# 1. INTRODUCTION

On January 25, 2011, Alaska Energy Authority (AEA) engaged MWH Americas, Inc. (MWH) and its subcontractors, under AEA Contract No. AEA-11-022, to conduct engineering feasibility studies and support them with Federal Energy Regulatory Commission (FERC) licensing of the Susitna-Watana Hydroelectric Project (Susitna-Watana Project or the Project). The starting point for this work was the November 23, 2010 Railbelt Large Hydro Evaluation Preliminary Decision Document prepared by AEA, determining that the Susitna-Watana Project be favored over other potential large scale hydro projects to serve future Railbelt power needs. The engineering feasibility studies conducted between February 2011 and July 2014 are documented in this draft report. Future geotechnical investigations beyond those completed to date may alter the conclusions reached thus far, as documented herein. The result of any future geotechnical exploration will be reflected in the license application.

## 1.1. Background

The Project will be a major development on the Susitna River some 125 miles north and east of Anchorage and about 140 miles south of Fairbanks. The general location of the proposed project is shown in Figure 1.1-1 and in Figure 1.1-2.

This Project is being developed to provide long-term power supply to the Railbelt. It will be capable of generating up to 50 percent of the Railbelt's electricity, or approximately 2,800,000 megawatt hours (MWh) of annual energy (depending on the agreed operating rules), once all units come on line, which is dependent on the timely award of a FERC license. The Project's installed rated turbine power capacity will be 459 megawatts (MW), equivalent to 446 MW generator output.

As proposed, the Susitna-Watana Project would include construction of a dam, reservoir, and related facilities in a remote part of the Susitna River as shown on Figure 1.1-3 (also included as Drawing 01-00G001 in Appendix A, where all drawings for this report are located). The project is located 187 project river miles (PRM) from Cook Inlet, and more than 80 PRM upstream of Talkeetna and 32 PRM above Devils Canyon. Transmission lines connecting to the existing Railbelt transmission system and an access road and railhead improvements would also be constructed.

AEA is engaged in a complex licensing and permitting process overseen by FERC, the federal agency, which oversees all hydropower development in the United States, and is currently scheduled to file an application for license on December 1, 2016.

