M-Hill report as having minimal environmental impacts. It should be noted that under the recently passed Alaska National Interest Lands Conservation Act (PL 96-487, December 2, 1980) the lands including the Chakachamna site have not received protected status of any type. This applies to both the project area and the existing Lake Chakachamna. Although the boundary of designated wilderness area is located a few miles from the eastern end of the lake, operation of the lake would have little direct effect on the wilderness area. Because the Chakachamna site is desirable in other respects, it is being considered as a viable alternate competing with the Susitna Project.

Three sites were chosen on the Talkeetna River. These are Cache, Keetna, and Talkeetna-2 which are being studied as an integrated system alternative. Although the identified environmental problems are significant, the system is being studied for several reasons. It

is believed that with the system approach, the incremental impacts of building a second or third plant on the same river system would be smaller than the impacts associated with building plants on completely separate rivers. The integrated system not only improves the economic potential of the operating capacity, but also allows for better control over regulation of stream flows as needed by the downstream ecosystems. Secondly, the choice of the Talkeetna River was made over other rivers with potential for development of similar systems, because the environmental sensitivity of the Talkeetna was not as great as that of the Yentna-Skwentna basin, the Chulitna River or the lower Susitna basin, particularly with regards to the presence of anadromous fish or big game. And finally, the Talkeetna River developments were some of the best sites economically, thus providing better competition to Susitna.

The remaining sites of the 10 studied in detail are Allison Creek, Snow, and Bruskasna. These are sites that were identified by the environmental evaluation as being the best environmentally of the 28 economically superior sites.

(e) Plan Formulation and Evaluation

Steps 4 and 5 in the planning process are the formulation of the preferred sites identified in Step 3 into Railbelt generation scenarios. To adequately formulate these scenarios, the engineering, energy and environmental aspects of the ten shortlisted sites were further refined (Step 4).

Engineering sketch layouts (Figures C.2 to C.10) were produced for seven of the sites with capacities of 50 MW or greater, and site specific construction cost estimates were prepared on the basis of this more detailed information (Tables C.12 through C.18). For the three remaining sites, construction costs were developed by a process of judgemental interpolation on the basis of the estimates for the seven larger developments. Costs and parameters associated with all ten sites are summarized in Table C.19. These costs incorporate a 20 percent allowance for contingencies and 10 percent for engineering and owner's administration. Cost of money has again been assumed to be three percent, net of inflation. Energy and power capability was determined for each of the sites using a monthly streamflow simulation program (Appendix F). The annual average energy for each of the the sites are also given in Table C.19. Installed capacities were generally assumed that would yield a plant factor for the developments of approximately 50 percent. This ensures general consistency with Susitna developments and Railbelt system requirements.

The formulation of the ten sites into development plans resulted in the identification of five plans incorporating various combinations of these sites as input to the Step 5 evaluations. The five development plans are given in Table C.20.

The essential objective of Step 5 was established as the derivation of the optimum plan for the future Railbelt generation incorporating non-Susitna hydro generation as well as required thermal generation. The methodology used in the evaluation of alternative generation scenarios for the Railbelt are discussed in detail in Section 8. The criterion on which the preferred plan was finally selected in these activities was least present worth cost based on economic parameters established in Section 8.

The selected potential non-Susitna hydro developments (Table C.19) were ranked in terms of their economic cost of energy. Chakachamna is the highest ranked (preferred) with a cost of energy of 40 $/1000 kWh and Hicks is the lowest ranked with a cost of energy of 1612 $/1000 kWh. The potential developments were then introduced into the all-thermal generating scenario in groups of two or three. The most economic schemes were introduced first followed by the less economic schemes.

The results of these runs are given in Table C.21 and illustrate that a minimum total system cost of $7040 million can be achieved by the introduction of the Chakachamna, Keetna and Snow projects (Plan C.2). This plan includes 1211 MW of thermal capacity and assumes a medium load forecast. No renewal of gas plants at retirement is also assumed. The make-up of the Railbelt generation system under this least cost scenario is shown in Figure C.11. Additional sites such as Snow, Strandline and Allison Creek could be introduced without significantly changing the economics of the generation scenarios. The introduction of these latter projects would be beneficial in terms of displacing non-renewable energy resource consumption.

LIST OF REFERENCES

(1) U.S. Army Corps of Engineers, National Hydropower Study, July, 1979.

(2) Alaska Power Administration, Hydroelectric Alternatives for the Alaska Railbelt, February, 1980.

(3) Handy-Whitman, Cost Index for Hydropower Production in the Pacific Northwest, 1978.

TABLE C.1 - SUMMARY OF RESULTS OF SCREENING PROCESS

Site [1]	Elimination Iteration 1	2	3	4
Allison Creek				
Beluga Lower			*	
Beluga Upper				*
Big Delta	*			
Bradley Lake				*
Bremmer R. -Salmon	*			
Bremmer R. -S.F.	*			
Browne				
Bruskasna				
Cache				
Canyon Creek	*			
Caribou Creek	*			
Carlo		*		
Cathedral Bluffs				*
Chakachamna				
Chulitna E.F.	*			
Chulitna Hurrican			*	
Chulitna W.F.	*			
Cleave		*		
Coal			*	
Coffee				*
Crescent Lake			*	
Crescent Lake - 2		*		
Deadman Creek	*			
Eagle River	*			

Site [1]	Elimination Iteration 1	2	3	4
Fox	*			
Gakona		*		
Gerstle			*	
Granite Gorge			*	
Grant Lake			*	
Greenstone			*	
Gulkana River			*	
Hanagita		*		
Healy		*		
Hicks				
Jack River	*			
Johnson				*
Junction Island		*		
Kanhshna River			*	
Kasilof River		*		
Keetna				
Kenai Lake				*
Kenai Lower			*	
Killey River	*			
King Mtn	*			
Klutina				*
Kotsina	*			
Lake Creek Lower		*		
Lake Creek Upper				*
Lane				*

Site [1]	Elimination Iteration 1	2	3	4
Lowe				*
Lower Chulitiua				*
Lucy	*			
McClure Bay			*	
McKinley River		*		
McLaren River	*			
Million Dollar		*		
Moose Horn	*			
Nellie Juan River	*			
Nellie Juan R. -Upper				*
Ohio			*	
Power Creek		*		
Power Creek - 1	*			
Ramport		*		
Sanford		*		
Sheep Creek			*	
Sheep Creek - 1	*			
Silver Lake				*
Skwentna				*
Snow				
Solomon Gulch			*	
Stelters Ranch	*			
Strandline Lake				
Summit Lake	*			
Talachulitna			*	

Site [1]	Elimination Iteration 1	2	3	4
Talachulitna River	*			
Talkeetnna R. -Sheep	*			
Talkeetna - 2				
Tanana River			*	
Tazlina				*
Tebay Lake		*		
Teklanika		*		
Tiekel River	*			
Tokichitna				*
Totatlanika	*			
Tustumena				*
Vachon Island		*		
Whiskers				*
Wood Canyon		*		
Yanert - 2		*		
Yentna			*	

NOTES:

(1) Final site selection underlined.

* Site eliminated from further consideration.

TABLE C.2 - SITES ELIMINATED IN SECOND ITERATION

Site	Criterion
Healy Carlo Yanert - 2	National Park (Mt. McKinley)
Cleave	National Monument (Wrangell-St. Elias National Park) and Major Fishery
Tebay Lake Hanagita Gakona Sanford	National Monument (Wrangell-St. Elias National Park)
Lake Creek Upper McKinley River Teklanika	Naional Monument (Denali Naitonal Park)
Crescent Lake	National Monument (Lake Clark National Park)
Kasilof River Million Dollar Rampart Vachon Island Junction Island Power Creek	Major Fishery

TABLE C.3 - EVALUATION CRITERIA

Evaluation Criteria	General Concerns
(1) Big Game	- protection of wildlife resources
(2) Agricultural Potential	- protection of existing and potential agricultural resources
(3) Waterfowl, raptors & endangered species	- protection of wildlife resources
(4) Anadromous fisheries	- protection of fisheries
(5) Wilderness Consideration	- protection of wilderness and unique features
(6) Cultural, recreation & scientific features	- protection of existing and identified potential features
(7) Restricted land use	- consideration of legal restriction to land use
(8) Access	- identification of areas where the greatest change would occur

TABLE C.4 - SENSITIVITY SCALING

Scale Rating	Definition
A. EXCLUSION	The significance of one factor is great enough to exclude a site from further consideration. There is little or no possibility for mitigation of extreme adverse impacts or development of the site is legally prohibited.
B. HIGH SENSITIVITY	1) The most sensitive components of the environmental criteria would be disturbed by development, or 2) There exists a high potential for future conflict which should be investigated in a more detailed assessment.
C. MODERATE SENSITIVITY	Areas of concern were less important than those in "B" above.
D. LOW SENSITIVITY	1) Areas of concerns are common for most or many of the sites. 2) Concerns are less important than those of "C" above. 3) The available information alone is not enough to indicate a greater significance.

TABLE C.5 - SENSITIVITY SCALING OF EVALUATION CRITERIA

Evaluation Criteria	SCALE			
	A Exclusion	B High	C Moderate	D Low
Big Game:	--	- seasonal concentration are key range areas - calving areas	- big game present - bear denning area	- habitat or distribution area for bear
Agricultural Potential	--	- upland or lowland soils suitable for farming	- marginal farming soils	- no identified agricultural potential
Waterfowl, Raptors and Endangered Species	--	- nesting areas for: . Peregrine Falcon . Canada Geese . Trumputee Swan - year round habitat for Neritic seabirds and raptors - key migration area	- high density waterfowl area - waterfowl migration and hunting area - waterfowl migration route - waterfowl nesting or or molt area	- medium or low density waterfowl areas - waterfowl present
Anadromous Fisheries	- major anadromous fish corridor for three or more species - more than 50,000 salmon passing site	- three or more species present or spawning - identified as a major anadromous fish area	- less than three species present or spawning - identified as an important fish area	- not identified as a spawning or rearing area.
Wilderness Consideration	--	All of the following - good to high quality: . scenic area . natural features . primitive values - selected for wilderness consideration	Two of the following - good to high quality: . scenic area . natural features . primitive value - site in or close to an area selected for wilderness consideration	One or less of the following - good to high quality: . scenic area . natural features . primitive value
Cultural, Recreational and Scientific Features	--	- existing or proposed historic landmark - reserve proposed for the Ecological Reserve System	- Site affects one or more of the following: . boating potential . recreational potential . historic feature . historic trail . archeological site . ecological reserve nomination . cultural feature	- site near one of the factors in B or C

TABLE C.5 (Continued)

Evaluation Criteria	SCALE			
	A Exclusion	B High	C Moderate	D Low
Restricted Land Use	- Significant impact to: . Existing National Park . Federal Lands withdrawn by National Monument Proclaimations	- Impact to: . National Wildlife Range . State Park . State game refuge, range, or wilderness preservation area	- Increase: . National Forest . Proposed wild and scenic river . National resource area . Forest land withdrawn for mineral entry	- In one of the following: . State land . Native land . None of A, B, C
Restricted Land Use	--	- no existing roads, railroads or airports - terrain rough and access difficult - increase access to wilderness area	- existing trails - proposed roads or - existing airports - close to existing roads	- existing roads or railroads - existing power lines