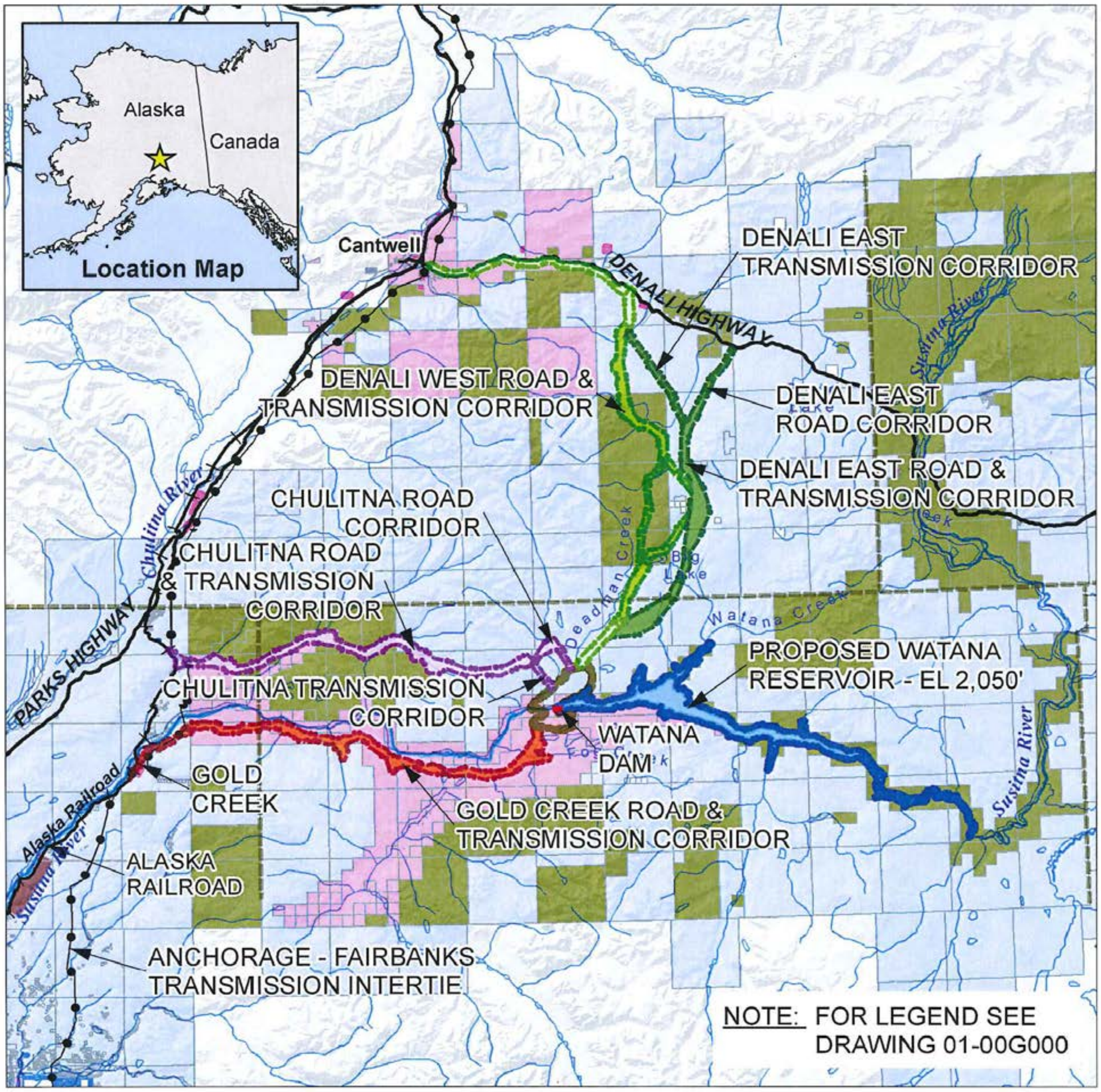


**Figure 1.1-1. General Location**

**Figure 1.1-2. Watana Dam Site on Susitna River, Looking Upstream**

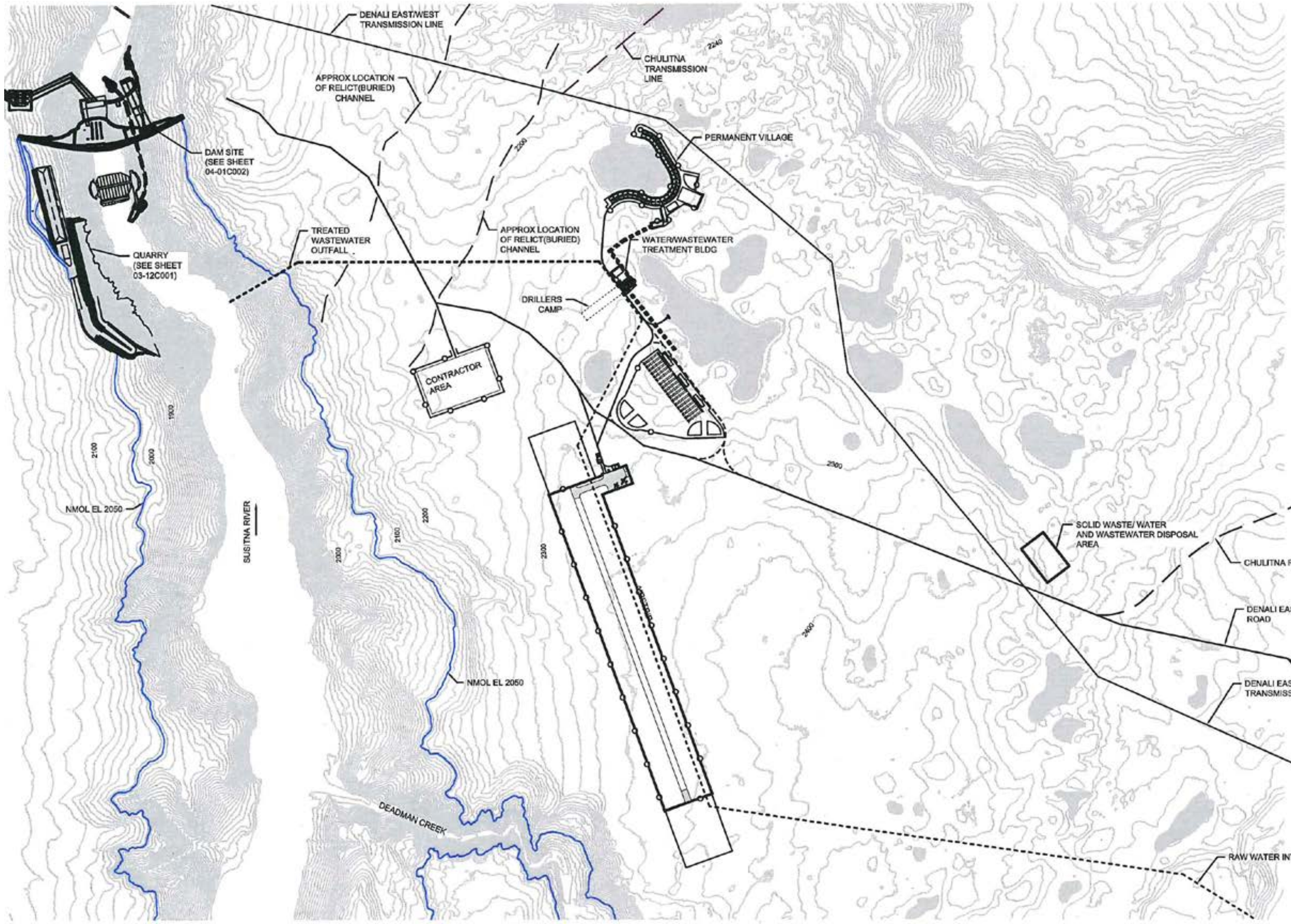


**Figure 1.1-3. Site Plan**

The anticipated project cost at the date of this report is currently estimated to be approximately US$ 5.655 billion (July 2014 dollars), including licensing, design, and construction, but excluding escalation, and interest during construction. Probabilistic simulation has been performed on the current estimate to derive a range of probable costs.

While the evaluation of alternative financing plans for the project is beyond the scope of this report, initial economic model runs indicate that future power rates from the project will be competitive with other energy sources at the time it is expected to commence operation, and will contribute significantly to a reduction in projected power prices in the long term.

This Feasibility Report reflects the proposed project development as of July 2014, at the end of the engineering study program. The various study results described in this Report reflect a progression from the results presented by AEA in its Pre-Application Document (PAD), which was submitted to FERC in December 2011, and MWH's Interim Feasibility Report Summary dated December 2012. Planned geotechnical investigation programs were not implemented in 2013 due in part to funding limitations and lack of site access; an abbreviated investigation program was carried out during 2014 and more investigation is vital to enable detailed design to proceed. Results of those investigations may modify the information contained in this draft report, so the feasibility design remains preliminary until such time that the geotechnical work is completed. This is discussed further in Section 10. Engineering feasibility updates based on more in-depth geotechnical investigations (including adits to verify rock properties, the extent and character of "permafrost" and shear zone characteristics), and results of environmental studies completed during 2014 and proposed in 2015, are expected to result in further design refinements and modifications to the proposed project features as well as to the operational criteria ultimately proposed for the Project in the FERC License Application.

The Railbelt utilities have been actively engaged with AEA during the past three years in the development process as key partners and stakeholders. To date this engagement has focused on the operational modeling of the project, sizing of the generating units, and system integration work, all of which are key to the benefits this long-term resource will bring to the utilities.