TABLE C.6 - SITE EVALUATIONS

Site	Evaluation Criteria						
	Big Game	Agricultural Potential	Waterfowl, Raptors, Endangered Species	Anadromous Fisheries	Wilderness Consideration	Cultural, Recreational, and Scientific Fisheries	Restricted Land Use
Allison Creek	- Black and Grizzly bear present	- None identified	- Year round habitat for neritic seabirds and raptors - Peregrine falcon nesting area - Waterfowl present	- Spawning area for 2 salmon species	- High to good quality scenic area	- None identified	- Near Chugach National Forest
Bradley Lake	- Black and Grizzly bear present - Moose present	- 25 to 30 percent of soil marginall suitable for farming - high quality forests	- Peregrine Falcon nesting areas	- None identified	- Good to high quality scenery	- Boating area	- None identified
Browne	- Black and Grizzly bear present - Moose present - Caribou winter range	- More than 50 percent marginally suitable for farming	- Low density of waterfowl	- None	- None	- Boating potential	- None identified
Bruskasna	- Black and Grizzly bear present - Moose present - Caribour winter range	- None identified	- Low density of waterfowl - Nesting and molting area	- None	- Good to high quality scenery	- Boating potential - Proposed ecological reserve site	- None identified
Chakachamna	- Black bear habitat - Moose present	- Upland spruce, hardwood forest	- Waterfowl nesting and molting area	- Two species present	- Area under wilderness consideation, - Good to high quality scenery - Primitive and natural features	- Boating areas	- None identified
Coffee	- Black and Grizzly bear present - Moose present	- More than 50% of upper lands suitable for agricultural - Good forests	- Key waterfowl habitat	- Four species present, two spawning in area	- None identified	- Boating area	- None identified
Cathedral Oluffs	- Black and Grizzly bear present - Moose present - Dall sheep present - Moose concentration area	- More than 50% of land marginal for farming - Upland spruce-hardwood forest	- Low density of waterfowl - Nesting and molting area	- One species present	- Good scenery	- None identified	- None identified
Hicks	- Black and Grizzly bear present - Caribou present - Moose wintering area	- None identified	- Waterfowl nesting and molting area	- Far downstream of site only	- None identified	- None identified	- No present restrictions
Johnson	- Black and Grizzly bear present - Moose, caribou and bison present	- 25 to 50% of upland soil suitable for farming - Upland spruce-hardwood forest	- Low density waterfowl area - Nesting and molting area	- Salmon spawning area, one species present	- None identified	- Boating potential	- None identified
Keetna	- Black and Grizzly bear present - Caribou winter area - Moose fall/winter concentration area	- None identified	- None identified	- Four species present, one species spawning near site	- Good to high quality primitive lands	- High boating potential	- None identified
Kenai Lake	- Black and Grizzly bear present - Dall sheep habitat - Moose fall/winter concentration area	- None identified - Coastal hemlock-sitka spruce forest	- Waterfowl nesting and molting area	- Four species present, two spawning	- High quality scenery - Natural features	- Boating potential	- Chugach National Forest

TABLE C.6 (Continued)

Site	Evaluation Criteria						
	Big Game	Agricultural Potential	Waterfowl, Raptors, Endangered Species	Anadromous Fisheries	Wilderness Consideration	Cultural, Recreational, and Scientific Fisheries	Restricted Land Use
Klutina	- Black and Grizzly bear present - Caribou present - Moose fall concentration area	- 25 to 50 percent of soils marginal for farming - Climate marginal for farming upland spruce-hardwood forest	- Low density waterfowl area - Nesting and molting area	- Two species present, one species spawn in vicinity of site	- High quality scenery - Natural formations - Primitive lands - Selected for wilderness consideration	- Boating potential	- None identifed
Lane	- Black bear present - Moose present - Caribou present	- More than 50 percent of the soils in upperlands suitable for farming - Bottomland spruce-poplar forest	- Low density waterfowl area - Nesting and molting area	- Five species present and spawn in site vicinity	- None identified	- Boating opportunities identified	- None identified
Lowe	- Black and Grizzly bear present - Moose present	- None identified - Coastal western hemlock-sitka spruce forest	- Perigrene falcon nesting area	- One species present, others downstream of site	- Good to high quality scenery - Area selected for wilderness consideration	- Historical feature - Proposed ecological reserve site	- Located near the border of Chugach National Forest
Lower Chulitna	- Black and Grizzly bear present - Caribou present	- More than 50 percent of the upland soils suitable for farming	- Medium density waterfowl area - Nesting and molting area	- Four species present, three spawning in vicinity	- Area selected for wilderness consideration	- Boating potential	- None identified
Silver Lake	- Black and Grizzly bear present - High density of seals	- None identified - Coastal western hemlock-sitka spruce forest	- Year round habitat for neritic seabirds and raptors	- One species present, more downstream	- Good to high quality scenery - Primitive value	- Boating area potential	- Chugach National Forest
Skwentna	- Black and Grizzly bear present - Moose winter concentration area	- 50 percent of upperlands suitable for farming - Lowland spruce - hardwood forest	- Low density waterfowl area - Nesting and molting area	- Three species present, spawning in area	- None identified	- Boating area - Historical trails	- None identified
Snow	- Black bear present - Dall sheep habitats - Moose winter concentration area	- None identified	- Nesting and molting area	- None	- None identified	- Proposed ecological reserve site	- Located in Chugach National Forest
Strandline Lake	- Moose, black bear habitat - Grizzly bear present	- 25 to 50 percent marginal farming soils - Alpine tundra	- Nesting and molting area	- None present	- Good to high quality scenery - Primitive lands	- None identified	- None identified
Talkeetna 2	- Black and Grizzly bear present - Moose fall/winter concentration area - Caribou winter range	- None identified	- None identified	- Four species present, one species spawns at site	- Good to high quality scenery - Primitive lands	- Boating potential	- None identified
Cache	- Black and Grizzly bear present - Moose winter concentration area - Caribou winter range	- None identified	- None identified	- Four species of salmon present, spawning areas identified	- Good to high quality scenery - Primitive lands	- Boating potential	- None identified
Tazlina	- Black and Grizzly bear present - Moose winter range - Caribou winter range	- None identified - Lowland spruce-hardwood forest	- Medium density waterfowl area - Nesting and molting area	- Two species present at site and upstream	- None identified	- Boating potential	- None identified
Talkeetna	- Black bear present - Moose present - Caribou present	- More than 50 percent of soils are usable for farming (in upper lands)	- Medium density waterfowl area - Nesting and molting area	- Four species present, three species spawn in site vicinity	- Border primitive area	- Boating potential	- None identified

TABLE C.6 (Continued)

Site	Evaluation Criteria						
	Big Game	Agricultural Potential	Waterfowl, Raptors, Endangered Species	Anadromous Fisheries	Wilderness Consideration	Cultural, Recreational, and Scientific Fisheries	Restricted Land Use
Tustumena	- Black bear habitat - Dall sheep habitat	- None identified	- None identified	- None identified	- Selected for wilderness consideration - Good to high quality scenery - Natural features - Primitive lands	- None identified	- Located in Kenai National Moose Range - Site within a designated National Wilderness area
Upper Beluga	- Moose present	- More than 50 percent of upper lands are suitable for farming - Lowland spruce-hardwood forest	- Medium density waterfowl area - Nesting and molting area	- Four species present, two species spawn in area	- None identified	- Boating area	- None identified
Upper Nellie Juan	- Grizzly bear present - Moose present - Black bear habitat	- None identified - Coastal western hemlock-sitka spurce forest	- None identified	- None identified	- Selected for wilderness consideration - High primitive, scenic, and natural features	- Boating potential	- Chugach National Forest
Whiskers	- Black and Grizzly bear present - Moose present - Caribou present	- 50 percent of upperlands suitable for farming - Bottomland spurce-poplar forest	- Low density waterfowl area - Nesting and molting area	- Five species present, two spawn in area	- None identified	- Boating potential	- None identified
Yentna	- Black and Grizzly bear present - Moose, spring/summer/ winter concentration	- 25 to 50 percent of soils in lowlands are suitable for farming - Bottomland spruce- poplar forest	- Medium density waterfowl area - Nesting and molting area	- Five species spawn in area	- None identified	- Boating potential	- None identified

TABLE C.7 - SITE EVALUATION MATRIX

	Big Game	Agricultural Potential	Waterfowl, Raptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Crescent Lake	C	D	D	B	C	C	A	B	--	Reservoir w/Diversion	<150	<5000
Chakachamna	C	D	C	C	B	C	B	C	>100	Reservoir w/Diversion	<150	<5000
Lower Beluga	C	D	C	B	D	C	D	D	<25	Reservoir and Dam	<150	<5000
Coffee	C	B	C	B	D	C	D	D	25-100	Dam and Reservoir	<150	<5000
Upper Beluga	C	D	C	B	D	C	D	D	25-100	Dam and Reservoir	150-350	5000 to 100,000
Strandline Lake	C	C	C	D	C	D	D	D	<25	Reservoir w/Diversion	<150	<5000
Bradley Lake	C	C	B	D	C	C	D	D	25-100	Reservoir w/Diversion	<150	<5000
Kasilof River	C	B	C	A	D	C	B	D	--	Reservoir w/Diversion	150-350	>100,000
Tustumena	C	D	D	D	B	D	B	B	<25	Reservoir w/Diversion	<150	<5000
Kenai Lower	C	B	C	B	C	C	B	D	25-100	Dam and Reservoir	<150	<5000
Kenai Lake	B	D	C	B	C	D	C	D	>100	Dam and Reservoir	>350	5000 to 100,000
Crescent Lake-2	C	D	C	C	C	C	C	D	<25	Reservoir w/Diversion	<150	<5000
Grant Lake	B	D	C	B	C	C	C	D	<25	Reservoir w/Diversion	<150	<5000
Snow	B	D	C	D	D	C	C	D	25-100	Reservoir w/Diversion	150-350	5000 to 100,000
McClure Bay	D	D	B	C	B	D	C	C	<25	Reservoir w/Diversion	<150	<5000
Upper Nellie Juan R	C	D	D	D	B	C	C		<25	Reservoir w/Diversion	<150	<5000
Allison Creek	D	D	B	C	D	D	D	D	<25	Reservoir w/Diversion	<150	<5000
Solomon Gulch	D	D	B	C	D	D	D	D	<25	Reservoir w/Diversion	<150	<5000
Lowe	C	D	B	C	C	C	D	D	25-100	Dam and Reservoir	150-350	5000 to 100,000
Silver Lake	D	D	B	C	C	C	C	C	<25	Reservoir w/Diversion	<150	<5000
Power Creek	D	D	B	A	C	C	C	C	<25	Reservoir w/Diversion	<150	<5000
Million Dollar	D	D	B	A	B	C	C	C	--	Dam and Reservoir	<150	5000 to 100,000

TABLE C.7 (Continued)

	Big Game	Agricultural Potential	Waterfowl, Raptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Keetna	B	D	D	B	D	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Granite Gorge	B	D	D	B	C	C	D	C	25-100	Reservoir w/Diversion	150-350	<5000
Talkeetna-2	B	D	D	B	C	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Greenstone	B	D	D	B	C	C	D	C	25-100	Reservoir w/Diversion	150-350	<5000
Cache	B	D	D	B	C	C	D	C	25-100	Dam and Reservoir	150-350	<5000
Hicks	B	D	C	D	D	D	D	D	25-100	Dam and Reservoir	150-350	<5000
Rampart	C	B	B	A	D	C	C	--	>100	Dam and Reservoir	>350	>100,000
Vachon Island	B	B	C	A	D	C	D	C	>100	Dam and Reservoir	<150	>100,000
Junction Island	B	B	C	A	D	C	D	C	>100	Dam and Reservoir	150-350	>100,000
KanLishna River	C	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	>100,000
McKinley River	B	D	C	D	B	C	A	--	--	Dam and Reservoir	150-350	<5000
Taklanika River	B	D	D	D	B	D	A	B		Dam and Reservoir	>350	5000 to 100,000
Browne	B	C	D	D	D	C	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000
Healy	B	C	D	D	B	B	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Carlo	B	D	D	D	B	C	A	D	--	Dam and Reservoir	150-350	<5000
Yanert-2	B	D	D	D	B	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Bruskasna	B	D	C	D	D	B	D	D	25-100	Dam and Reservoir	150-350	5000 to 100,000
Tanana	B	B	C	B	D	C	D	D	25-100	Dam and Reservoir	<150	5000 to 100,000
Gerstle	B	B	C	C	D	C	D	C	25-100	Dam and Reservoir	<150	<5000
Johnson	C	B	C	C	D	C	D	D	>100	Dam and Reservoir	<150	5000 to 100,000
Cathedral Bluffs	B	C	C	C	D	D	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000

TABLE C.7 (Continued)

	Big Game	Agricultural Potential	Waterfowl, Raptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Cleave	C	D	B	B	B	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Wood Canyon	C	D	C	B	B	B	A	D	--	Dam and Reservoir	>350	>100,000
Tehay Lake	C	D	D	C	B	D	A	B	--	Reservoir w/Diversion	<150	<5000
Hanagita	C	D	D	D	B	D	A	B	--	Reservoir w/Diversion	<150	<5000
Klutina	B	C	C	C	B	C	D	--	25-100	--	--	--
Tazlina	B	D	C	C	D	C	C	--	>100	Dam and Reservoir	150-350	5000 to 100,000
Gakona	B	C	C	C	D	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Sanford	B	C	C	C	D	C	A	D	--	Dam and Reservoir	--	--
Gulkana	B	D	C	C	D	B	B	D	25-100	Reservoir w/Diversion	150-350	5000 to 100,000
Yentna	B	B	C	B	D	C	D	C	>100	Dam and Reservoir	<150	>100,000
Talachultna	B	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	5000 to 100,000
Skwentna	B	B	C	B	D	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Lake Creek Upper	C	D	C	C	C	D	A	C	--	Reservoir w/Diversion	<150	<5000
Lake Creek Lower	C	B	C	B	D	C	D	C	--	Dam and Reservoir	150-350	<5000
Lower Chulitna	C	B	C	B	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Tokichitna	C	B	C	B	C	C	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000
Coal	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Ohio	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Chulitna	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Whiskers	C	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	<5000
Lane	C	B	C	B	D	C	D	C	>100	Dam and	150-350	<5000

TABLE C.7 (Continued)

	Big Game	Agricultural Potential	Waterfowl, Raptors, Endg. Species	Anadromous Fisheries	Wilderness Consideration	Cult, Recrea, & Scientific	Restricted Land Use	Access	Installed Capacity (MW)	Scheme	Dam Height (ft)	Land Flooded (Acres)
Cleave	C	D	B	B	B	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Wood Canyon	C	D	C	B	B	B	A	D	--	Dam and Reservoir	>350	>100,000
Tebay Lake	C	D	D	C	B	D	A	B	--	Reservoir w/Diversion	<150	<5000
Honagita	C	D	D	D	B	D	A	B	--	Reservoir w/Diversion	<150	<5000
Klutina	B	C	C	C	B	C	D	--	25-100	--	--	--
Tazlina	B	D	C	C	D	C	C	--	>100	Dam and Reservoir	150-350	5000 to 100,000
Gakona	B	C	C	C	D	C	A	D	--	Dam and Reservoir	150-350	5000 to 100,000
Sanford	B	C	C	C	D	C	A	D	--	Dam and Reservoir	--	--
Gulkana	B	D	C	C	D	B	B	D	25-100	Reservoir w/Diversion	150-350	5000 to 100,000
Yentna	B	B	C	B	D	C	D	C	>100	Dam and Reservoir	<150	>100,000
Talachultna	B	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	5000 to 100,000
Skwentna	B	B	C	B	D	C	D	C	25-100	Dam and Reservoir	>350	5000 to 100,000
Lake Creek Upper	C	D	C	C	C	D	A	C	--	Reservoir w/Diversion	<150	<5000
Lake Creek Lower	C	B	C	B	D	C	D	C	--	Dam and Reservoir	150-350	<5000
Lower Chulitna	C	B	C	B	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Tokichitna	C	B	C	B	C	C	D	D	>100	Dam and Reservoir	150-350	5000 to 100,000
Coal	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Ohio	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Chulitna	B	D	C	C	C	C	D	D	25-100	Dam and Reservoir	150-350	<5000
Whiskers	C	B	C	B	D	C	D	C	25-100	Dam and Reservoir	<150	<5000
Lane	C	B	C	B	D	C	D	C	>100	Dam and Reservoir	150-350	<5000
Sheep Creek	B	D	D	D	C	C	D	C	25-100	Dam and Reservoir	>350	<5000

TABLE C.8 - CRITERIA WEIGHT ADJUSTMENTS

	Initial Weight	Adjusted Weights					
		Dam Height			Reserv. Area		
		+	++	+++	+	++	+++
Big Game	8				6	7	8
Agricultural Potential	7				5	6	7
Birds	8				6	7	8
Fisheries	10	8	9	10			

TABLE C.9 - SITE CAPACITY GROUPS

Site Group	No. of Sites Evaluated	No. of Sites Accepted
$\leq$ 25 MW	5	3
25- 100 MW	15	4 - 6
$\geq$100 MW	8	4

TABLE C.10 - RANKING RESULTS

Site Group	Partial Score	Total Score
Sites: < 25 MW		
Strandline Lake	59	85
Nellie Juan Upper	37	96
Tustumena	37	106
Allison Creek	65	82
Silver Lake	65	111
Sites: 25 - 100 MW		
Hicks	62	79
Bruskasna	71	104
Bradley Lake	71	104
Snow	71	106
Cache	86	127
Lowe	89	122
Keetna	89	131
Talkeetna - 2	98	134
Coffee	101	126
Whiskers	101	134
Klutina	101	142
Lower Chulitiua	106	139
Beluga Upper	117	142
Talachultna River	126	159
Skwentna	136	169
Sites > 100 MW		
Chakachamna	65	134
Browne	69	94
Tazlina	89	124
Johnson	96	121
Cathedral Bluffs	101	126
Lane	106	139
Kenai Lake	112	147
Tokichitna	117	150

TABLE C.11 - SHORTLISTED SITES

Environmental	Capacity		
Rating	0 - 25 MW	25 - 100 MW	100 MW
Good	Strandline Lake*	Hicks*	Browne*
	Allison Creek*	Snow*	Johnson
	Tustumena	Cache*	
	Silver Lake	Bruskasna*	
Acceptable		Keetna*	Chakachamna*
Poor		Talkeetna-2*	Lane
		Lower Chulitna	Tokichitna

* 10 selected sites

Table C.12 - PRELIMINARY COST ESTIMATE - SNOW

Description	Quantity	Unit	Cost/Unit $	Amount $10^6	Totals $10^6
Diversion Tunnel	2,000	LF	3,060.00	6.12	
Earth Cofferdams	132,000	cy	10.25	1.35	
Excavation - Overburden	768,000	cy	4.50	3.46	
- Spillway					
Impervious Fill	638,000	cy	5.00	3.19	
Pervious Fill	3,028,000	cy	5.00	15.14	
Filter Stone	83,000	cy	8.00	0.66	
Coarse Rock Fill	57,000	cy	8.50	0.49	
Concrete Spillway	1,600	LF	24,900.00	39.80	
9 Ft Ø Power Tunnel	10,000	LF	1,978.00	19.78	
22 Ft Ø Surge Shaft	200	VLF	7,000.00	1.40	
50 MW Underground Powerhouse	1	ea		25.00	
Tailrace Tunnel	505	LF	1,978.00	1.00	
Tailrace Channel	2,000	LF	510.00	1.02	
Subtotal					118.41
Land/Damages				.98	
Reservoir Clearing				4.16	
Switchyard				3.00	
Transmission				7.20	
Roads				4.20	
Bridges				--	
On-site Roads				5.00	
Buildings/Equipment				8.00	
Mobilization				7.54	
Subtotal					158.49
Camp				20.00	
Catering				14.40	
Subtotal					192.89
Engineering, Administration Contingency				61.72	
TOTAL					254.61

Table C.13 - PRELIMINARY COST ESTIMATE - KEETNA

Description	Quantity	Unit	Cost/Unit $	Amount $10^6	Totals $10^6
Diversion Tunnel	2,000	LF	9,460.00	18.92	
Earth Cofferdams	824,000	cy	10.25	8.45	
Excavation - Overburden	1,474,000	cy	4.50	6.63	
Impervious Dam Fill	1,850,000	cy	5.00	9.25	
Pervious Dam Fill	8,513,000	cy	5.00	42.50	
Filter Stone	193,000	cy	8.00	1.54	
Coarse Rock - Rip Rap	148,000	cy	8.50	1.26	
Spillway Excavation	410,000	cy			
130 Ft Concrete Spillway	1,000	LF	100,500.00	100.50	
Power Tunnel	2,100	LF	4,110.00	8.64	
100 MW Surface Powerhouse	1	ea		50.00	
Subtotal					247.69
Lands/Damage				1.66	
Reservoir Clearing				12.18	
Switchyard				3.00	
Transmission				3.20	
Roads				3.60	
Bridges				5.00	
On-site Roads				5.00	
Buildings/Equipment				8.00	
Mobilization				14.47	
Subtotal					303.80
Camp				30.00	
Catering				27.30	
Subtotal					361.10
Engineering, Administration, Contingency				115.55	
TOTAL					476.65

Table C.14 - PRELIMINARY COST ESTIMATE - CACHE

Description	Quantity	Unit	Cost/Unit $	Amount 10^6	Totals 10^6
Diversion Tunnel	2,200	LF	8,390.00	18.45	
Earth Cofferdams	301,000	cy	10.25	3.09	
Excavation - Overburden	2,946,000	cy	4.50	13.25	
- Spillway	490,000	cy			
Impervious Fill	2,750,000	cy	5.00	13.75	
Pervious Fill	12,018,000	cy	5.00	60.09	
Filter Stone	284,000	cy	8.00	2.27	
Coarse Rock Fill	196,000	cy	8.50	1.67	
Concrete Spillway	2,000	LF	71,400.00	142.80	
13 Ft Ø Power Tunnel	2,000	LF	2,870.00	5.74	
50 MW Surface Powerhouse	1	ea		25.00	
Subtotal					286.11
Lands/Damages				1.89	
Reservoir Clearing				13.96	
Switchyard				3.00	
Transmission				8.80	
Roads				12.00	
Bridges				5.00	
On-site Roads				5.00	
Buildings/Equipment				8.00	
Mobilization				17.19	
Subtotal					360.95
Camp				33.75	
Catering				32.40	
Subtotal					427.10
Engineering, Administration, Contingency				136.67	
TOTAL					563.77