The status of the preliminary design work conducted to date with respect to the key foci noted below is:

- With careful construction planning, particularly the planning of the logistics, it appears that the Project can be completed within 12 years of commencing the final design phase geotechnical investigations;
- The projected construction cost of the Project is as stated above, with the probabilities described in Section 13;

- Depending on the financing plan, and the expected increases in natural gas prices, the Project is financially viable, and will contribute to a general lowering of the expected Regional wholesale price of power in the long term; and,
- The Project appears to be technically feasible using a roller-compacted concrete (RCC) dam (if shears capable of co-seismic behavior are not present in the foundation) and the currently proposed layout as described in Section 10.

## 1.2. Summary of Previous Studies

The Project has been studied for many years, principally in the early 1980s by the State of Alaska, through the vehicle of the Alaska Power Authority (APA). Engaged by APA (which was renamed AEA in 1989), Acres American Incorporated, and subsequently Harza-Ebasco, evaluated a large number of alternatives for hydroelectric power development on the Susitna River and conducted extensive engineering, environmental and economic studies. Following those studies, in 1983 a draft Application for a license to construct a major power project was submitted to FERC. After further studies, it was concluded that a phased development of the Susitna basin would be the most attractive approach to the Project and a three-phase development was selected as appropriate. Stage I of the Project was to have been a 700-foot high dam at Watana with a 440 MW powerhouse. Subsequent stages outlined in the amended License Application in 1985 included the downstream Devils Canyon dam/powerhouse complex forming Stage II, followed by raising of Watana Dam as Stage III, increasing the total installed power capacity of the complex to about 1,790 MW. Those subsequent Stages II and III were intended to be brought on line as power demands in the region grew over the decades.

After submission of the License Application, and the preparation of a draft Environmental Impact Statement, in March 1986 the Project was put on hold by APA primarily because of the low cost and ample supply of oil and natural gas. In response, APA withdrew the License Application.

In 2008, the Alaska State Legislature, in the fiscal year (FY) 2009 capital budget, authorized AEA to reevaluate the Project as previously conceived in 1985. Future demand predictions were evaluated together with options to meet the demand, such as from renewables, demand-side management, and energy efficiency.

In 2010, the Alaska Legislature enacted House Bill 306 (HB 306), creating a goal that the State should obtain 50 percent of its electric generation from renewable and alternative energy sources by 2025. Hydropower is considered a renewable resource in Alaska. Following HB 306, a Preliminary Decision Document was prepared by AEA, documenting a comparison between the two major projects competing to satisfy the requirements of HB 306, Chakachamna and Susitna-

Watana. The result of the comparison was a recommendation by AEA to develop the Susitna-Watana site, the upper of the two sites that were the subject of the 1983 License Application.

In early 2011, after competitive proposals, AEA engaged MWH and its subcontractors to assist in the completion of engineering feasibility studies and FERC licensing of a revised concept for the Susitna-Watana Project. The engineering feasibility studies have been documented in this report, but the conclusions and recommendations are tentative until the results of ongoing site geotechnical investigations are completed.

Although the previous studies were used at the outset of these feasibility studies to advance the preliminary engineering designs for the major features as much as possible, for much of the early project analysis documented in this report, an up-to-date topographic survey was not available. Significant dam analysis and hydrological analysis had to be performed with 1980s data. For example, the only topography available for the first reconnaissance study of the roads had contour intervals of 100 ft. Similarly, the initial review of the dam types, and the first drafting of the layouts for the dam and power facilities was performed using hand digitized topography from the printed copy of the 1980s site plan drawings (using Horizontal North American Datum of 1927 and National Geodetic Vertical Datum of 1929). During 2012, the first topographic data became available using the Interferometric Synthetic Aperture Radar (IFSAR) elevation data and the MatSu-North Susitna Bare Earth Data using Horizontal North American Datum of 1983 and North American Vertical Datum of 1988). The IFSAR data had a vertical accuracy of +/- 3 meters. As a result, a secondary exercise was initiated to transfer all data to the newer more accurate topography.

*All elevations referenced throughout this document and appendices are North American Vertical Datum 1988, unless otherwise described.*

## 1.3. Scope of Current Engineering Work

The objectives of the current engineering feasibility studies were to finalize the feasibility design of the Project, derive the size capacity and type of the major features, develop the design to sufficient detail for verification of project development cost estimates and construction schedule, and define the project components and operation so that related environmental studies can be completed in support of preliminary designs and the FERC License Application.

Essentially, the work has focused on:

- Defining the proposed project and its operational parameters;
- Development of a schedule for design and construction of the project;

- Estimating the project construction cost;
- Establishing the project's technical feasibility; and
- Identifying uncertainties and defining the path forward.

At the completion of this stage of the feasibility studies in mid-2014, the project definition (with an understanding that revisions may be necessary because of the subsequent inclusion of future geotechnical investigation and environmental study results) has been deemed by AEA to be sufficient for the subsequent drafting of required License Application exhibits.

The Project engineering studies have been completed in stages, loosely aligned to calendar years, and the scope of the work documented in this Feasibility Report includes:

- Hydrological investigations to support project sizing;
- Geological and geotechnical investigations necessary to characterize the site and foundation conditions and facilitate the preliminary design work on the proposed facilities;
- Analysis of alternative dam types and selection of the preferred alternative;
- Preliminary optimization and verification of the project layout associated with the type of dam selected;
- Verification of the proposed normal maximum operating level (NMOL) for the reservoir;
- Verification of the proposed maximum reservoir drawdown;
- Verification of the size and number of installed generating units for the powerhouse, and the total installed capacity;
- Definition of preliminary project operating parameters and determining generation output;
- Derivation of the probable maximum precipitation (PMP) and probable maximum flood (PMF);
- Derivation of the routed PMF outflow, to determine freeboard on the dam and to size the spillway and emergency outlet works;
- Partial preparation of a site-specific seismic hazard analysis (SSSHA) (to be completed);
- Selection of the seismic design criteria;
- Establishing a long term seismic monitoring network;
- Preparation of the project site layout;

- Preparation of a layout for temporary works and associated site infrastructure;
- Preparation of the layout of the airstrip and operators permanent village and associated infrastructure;
- Development of alternative site access routes;
- Development of transmission corridors to connect the project with the existing grid;
- Outline design of a railhead transfer facility for construction access;
- Identification and assessment of construction material sources;
- Preliminary structural and thermal analysis of the dam;
- Construction planning of all major features of the project;
- Development of an Opinion of Probable Construction Cost (OPCC) at July 2014 together with an analysis of major risk factors that could impact the cost determination; and,
- Operational modeling of the project, integrated within the Railbelt system.