Table C.15 - PRELIMINARY COST ESTIMATE - BROWNE

Description	Quantity	Unit	Cost/Unit $	Amount $10^6	Totals $10^6
Diversion Tunnel	1,000	LF	12,000.00	12.00	
Earth Cofferdams	196,000	cy	10.25	2.00	
Excavation - Overburden	7,197,000	cy	4.50	32.39	
- Spillway					
Impervious Fill	2,497,000	cy	5.00	12.49	
Pervious Fill	11,895,000	cy	5.00	59.48	
Filter Stone	337,000	cy	8.00	2.70	
Coarse Rock Fill	329,000	cy	8.50	2.80	
Concrete Spillway	1,100	LF	128,000.00	141.00	
23 Ft Ø Power Tunnel	1,000	LF	5,540.00	5.54	
100 MW Surface Powerhouse	1	ea		50.00	
Tailrace Channel	300	LF	510.00	0.15	
Subtotal					320.55
Lands/Damages				4.62	
Reservoir Clearing				28.21	
Switchyard				3.00	
Transmission				2.00	
Roads				4.20	
Bridges				5.00	
On-site Roads				5.00	
Buildings/Equipment				8.00	
Mobilization				19.03	
Subtotal					399.61
Camp				37.50	
Catering				36.00	
Subtotal					473.11
Engineering, Administration, Contingency				151.40	
TOTAL					624.51

Table C.16 - PRELIMINARY COST ESTIMATE - TALKEETNA-2

Description	Quantity	Unit	Cost/Unit $	Amount $10^6	Totals $10^6
Diversion Tunnel	2,800	LF	8,660.00	24.25	
Earth Cofferdams	445,000	cy	10.25	4.56	
Excavation - Overburden	4,668,000	cy	4.50	21.00	
- Spillway	333,000	cy			
Impervious Fill	2,932,000	cy	5.00	14.66	
Pervious Fill	14,213,000	cy	5.00	71.07	
Filter Stone	294,000	cy	8.00	2.35	
Coarse Rock Fill	197,000	cy	8.50	1.67	
Concrete Spillway	1,200	LF	81,600.00	97.90	
12.5 Ft Ø Power Tunnel	2,400	LF	2,750.00	6.60	
50 MW Surface Powerhouse	1	ea		25.00	
Subtotal					269.06
Lands/Damages				0.48	
Reservoir Clearing				3.27	
Switchyard				3.00	
Transmission				5.60	
Roads				7.20	
Bridges				5.00	
On-site Roads				5.00	
Buildings/Equipment				8.00	
Mobilization				15.33	
Subtotal					321.94
Camp				27.50	
Catering				29.10	
Subtotal					378.54
Engineering, Administration, Contingency				121.13	
TOTAL					499.67

Table C.17 - PRELIMINARY COST ESTIMATE - HICKS

Description	Quantity	Unit	Cost/Unit $	Amount $10^6	Totals $10^6
Diversion Tunnel	2,400	LF	8,450.00	20.28	
Earth Cofferdams	641,000	cy	10.25	6.60	
Excavation - Overburden	2,136,000	cy	4.50	9.60	
- Spillway	292,000	cy			
Impervious Fill	2,160,000	cy	5.00	10.80	
Pervious Fill	8,713,000	cy	5.00	43.60	
Filter Stone	238,000	cy	8.00	1.90	
Coarse Rock Fill	154,000	cy	8.50	1.30	
Concrete Spillway	1,800	LF	79,444.00	143.00	
15 Ft Ø Power Tunnel	1,900	LF	3,342.00	6.35	
Surge Shaft					
60 MW Surface Powerhouse	1	ea		30.00	
Subtotal					273.43
Lands/Damages				1.76	
Reservoir Clearing				1.48	
Switchyard				3.00	
Transmission				20.00	
Roads				3.00	
Bridges				5.00	
On-site Roads				5.00	
Buildings/Equipment				8.00	
Mobilization				16.05	
Subtotal					336.72
Camp				33.75	
Catering				30.30	
Subtotal					400.77
Engineering, Administration, Contingency				128.25	
TOTAL					529.02

Table C.18 - PRELIMINARY COST ESTIMATE - CHAKACHAMNA

Description	Quantity	Unit	Cost/Unit $	Amount $10^6	Totals $10^6
Main Dam	1	ea		2.00	
26 Ft Concrete Lined Power Tunnel	57,000	LF	8,380.00	477.66	
Adit Tunnels	14,000	LF	1,680.00	23.50	
35 Ft Tailrace Tunnel	1,000	LF	3,500.00	3.50	
88 Ft Ø Surge Shaft	500	LF	50,000.00	25.00	
16 Ft Ø Penstocks	3,700	LF	5,090.00	18.85	
500 MW Underground Powerhouse	1	ea		273.50	
Diversion Tunnel	2,000	LF	9,580.00	19.15	
Subtotal					843.16
Lands/Damages				0.50	
Reservoir Clearing				--	
Switchyard				3.00	
Transmission				14.00	
Roads				31.80	
Bridges				10.00	
On-site Roads				10.00	
Buildings/Equipment				8.00	
Mobilization				44.40	
Subtotal					964.86
Camp				72.50	
Catering				84.00	
Subtotal					1121.36
Engineering, Administration, Contingency				359.05	
TOTAL					1480.41

Table C.19 - OPERATING AND ECONOMIC PARAMETERS FOR SELECTED HYDROELECTRIC PLANTS

No.	Site	River	Max. Gross Head Ft.	Installed Capacity (MW)	Average Annual Energy (Gwh)	Plant Factor (%)	Capital Cost[1] (10^6)	Economic Cost of Energy ($/1000 Kwh)
1	Snow	Snow	690	50	220	50	255	45
2	Bruskasna	Nenana	235	30	140	53	238	113
3	Keetna	Talkeetna	330	100	395	45	477	47
4	Cache	Talkeetna	310	50	220	51	564	100
5	Browne	Nenana	195	100	410	47	625	59
6	Talkeetna-2	Talkeetna	350	50	215	50	500	90
7	Hicks	Matanuska	275	60	245	46	529	84
8	Chakachamna	Chakachatna	945	500	1925	44	1480	30
9	Allison	Allison Creek	1270	8	33	47	54	125
10	Strandline Lake	Beluga	810	20	85	49	126	115

NOTES:
(1) Including engineering and owner's administrative costs but excluding AFDC.

TABLE C.20 - ALTERNATIVE HYDRO DEVELOPMENT PLANS

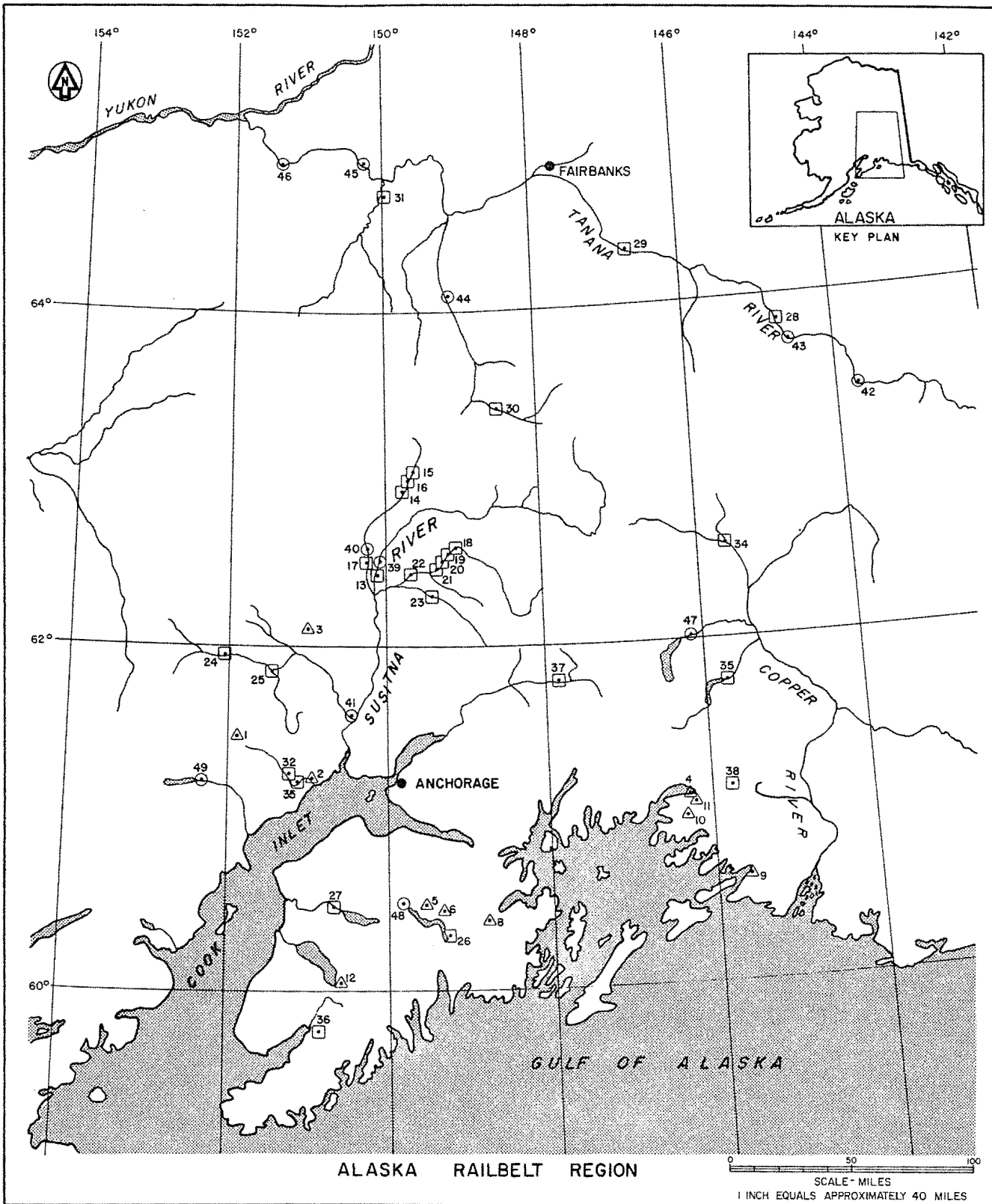
Plan	Description	Installed Capacity	On-Line Date
A.1	Chakachamna	500	1993
	Keetna	100	1997
A.2	Chakachamna	500	1993
	Keetna	100	1997
	Snow	50	2002
A.3	Chakachamna	500	1993
	Keetna	100	1996
	Snow	50	1998
	Strandline	20	1998
	Allison Creek	8	1998
A.4	Chakachamna	500	1993
	Keetna	100	1996
	Snow	50	2002
	Strandline	20	2002
	Allison Creek	8	2002
A.5	Chakachamna	500	1993
	Keetna	100	1996
	Snow	50	2002
	Talkeetna - 2	50	2002
	Cache	50	2002
	Strandline	20	2002
	Allison Creek	8	2002