## 1.4. Overview of FERC Licensing Process

An initial licensing process was carried out by the Alaska Power Authority, predecessor of AEA, in the 1980s for a much more extensive project, involving a two-dam complex. An application for license for what was then referred to as the Susitna Project was submitted to the Federal Power Commission (FPC) (predecessor of FERC) in 1983 under FPC number P-7114, and the application was subsequently amended under that same number in 1985. That application was withdrawn in March 1986.

After re-commencing the Project in 2009, as noted above, on December 29, 2011, AEA filed with FERC a Notification of Intent (NOI) and PAD to start the formal licensing process for the proposed Susitna-Watana Project, FERC No. 14241. The default FERC licensing process that is being used is the Integrated Licensing Process (ILP). The PAD provides licensing participants summaries of existing relevant, and reasonably available information related to the project and identified issues and preliminary study concepts AEA believes are important to address the identified issues. This document can be found on AEA's public website at: http://www.susitna-watanahydro.org/type/documents.

On February 24, 2012, FERC issued a public notice acknowledging the filing of AEA's NOI and PAD, officially commencing the licensing process, and soliciting public comment on the PAD and study requests from licensing participants. In addition, FERC issued a Scoping Document to outline the subject areas to be addressed in its environmental analysis of the project pursuant to the National Environmental Policy Act. FERC held six Scoping Meetings for the project in

March 2012 in major communities around the project site area. These were focused on obtaining comments and input on resource issues related to project operations from resource agencies, Alaska Natives, local governments, non-governmental organizations, and members of the public. The purpose of the meetings was for FERC to initiate scoping of the issues, review and discuss existing project information, identify information and study needs, and discuss the process plan and schedule for licensing activities required under the Integrated Licensing Process (ILP) requirements (18 Code of Federal Regulations §5.11). As discussed below, initial environmental review was carried out during 2012 to catalogue the relevant 1980s data that were collected and inform the future study planning process.

In parallel with the above activities, a number of Environmental Consulting firms were retained by AEA and detailed study plans were prepared covering the 2013-2015 timeframe. An initial Study Plan was prepared containing detailed scopes for 58 specific resource study areas, most of which have been carried out under various environmental services contracts.

Under the licensing protocol, FERC specifically requested three engineering studies – that would, in any case, have been performed as part of the engineering feasibility work – be covered in the Revised Study Plan (RSP) as follows (FERC numbering):

4.5 Geology and Soils Characterization

16.5 PMF Study

16.6 Site-Specific Seismic Hazard Analysis (SSSHA)

AEA filed the Proposed Study Plan for the 58 studies (including the three engineering oriented studies) with FERC on July 16, 2012. After extensive review and collaboration with licensing participants and FERC staff, AEA prepared a RSP and filed updates to the 58 study plans on December 14, 2012. The RSP provides a complete overview of the remainder of the licensing process and timeline and an update to the project description. FERC approved the study plans on February 1 and April 1, 2013. The first year of studies was carried out in 2013 and initial results reported in a draft Initial Study Report (ISR) filed on February 3, 2014. A complete Initial Study Report with plans for the second study season was filed June 3, 2014. All studies are anticipated to be complete by end of 2015 and an Updated Study Report (USR) will be filed with FERC in February 2016. Final results will be presented in the USR and the ensuing documentation included in AEA's License Application that is currently planned to be filed with FERC in late 2016. Interim updates for all studies being conducted by AEA have been provided through periodic Technical Workgroup meetings – which will continue until submittal of the License Application. The intent of the meetings is to update interested parties with information on study progress, initial results, and changes to anticipated conditions or study methodologies.

Engineering subjects under study, and documented in this report, will contribute to the following sections of the License Application:

| | |
|---|---|
| Exhibit A | Project Description |
| Exhibit B | Project Operation and Resource Utilization |
| Exhibit C | Proposed Construction Schedule |
| Exhibit D | Project Costs and Financing |
| Exhibit E, Chapter 6 | Geological and Soil Resources |
| Exhibit F | Supporting Design Report and Project Drawings |
| Exhibit G | Project Maps |

## 1.5. Status of Environmental Study Program

A thorough discussion of the environmental study program and schedule is included in the Revised Study Plan and Final Study Plans posted on AEA's Website (http://www.susitna-watanahydro.org). This work has been conducted by other consultants under separate contracts to AEA, and was not part of MWH's services. The work is summarized below for reference purposes only.

AEA completed 18 initial environmental studies during 2012. These initial studies helped inform the study planning process for the remaining work and provided updated information that supplements existing information gathered during the previous studies in the 1980s. Much of the information that was gathered in 2012 was used to help AEA and its consultants plan logistical aspects necessary to carry out complex field investigations, as well as provide vital input to the early concept design efforts for the project features and operational modeling studies. In some cases, updating information consisted of taking information developed in the 1980s and converting it into modern digital datasets for use in comparative analysis with the new information being obtained in the FERC formal licensing studies.

Key target milestone dates for the formal ILP study program are listed below:

- Study Season No. 1 – calendar year 2013
- Initial Study Report (ISR) (results of 2013 Study Season) draft, February 3, 2014 and final June 3, 2014
- Initial Study Report Meeting, October 15, 2014

- Initial Study Report Meeting Summary (and any AEA proposed changes to Study Plans) due October 31, 2014
- Study Season No. 2 – Currently planned for calendar year 2015
- Updated Study Report (USR) to be submitted to FERC by February 1, 2016
- Updated Study Report Meeting, February 16, 2016
- Updated Study Report Meeting Summary, March 2, 2016
- Preliminary Licensing Proposal, July 5, 2016
- Final License Application filed with FERC, December 1, 2016

A complete discussion of the ongoing environmental study program can be found on AEA's public licensing web site as noted above. The 58 studies are categorized below:

**Geology and Soils studies** to conduct a study to define the geologic, geotechnical, seismic, and foundation conditions at the sites of project works.

- Geology and Soils Characterization Study (by MWH)

**Water Resources studies** to characterize and evaluate any potential effects to the water quality of the Susitna River.

- Baseline Water Quality Study
- Water Quality Modeling Study
- Mercury Assessment and Potential for Bioaccumulation Study
- Geomorphology Study
- Fluvial Geomorphology Modeling below Watana Dam Study
- Groundwater-related Aquatic Habitat Study
- Ice Processes in the Susitna River Dam Study
- Glacial and Runoff Changes Study

**Fish Aquatics and Riparian studies** to assess hydrology characteristics and its relations with fish and aquatic biota and their habitats.

- Fish and Aquatics Instream Flow Study
- Riparian Instream Flow Study

**Fish and Aquatic Resources studies** to better understand the Susitna River fish populations.

- Fish Distribution and Abundance in the Upper Susitna
- Fish Distribution and Abundance in the Middle and Lower Susitna River
- Salmon Escapement Study
- River Productivity Study
- Characterization of Aquatic Habitats in the Susitna River with Potential to be Affected by the Susitna-Watana Project
- The Future Watana Reservoir Fish Community and Risk of Entrainment Study
- Study of Fish Passage at Watana Dam
- Study of Fish Passage Barriers in the Middle and Upper Susitna River and Susitna Tributaries
- Aquatic Resources Study within the Access Alignment, Transmission Alignment, and Construction Area
- Genetic Baseline Study for Selected Fish Species
- Analysis of Fish Harvest in and Downstream of the Susitna-Watana Hydroelectric Project Area
- Eulachon Distribution and Abundance in the Susitna River
- Cook Inlet Beluga Whale Study

**Wildlife Resources studies** of distribution, movements, population size, productivity, and habitat of wildlife in the Susitna River and surrounding area.

- Study of Distribution, Abundance, Productivity and Survival of Moose
- Study of Distribution, Abundance, Movements, and Productivity of Caribou
- Study of Distribution, Abundance, and Habitat Use of Dall’s Sheep
- Study of Distribution, Abundance, and Habitat Use by Large Carnivores
- Study of Distribution and Abundance of Wolverines
- Study of Terrestrial Furbearer Abundance and Habitat Use
- Study of Aquatic Furbearer Abundance and Habitat Use
- Study of Species Composition and Habitat Use of Small Mammals

- Study of Distribution and Habitat Use of Little Brown Bat
- Survey Study of Eagles and Other Raptors
- Waterbird Migration, Breeding and Habitat Study
- Breeding Survey Study of Landbirds and Shorebirds
- Study of Population Ecology of Willow Ptarmigan in Game Management Unit 13, South-central Alaska
- Study of Distribution and Habitat Use of Wood Frogs
- Evaluation of Wildlife Habitat Use Study
- Wildlife Harvest Analysis Study

**Botanical Resources studies** to collect necessary baseline data to evaluate the potential impacts to vegetation, wildlife habitat, wetland, and vascular-plant resources in the project area.

- Vegetation and Wildlife Habitat Mapping Study
- Riparian Study
- Wetland Mapping Study
- Rare Plant Study
- Invasive Plant Study

**Recreation and Aesthetic Resources studies** to document baseline conditions and help assess potential impacts on recreation and aesthetic resources from construction and operation of the proposed Susitna-Watana Project.

- Recreation Resources Study
- Aesthetics Resources Study
- Recreation Boating/River Access Study

**Cultural and Paleontological Resources studies** that will be used to assist in identifying appropriate protection, mitigation, and enhancement measures of cultural resources.

- Cultural Resources Study
- Paleontological Resources Study

**Subsistence Resources studies** to document traditional and contemporary subsistence harvest and use and to collect baseline data to facilitate the assessment of potential impacts.

- Subsistence Baseline Documentation Study

**Socioeconomic and Transportation Resource studies** that will evaluate regional economic effects as well as effects on social conditions and public goods and services.

- Regional Economic Evaluation Study
- Social Conditions and Public Goods and Services Study
- Transportation Resources Study
- Health Impact Assessment Study
- Air Quality Study

**Project Safety studies** to assess the stability of project facilities during flood loading conditions, to estimate earthquake ground motion parameters, and verify the lack of potential hazard of fault or shear zone movements.

- Probable Maximum Flood Study (by MWH)
- Site Specific Seismic Hazard Study (by MWH)

## 1.6. Project Description

### 1.6.1. General

This brief overview of the project location, facilities, and proposed operational characteristics reflects the project development at the time of writing of this report.