TABLE C.21 - RESULTS OF ECONOMIC ANALYSES OF ALTERNATIVE GENERATION SCENARIOS

Generation Scenario			OGP5 Run	Installed Capacity (MW) by Category in 2010				Total System Installed	Total System Present Worth
				Thermal			Hydro		
Type	Description	Load Forecast	Id. No.	Coal	Gas	Oil		Capacity in 2010 (MW)	Cost - (10^6)
All Thermal	No Renewals	Very Low[1]	LBT7	500	426	90	144	1160	4930
	No Renewals	Low	L7E1	700	300	40	144	1385	5920
	With Renewals	Low	L2C7	600	657	30	144	1431	5910
	No Renewals	Medium	LME1	900	801	50	144	1895	8130
	With Renewals	Medium	LME3	900	807	40	144	1891	8110
	No Renewals	High	L7F7	2000	1176	50	144	3370	13520
	With Renewals	High	L2E9	2000	576	130	144	3306	13630
	No Renewals	Probabilistic	LOF3	1100	1176	100	144	3120	8320
Thermal Plus Alternative Hydro	No Renewals Plus: Chakachamna (500)[2]-1993 Keetna (100)-1997	Medium	L7W1	600	576	70	744	1990	7080
	No Renewals Plus: Chakachamna (500)-1993 Keetna (100)-1997 Snow (50)-2002	Medium	LFL7	700	501	10	794	2005	7040
	No Renewals Plus: Chakachamna (500)-1993 Keetna (100)-1996 Strandline (20), Allison Creek (8), Snow (50)-1998	Medium	LWP7	500	576	60	822	1958	7064
	No Renewals Plus: Chakachamna (500)-1993 Keetna (100)-1996 Strandline (20), Allison Creek (8), Snow (50)-2002	Medium	LXF1	700	426	30	822	1978	7041
	No Renewals Plus: Chakachamna (500)-1993 Keetna (100)-1996 Snow (50), Cache (50), Allison Creek (8), Talkeetna-2 (50), Strandline (20)-2002	Medium	L403	500	576	30	922	2028	7088

Notes:

(1) Incorporating load management and conservation
(2) Installed capacity



△ 0 - 25 MW

⊡ 25 - 100 MW

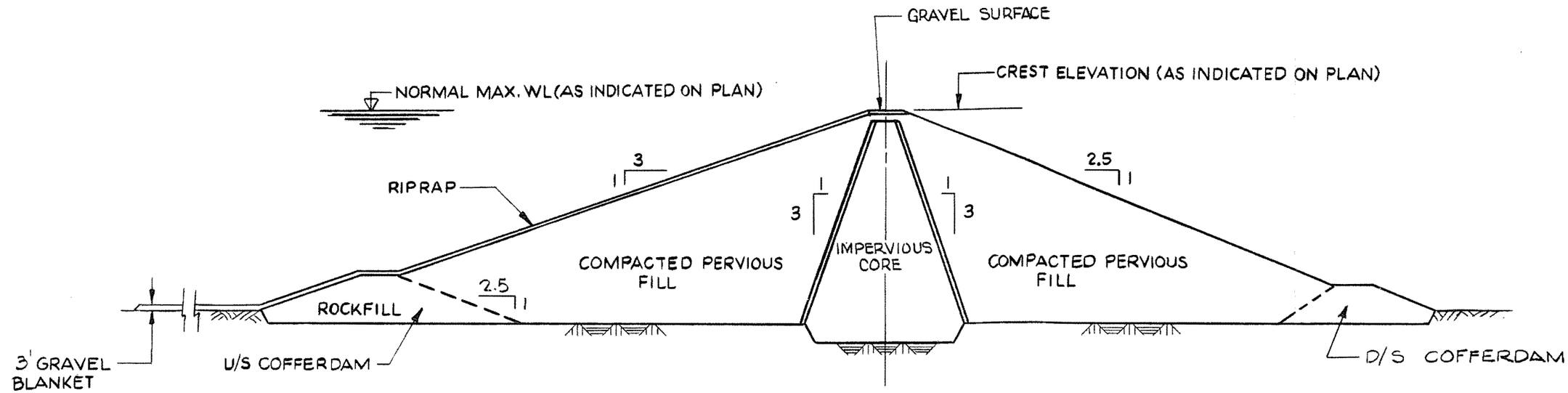
⊙ > 100 MW

1.	STRANDLINE L.	13.	WHISKERS	26.	SNOW	39.	LANE
2.	LOWER BELUGA	14.	COAL	27.	KENAI LOWER	40.	TOKICHITNA
3.	LOWER LAKE CR.	15.	CHULITNA	28.	GERSTLE	41.	YENTNA
4.	ALLISON CR.	16.	OHIO	29.	TANANA R.	42.	CATHEDRAL BLUFFS
5.	CRESCENT LAKE 2	17.	LOWER CHULITNA	30.	BRUSKASNA	43.	JOHNSON
6.	GRANT LAKE	18.	CACHE	31.	KANTISHNA R.	44.	BROWNE
7.	McCLURE BAY	19.	GREENSTONE	32.	UPPER BELUGA	45.	JUNCTION IS.
8.	UPPER NELLIE JUAN	20.	TALKEETNA 2	33.	COFFEE	46.	VACHON IS.
9.	POWER CREEK	21.	GRANITE GORGE	34.	GULKANA R.	47.	TAZILNA
10.	SILVER LAKE	22.	KEETNA	35.	KLUTINA	48.	KENAI LAKE
11.	SOLOMON GULCH	23.	SHEEP CREEK	36.	BRADLEY LAKE	49.	CHAKACHAMNA
12.	TUSTUMENA	24.	SKWENTNA	37.	HICK'S SITE		
		25.	TALACHULITNA	38.	LOWE		