*Locations along the Susitna River referenced in this report are designated by two sets of river miles. River Miles (RM) refer to the distance along the river channel measured upstream from its mouth in Cook Inlet and reported in various studies originating in the 1980s. Project River Miles (PRM) refer to the recalibrated distance (for these current studies) along the channel measured upstream from its mouth. There is no single conversion between the older RM and the recent PRM; however, the maximum difference is about three miles. Precise conversion between RM and PRM at a particular location can be determined using GIS.*

The proposed Project is located in the South-central region of Alaska, approximately 125 miles north-northeast of Anchorage and 140 miles south-southwest of Fairbanks. As proposed, the Project would include construction of a dam, reservoir, and power plant on the Susitna River starting at 187 PRM, approximately 32 PRM upstream of Devils Canyon, as shown on

Figure 1.6-1. Transmission lines connecting into the existing Railbelt transmission system and an access road and railhead improvements would also be constructed. Because engineering and environmental studies are helping define the locations and configurations of the project components, the current study area for the Project is larger than that which will be proposed as the FERC Project Boundary for the licensed project works. The study area includes alternative transmission and road corridors that may eventually be narrowed down to one or two proposed corridors for the license application.

**Figure 1.6-1. Proposed Watana Dam Site, Looking Upstream**

### 1.6.2. Watana Dam and Reservoir

As currently envisioned, the Project would include a significant dam with a 23,500-acre reservoir (at normal maximum operating level). The Watana Dam arrangement is shown on Figure 1.6-2 and on Drawings 04-01C002 and 04-01C004 in Appendix A. The Watana Dam has a nominal crest elevation (El.) 2065 ft. corresponding with a maximum height of approximately 705 ft. above the prepared rock foundation and a crest length of approximately 2,810 ft. The maximum height of the structure will depend both on the results of the ongoing site investigations (which will indicate the extent of rock excavation required below the river bed) and any requirements for downstream flow release negotiated with agencies as part of the licensing process.

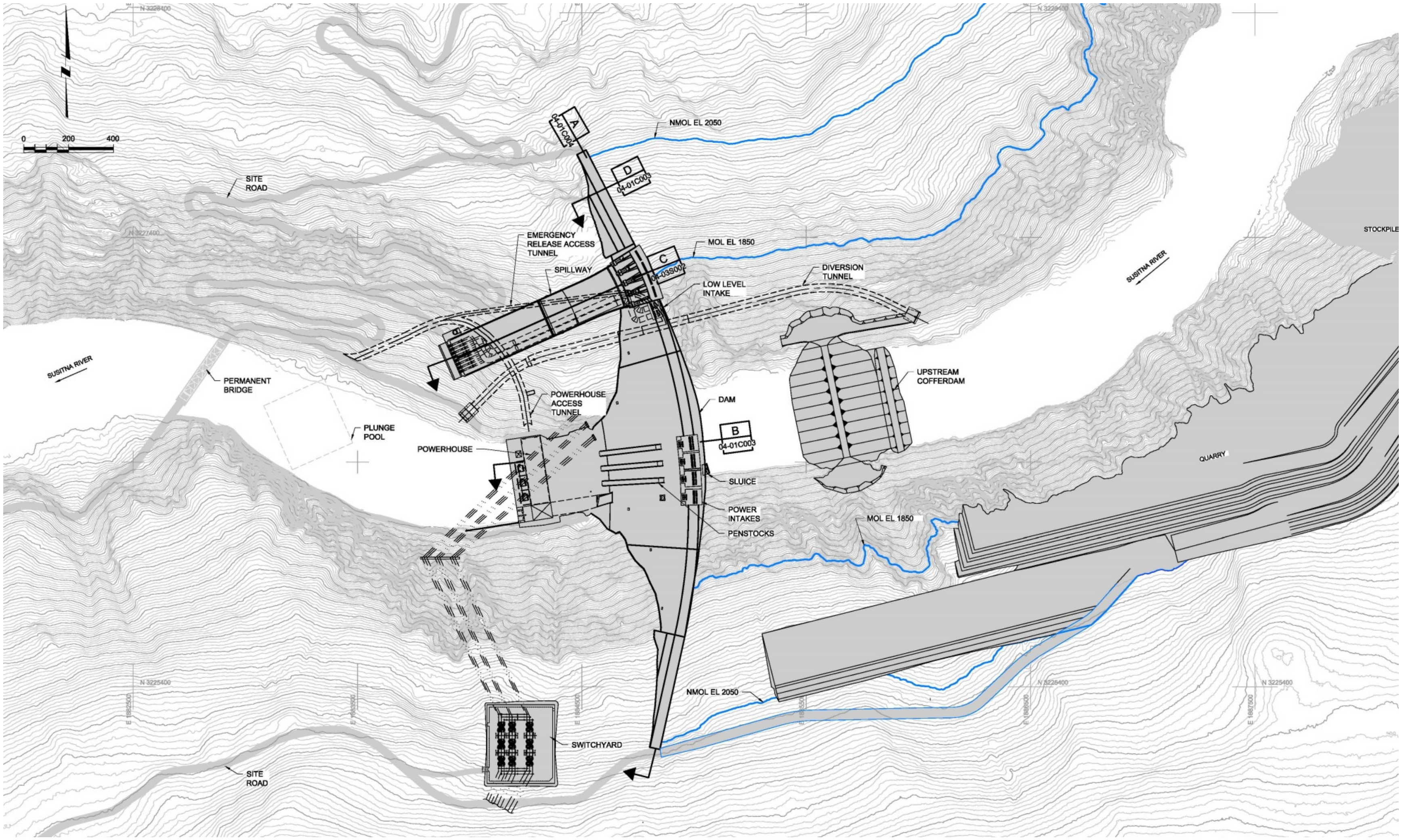


**Figure 1.6-2. Dam Arrangement**

The Watana Reservoir normal maximum operating level has been reassessed since that initially proposed in the PAD, and is now proposed as El. 2050 ft. The impounded reservoir will be approximately 42 miles long (along reservoir centerline) with a maximum width of approximately three miles (at Watana Creek; the typical width of the reservoir is approximately 1.25 miles). The minimum reservoir level will be 1,850 ft. in the extreme year, resulting in a maximum drawdown of 200 ft. In normal years, the reservoir would be drawn down only about 120 to 150 ft. The reservoir will have a total storage capacity of approximately 5.2 million acre-ft., of which approximately 3.4 million acre-ft. will be active storage.

Certain provisions have been incorporated in the proposed project configuration to facilitate any future decision to raise the dam. Among them are positioning the powerhouse sufficiently downstream, with extra RCC between the dam and the powerhouse. The total cost of these provisions for dam raising is US$ 27.2 million.

The Watana Dam will incorporate the following facilities for making reservoir releases before using the spillway:

- Penstocks which direct water through the turbines in the powerhouse; and,
- Low level outlet facilities discharging below the spillway.

In addition, there will be emergency release facilities installed within the diversion tunnels capable of operation only with a water level at or below the minimum power pool level of El. 1850 ft.

The low level outlet facilities enable the discharge of up to 32,000 cubic ft. per second (cfs) (which together with the maximum powerhouse flow represents the reservoir attenuated outflow of up to a 50-year flood or a flushing flow) without opening the spillway gates. Reservoir storage between El. 2050 ft. and El. 2057.6 ft. has been allocated for attenuation of up to a 50-year flood so that opening of the spillway gates would be a rare event. The facilities will be located at an elevation that they may be used even when the reservoir level is at its minimum operating level.

Construction materials for the Watana Dam and appurtenant structures will utilize, as far as possible, rock from the structure excavations to minimize the quarry development. Stable excavations and rock cuts will be designed with suitable rock reinforcement and berms.

It is proposed that the bulk of the aggregate for construction be excavated from a quarry to be located on the left abutment upstream of the Watana Dam. A criterion for the quarry planning will be to ensure, as far as possible, that the final flat floor of the quarry is below the projected minimum operating water level of the reservoir to minimize visual impact. In a similar manner, the area upstream of the quarry is being investigated to try to define a spoil area upstream of the Watana Dam that will be permanently submerged.

Clearing of shrubs and trees is not contemplated through the whole reservoir area. It is proposed that clearing of all substantive vegetation only be initiated for a distance of some two to three miles upstream of the Watana Dam, although consideration will be given during final design to clearing of trees in the area between the top and bottom water level throughout the length of the reservoir.

AEA may research and review the potential use of biomass (from the reservoir clearing) as an energy source.

The quarry will incorporate sloping roads to facilitate access from bench to bench, and during operation, it is expected that any floating debris will be captured by boat and brought to the ramps in the flooded quarry for removal and disposal. The intakes themselves will incorporate trash racks and rakes for removal of any debris not collected by boat operations.

Thick alluvial deposits will be removed from the river bed at the Watana Dam site, and there will be excavation of weathered or loose rock to found the Watana Dam and appurtenant structures on sound bedrock.

### 1.6.3. Powerhouse

The powerhouse will be located immediately downstream of the Watana Dam, and will house three generating units, each with a turbine rated capability of 153 MW unit output at reservoir water level of El. 1950 ft. for a total plant rated installed turbine capacity at maximum head of 618 MW. An overall plan, elevation view, and profile of the powerhouse complex are shown on Drawings 04-01C002, 05-08S001, 05-08S007, 05-08S008, and 05-08S009. Studies have addressed Railbelt electrical system stability, and the arrangement chosen has been determined to be satisfactory.

The average annual generation capability of the Project is currently estimated to be approximately 2,800 gigawatt hours (GWh) at the generator bus. The powerhouse will be designed and constructed with an extra empty generating unit bay for the potential installation of a fourth unit at a future time. There will be two low level outlet works facility structures and four power intake structures (one corresponding to the extra unused powerhouse bay).

Certain measures have been included in the proposed power facilities that will allow expansion by the addition of a fourth unit. Such measures include the fourth intake structure, a penstock stub, and concrete works below deck level. The total cost of these provisions for powerhouse expansion is US$ 41.5 million.

### 1.6.4. Ancillary Facilities

Construction of the Susitna-Watana site development will require various facilities to support activities throughout the entire construction period. Following construction, the operation of the Project will require a small permanent staff and facilities to support the permanent operation and maintenance (O&M) program. A plan view of the site infrastructure is shown on Drawing 01-00G001 in Appendix A.

The most significant item among the temporary site facilities will be a construction camp. The construction camp will be a largely self-sufficient community normally housing approximately 800 persons, but with a peak capacity of up to 1,200 people. After construction, AEA plans to remove most of the infrastructure of the camp facility, leaving only those aspects that are to be used to support the smaller permanent residential and O&M facilities.

Other site facilities include contractor work areas, site power, services, and communications. Site power and fiber optic cabling for construction will be brought either on the transmission line route, or along the side of the access road. Items such as power and communications will also be required for construction operations, independent of camp operations.

Permanent facilities will include community facilities for O&M staff members and any families. Other permanent facilities will include maintenance buildings for use during operation of the power plant.

Both the gravel airstrip and helicopter/airplane hard standing that will be constructed to facilitate construction will be left in place after construction is completed.

### 1.6.5. Transportation Access

There will be both temporary, and permanent, site access facilities to provide a transportation system to support construction activities – and to facilitate orderly development and ongoing operation and maintenance of the Project. The current planning assumes restricted public access during construction for safety considerations. Another goal is to co-locate access roads and transmission facilities, to the extent possible, in the same corridor to minimize environmental impacts.

Three possible alternatives for access roads and transmission lines have been identified for the Project (Drawing 01-00G000) and this report makes no recommendation of a favored route. Two of the alternatives would accommodate east-west transmission lines in combination with a new site access road connecting to the Alaska Intertie Transmission Line (Alaska Intertie) and a transloading facility at the Alaska Railroad. One of these corridors, designated as the Chulitna Corridor, would run north of the Susitna River, and extend to the Chulitna siding area. The other alternative, designated as the Gold Creek Corridor, would run south of the Susitna River, and extend to the Gold Creek area. Neither of these two access roads would connect to public roads, instead terminating at the railway tracks.