SELECTED ALTERNATIVE HYDROELECTRIC SITES

FIGURE C.1

ACRES



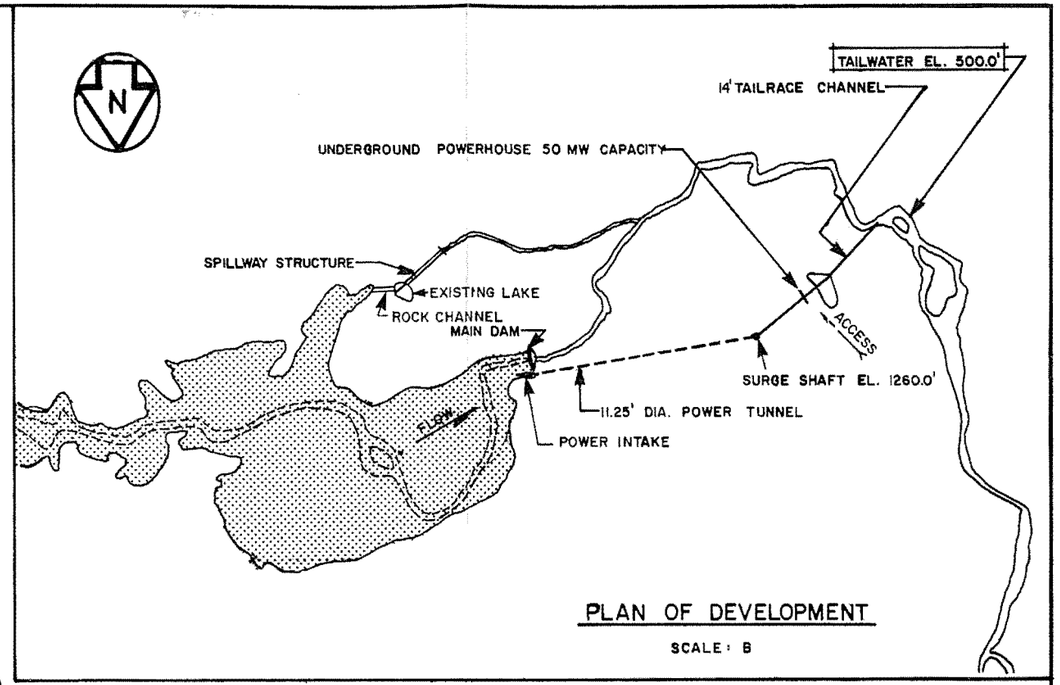
DAM CROSS SECTION

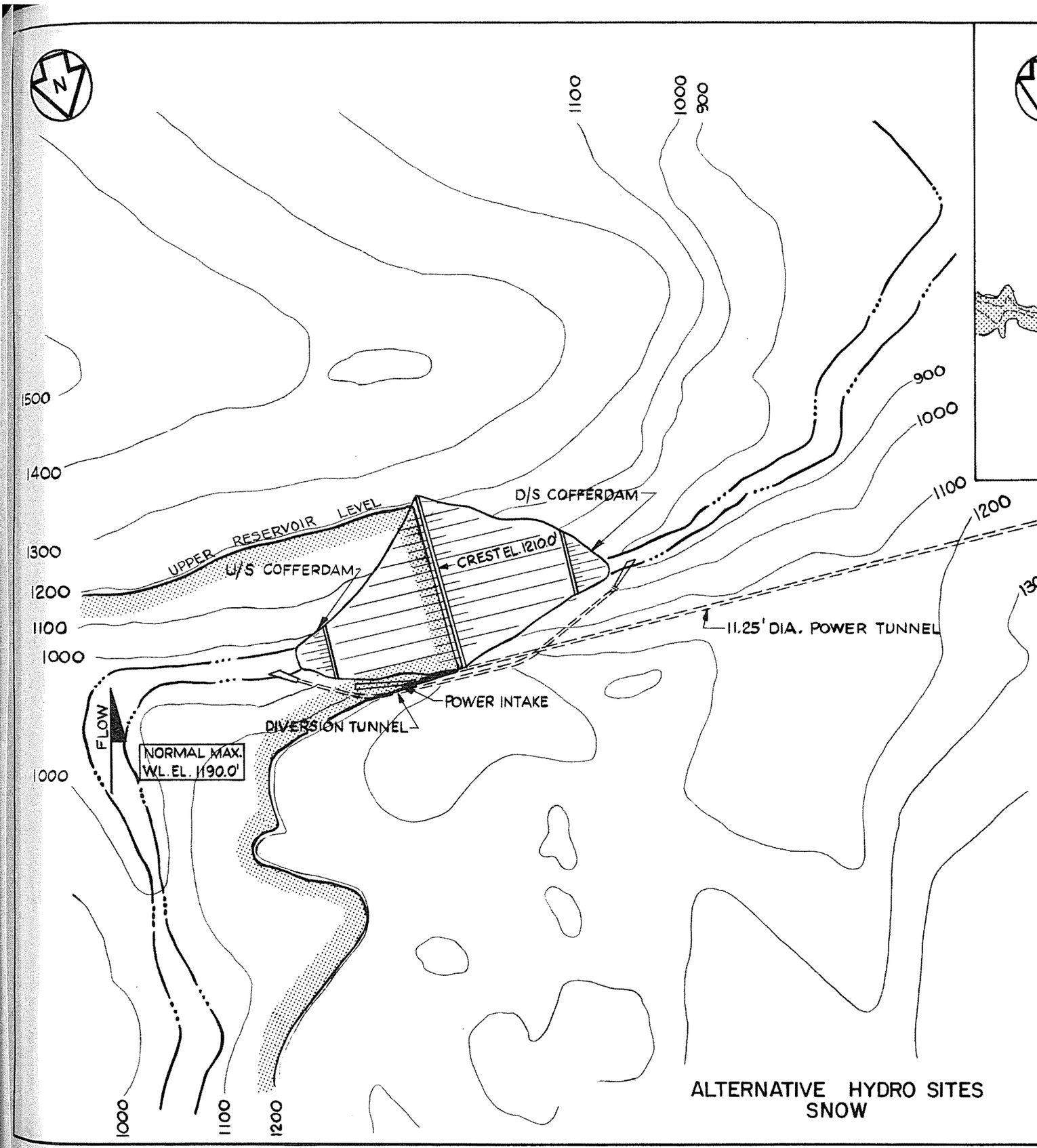
SCALE : 0 200 400 FEET

ALTERNATIVE HYDRO SITES
TYPICAL DAM SECTION

FIGURE C.2

ACRES





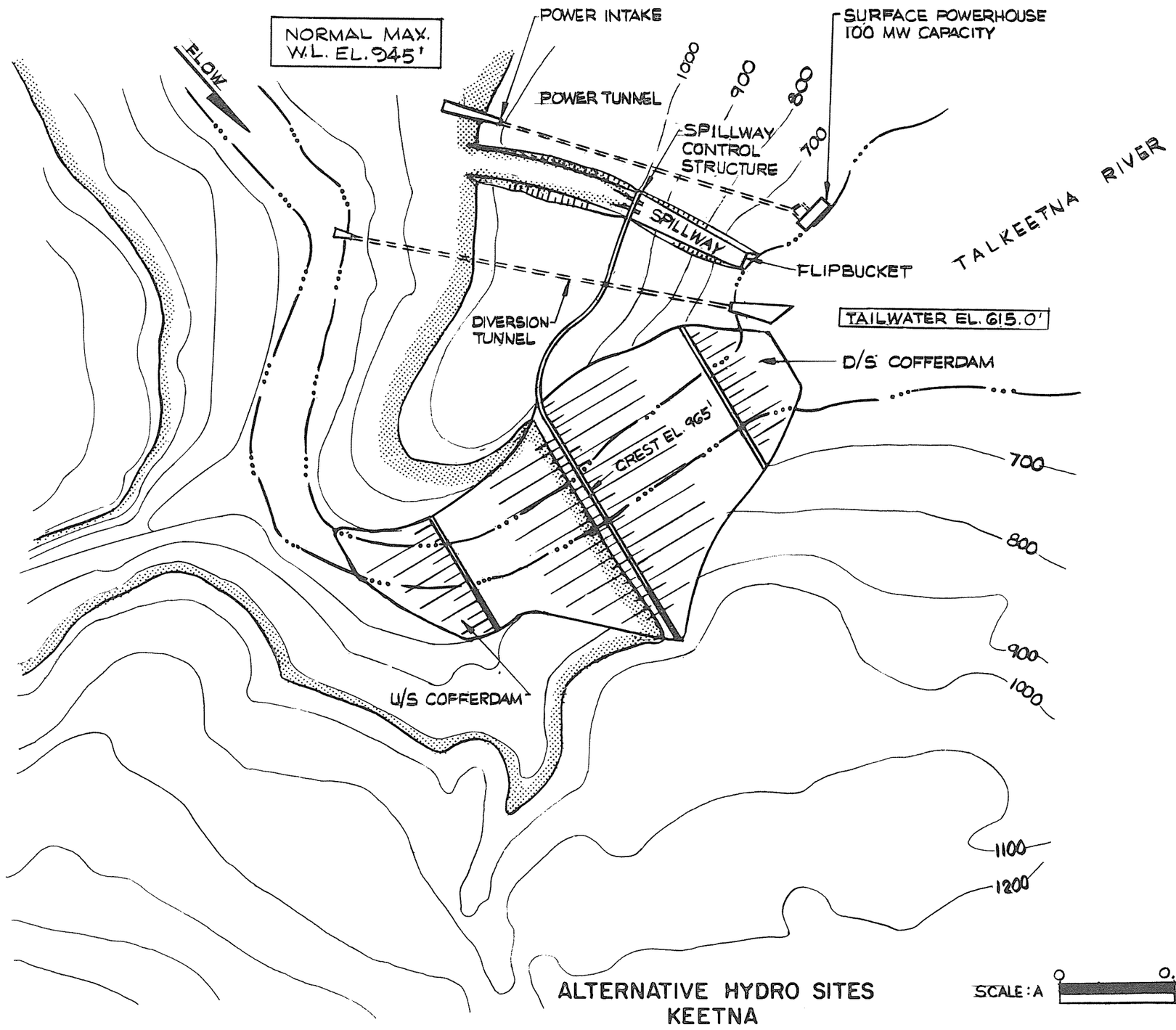
ALTERNATIVE HYDRO SITES
SNOW

SCALE: A 0 0.1 0.2 MILES

SCALE: B 0 1 2 MILES

FIGURE C.3

ACRES

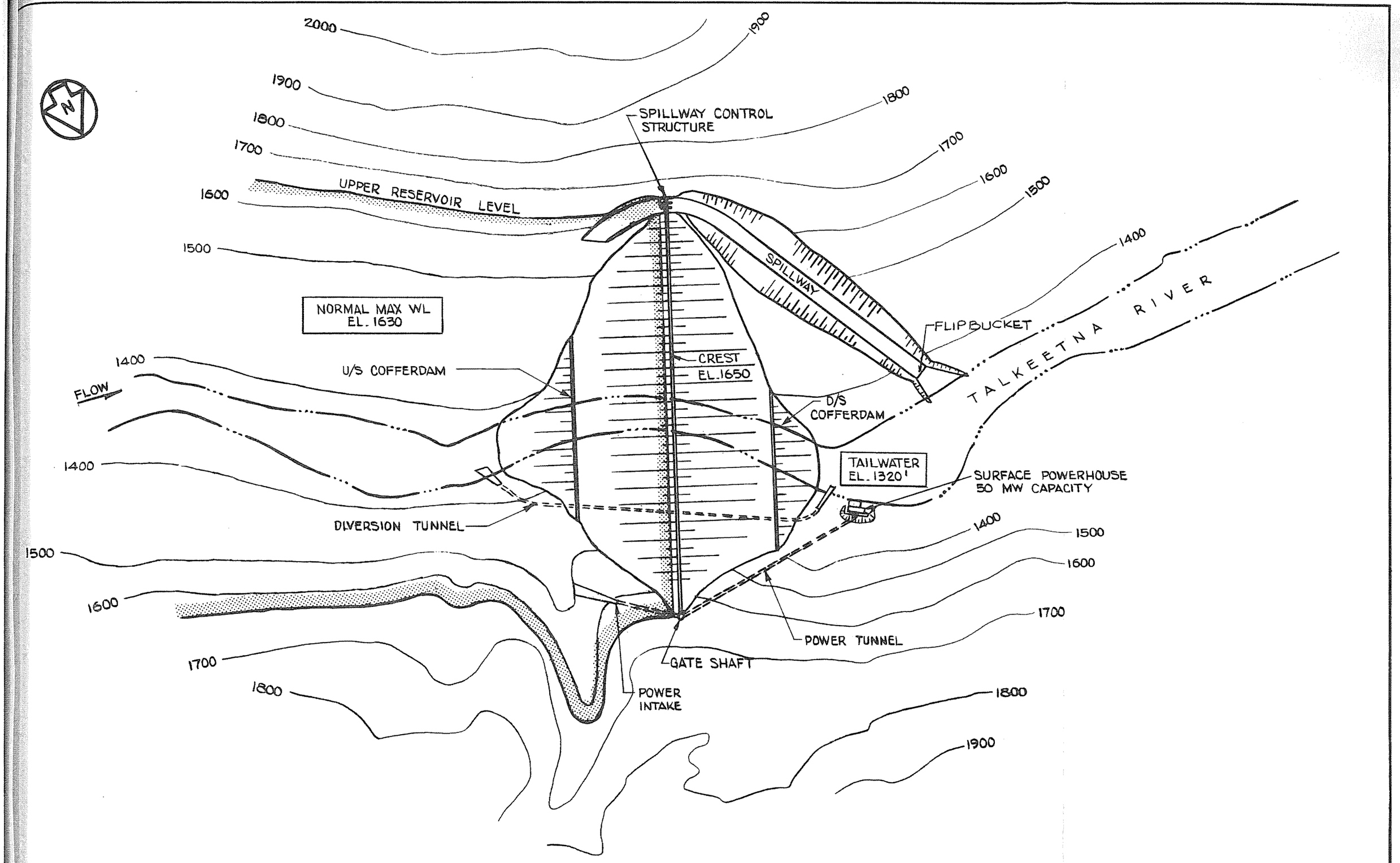


ALTERNATIVE HYDRO SITES
KEETNA

SCALE: A 0 0.1 2 MILES

FIGURE C.4

ACRES



ALTERNATIVE HYDRO SITES
CACHE

SCALE: 0 0.1 0.2 MILES

ACRES

FIGURE C.5

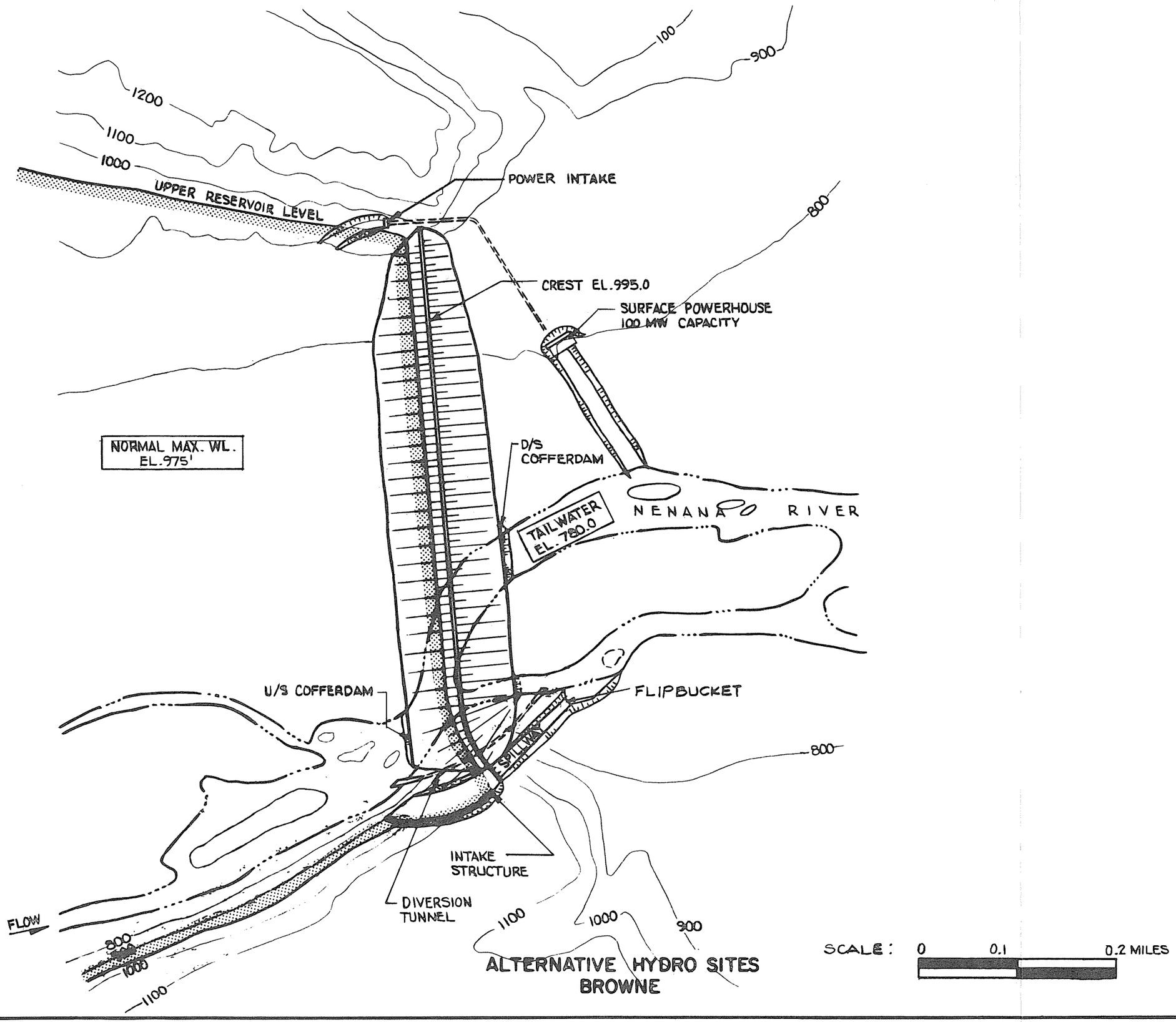
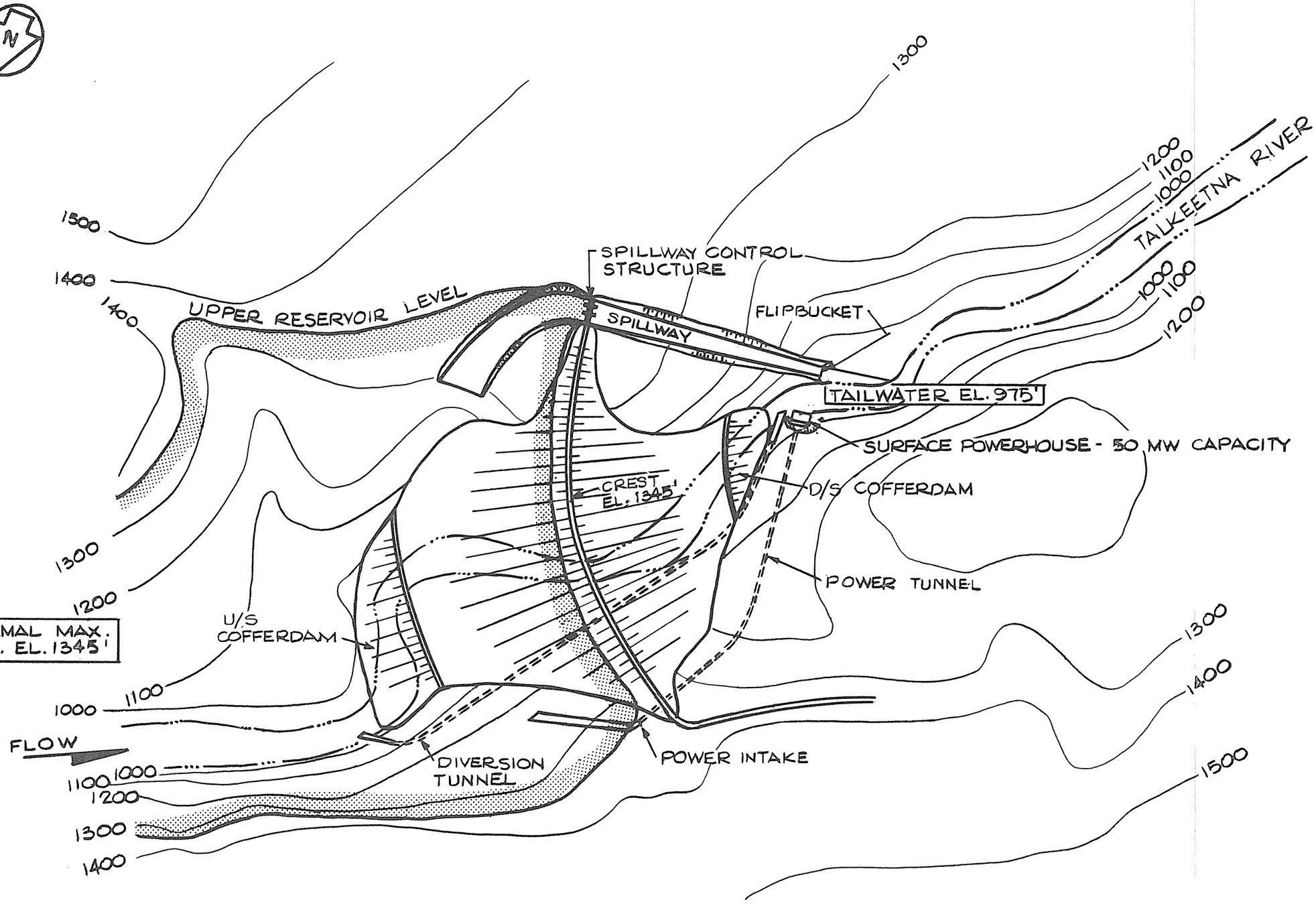


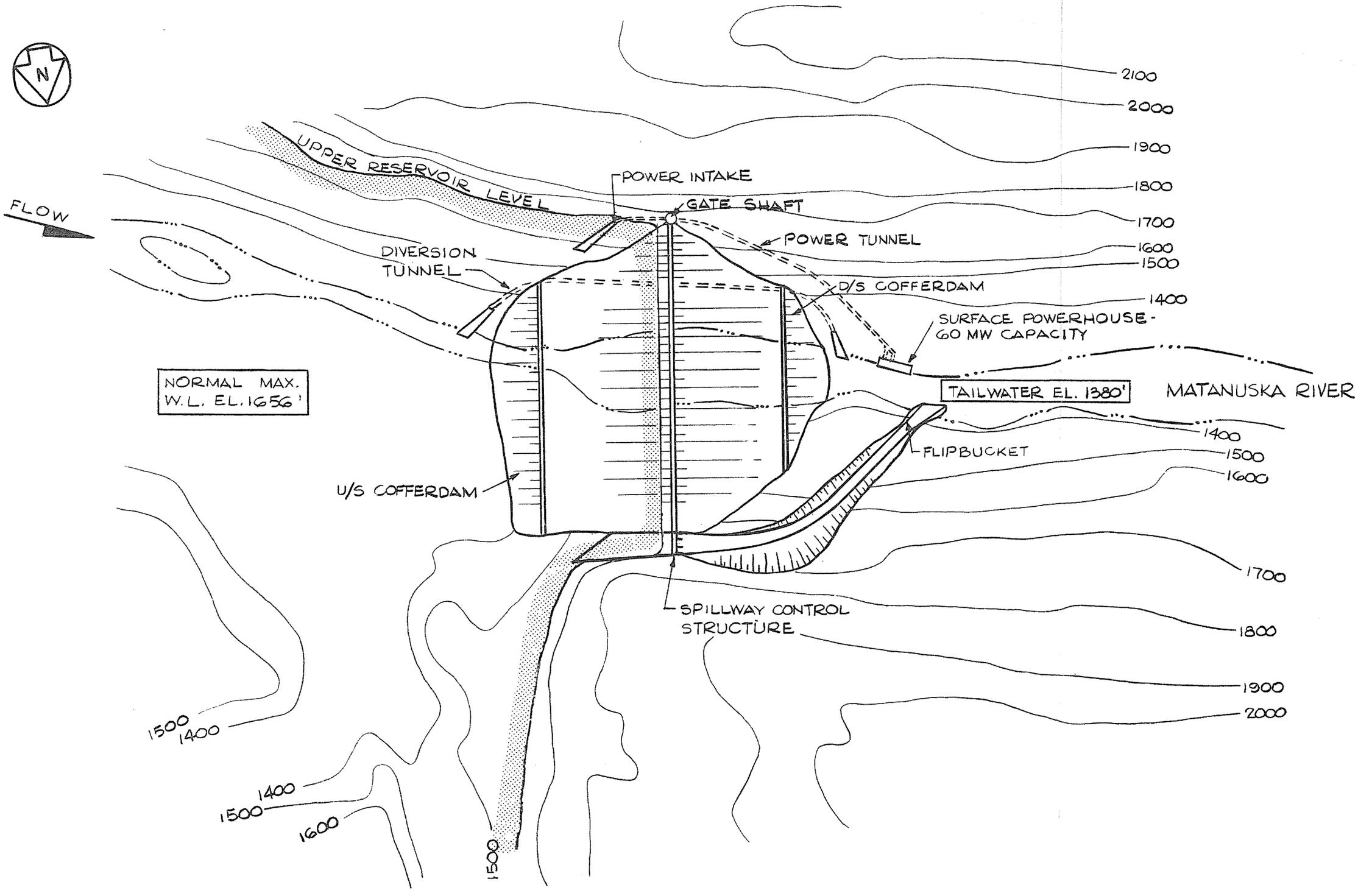
FIGURE C.6

ACRES



ALTERNATIVE HYDRO SITES
TALKEETNA 2

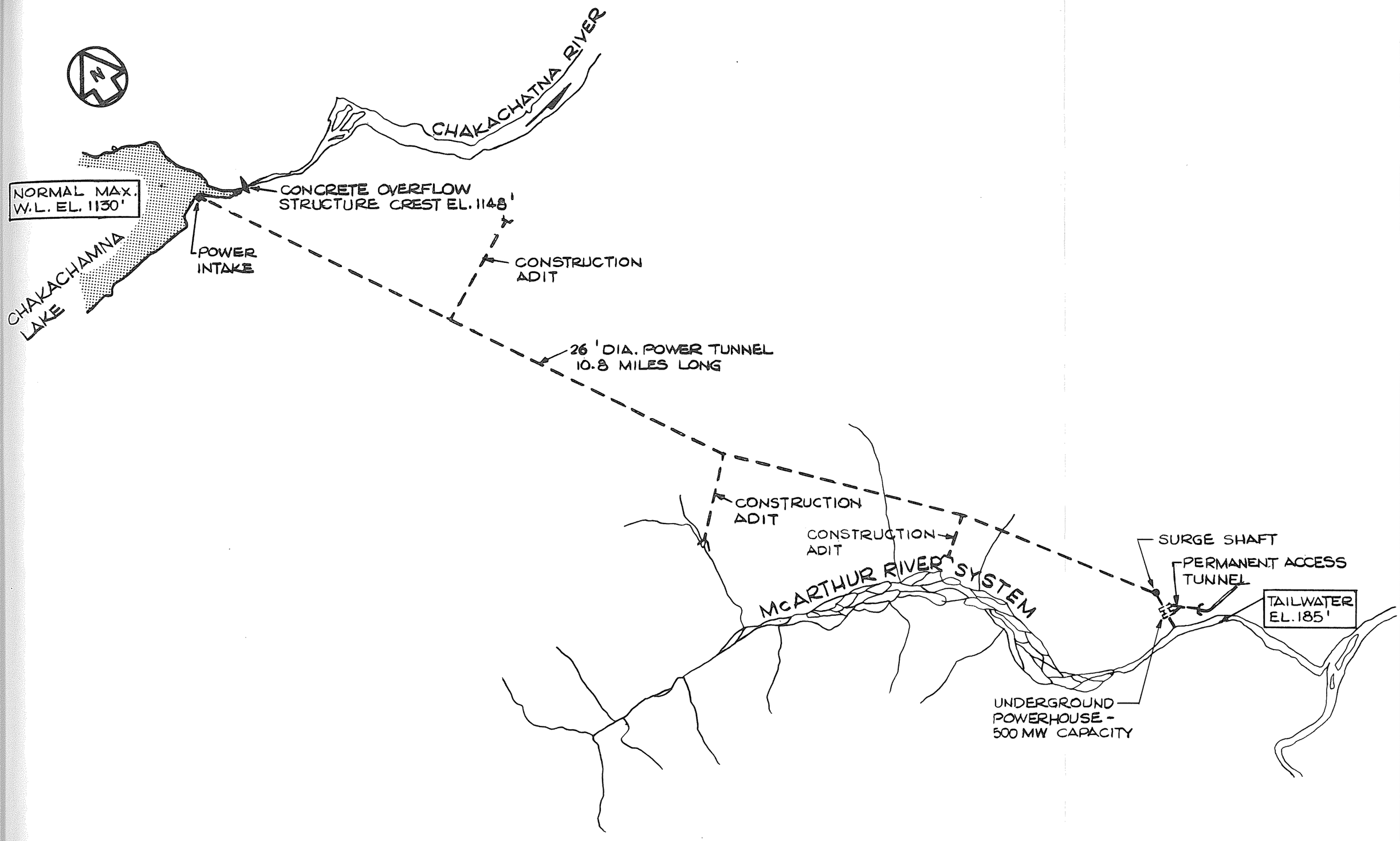
FIGURE C.7



ALTERNATIVE HYDRO SITES
HICKS

SCALE 0 0.1 0.2 MILES

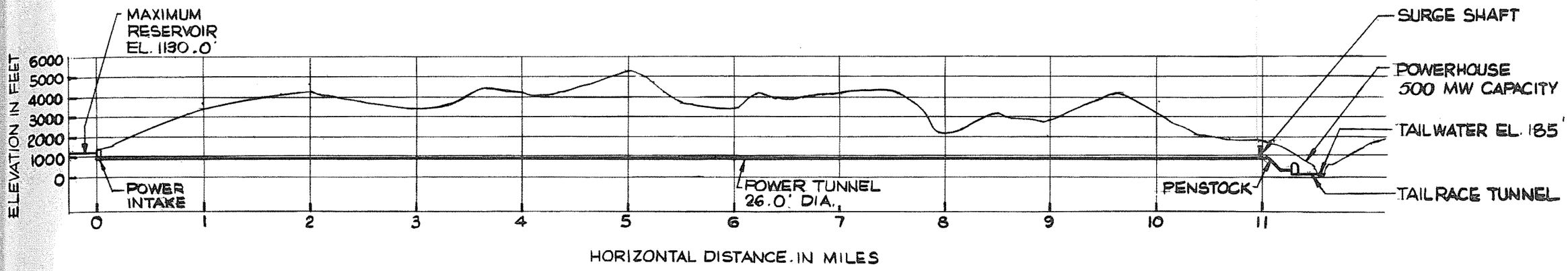
FIGURE C.8



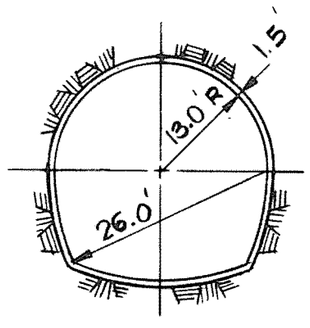
ALTERNATIVE HYDRO SITES
CHAKACHAMNA

FIGURE C.9

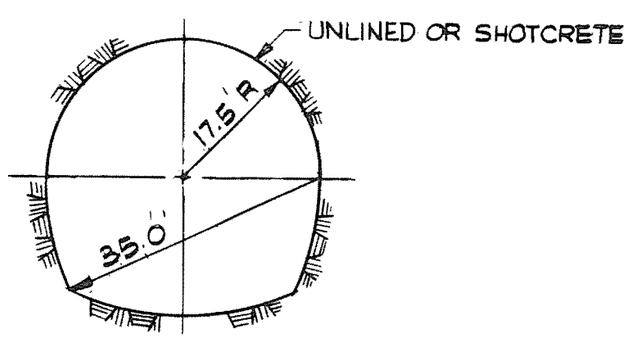
ACRES



PROFILE ALONG ℄ OF INTAKE, TUNNEL, & POWERHOUSE



POWER TUNNEL SECTION



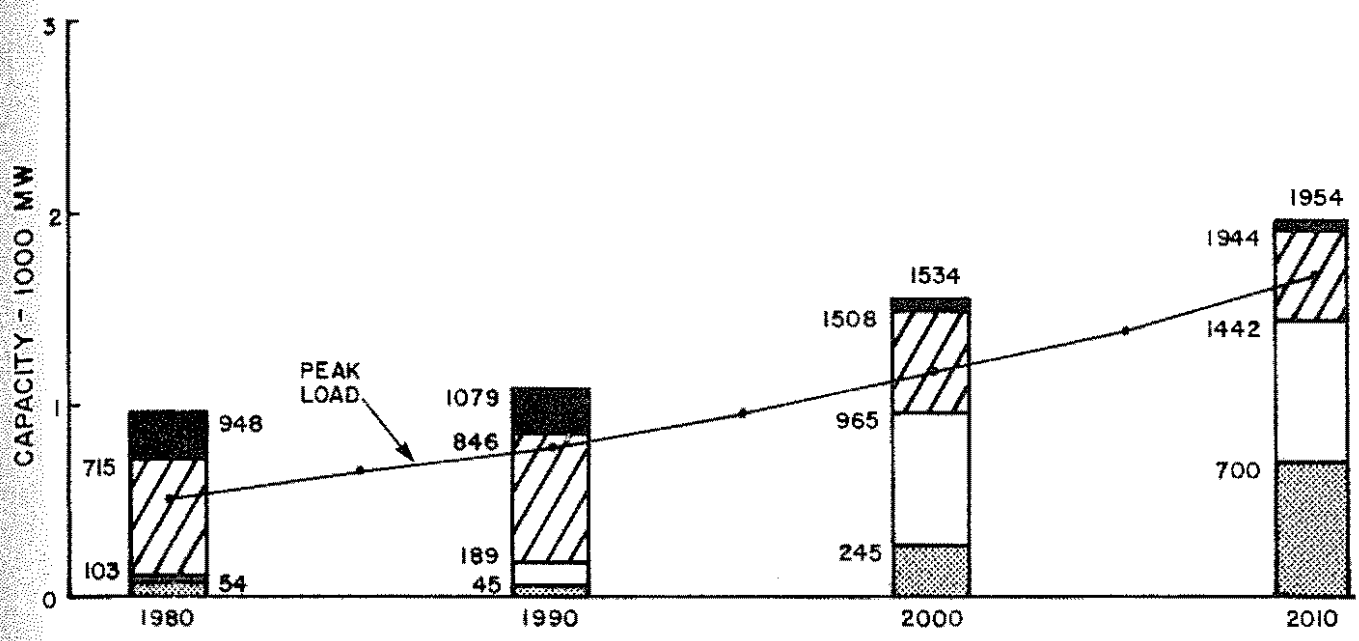
TAILRACE TUNNEL

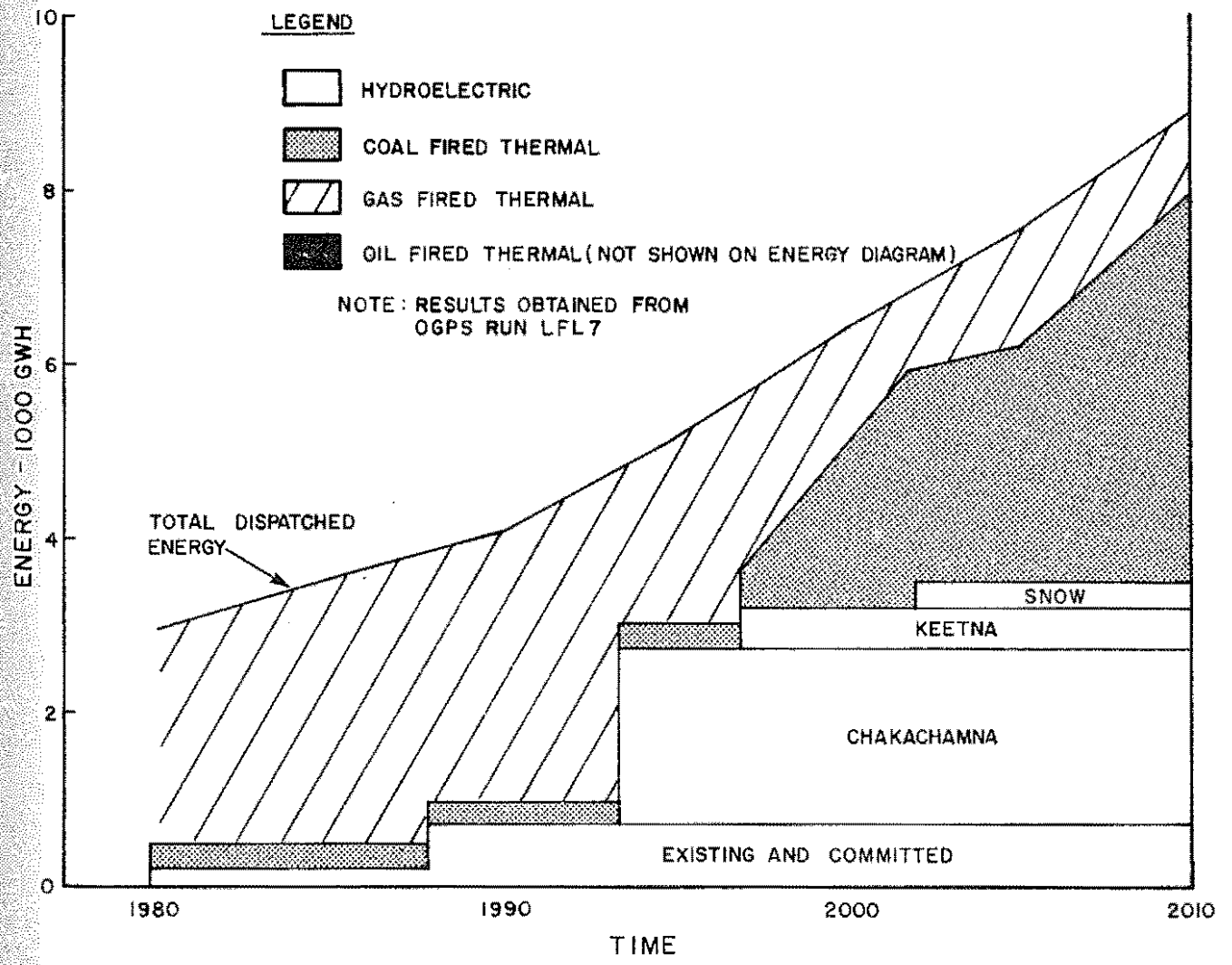
ALTERNATIVE HYDRO SITES
CHAKACHAMNA - PROFILE AND SECTIONS

SCALE 0 20 40 FEET

FIGURE C.10

ACRES





GENERATION SCENARIO INCORPORATING THERMAL AND ALTERNATIVE HYDROPOWER DEVELOPMENTS - MEDIUM LOAD FORECAST-

FIGURE C.11