A third corridor, designated as the Denali Corridor, would run due north, connecting the project site to the Denali Highway by road over a distance of about 43.5 miles. If a transmission line is constructed along this corridor, it would be extended westward along the existing Denali Highway and connect to the Alaska Intertie near Cantwell.

If the Denali Corridor is selected, the affected sections of the Denali Highway will be upgraded to facilitate safe construction of the project. The Denali Highway upgrades would not be within the FERC project boundary, although costs are included.

Regardless of which road is chosen, the majority of the new road will follow terrain and soil types that allow construction using side borrow techniques, resulting in minimum disturbance to areas away from the alignment. At the chosen location for connection, a railhead and storage facility occupying up to 40 acres will be constructed alongside the existing railroad. New sidings will be constructed so that off-loading and transfer of goods and materials can take place without interrupting the daily operations of the Alaska Railroad Corporation (ARRC). This facility will act as the transfer point from rail to road transport, as a backup or interim storage area for materials and equipment, and as an inspection and maintenance facility for trucks and their loads. Within the 40 acres would be a small residential camp for early use before the main camp at the site is complete. It is intended that elements of this camp will be moved to the main site camp, leaving only sufficient facilities for drivers trucking equipment to the construction site, for laborers and staff operating the transfer, for emergency use, and for support staff such as cooks and maintenance workers.

If the Denali Corridor is chosen for road access, the pavement on the first section of the Denali Highway in the community of Cantwell will be extended for a distance of approximately 4 miles to eliminate any problem with dust and debris from construction vehicles. In addition, the following measures will be taken:

- Speed restrictions will be imposed along appropriate segments.
- Improvements will be made to the intersections including pavement markings and traffic signals.

Some consideration has been given to the use of expected airship development, particularly as a means of commencing early site construction while the permanent access is developed. The date of commencement of commercial and economic use of heavy lift airships is not yet clear, so it has been discounted at the time of writing. During further project design and construction contract development, it will be reconsidered if commercial certification and application appears more certain.

### 1.6.6. Electric Transmission and Interconnection Facilities

Transmission lines to deliver full Susitna-Watana power to the existing grid will begin at Watana Powerhouse Switchyard and consist of three 230-kilovolt (kV) lines, in either single- or double-circuit configuration. The same three corridors under consideration for the access road are also those under consideration to connect the project primary transmission lines to the Alaska Intertie (see Drawing 01-00G000) and this report makes no recommendation for a route. One or two transmission corridors may be chosen to allow the lines to be separated somewhat, in case of line interruption. Depending on which corridor is (or corridors are) chosen, the transmission system will include a switching station at the point of tie-in (at Chulitna, Gold Creek, or Cantwell). From the Watana substation, the transmission corridors are essentially co-located with the access road corridors except for three specific areas:

1. For the northern westward route (Chulitna Corridor), the first five miles (westward from the power facilities) of the double circuit 230-kV transmission lines will not follow the coincident road corridor. The two lines will cross the river from the switchyard (together with any line destined for the northern route) in a northerly direction for two miles, after which the two lines will turn northwesterly to cross Tsusena Creek and three miles later will intersect the Chulitna road corridor. The westerly end of the corridor will be wider to facilitate the divergence of the road and the transmission line, which will continue to a switching station on the Alaska Intertie.
2. For the southern westward route (Gold Creek Corridor), the transmission lines would occasionally not follow the planned road corridor, because the transmission lines can span some of the rough topography that the road must avoid. Near the westerly end of the corridor, both the transmission lines and road can be co-located into one single corridor. Some five miles northeast of Gold Creek will be a switching station on the existing Alaska Intertie, beyond which, to the west, the road will be the sole occupant of the corridor.
3. For the northern route (Denali Corridor), there are two options for transmission line routes. The transmission will generally follow the road corridors with the transmission

corridor following the Denali Highway. The transmission corridor will then continue west along the Denali Highway to the Cantwell interconnection with the Alaska intertie.

The right-of-way for the transmission lines within the corridors will consist of a linear strip of land; the width will depend on the number of lines. The transmission rights-of-way will be 200, 300, or 400 ft., depending on whether one, two, or three lines run in parallel.

The switching and substations will each occupy a total of approximately 16 acres.

Rights-of-way for permanent access to switchyard and substations will be required, connecting to the permanent site access road. These rights-of-way will be 100 ft. wide.

Access to the transmission line corridors will be:

- via unpaved vehicle access track from the permanent access roads at intermittent points along the corridor (the exact location of these tracks will be established in the final design phase); or
- by helicopter, where there is no access road projected.

Within the transmission corridor itself, an unpaved vehicle access track up to 25-ft.-wide will run along the entire length of the corridor, except at areas such as major river crossings and deep ravines where an access track would not be utilized for the movement of equipment and materials.

### 1.6.7. Project Operations

Project operating flexibility is understood to be important to Railbelt utilities that will utilize the project's capacity and energy output. The "production modeling" simulation encompassed the entire Alaska Railbelt interconnected system to maximize the benefit of the Susitna-Watana generation. The simulation resulted in a decision by AEA to select an operating regime such that the power plant has flexibility to operate in a load-following mode when and if needed, such that energy is maximized during the critical winter months of November through April each year to meet Railbelt utility load requirements.

Reservoir storage capability is vital to the project's intended function – to provide critical winter generation capacity – by regulating the flows of the Susitna River, and to serve as a major long-term power generating resource for the region. The requirement for substantial storage clearly identified in all the previous studies of the Susitna River, documented in Section 3, provides for capture and storage of spring snowmelt for later release through the powerhouse during the winter months. This capability also serves to ensure that seasonal flow releases needed to both protect environmental habitat and enhance river recreational opportunities downstream of the project can be provided. In contrast, a run-of-river hydro project on the Susitna (or any river) without storage cannot provide these important system, environmental and/or recreational benefits.

Production cost modeling has encompassed the whole Railbelt system and has highlighted the benefits that will accrue to the whole system if a centralized dispatch method of operation is selected.

To facilitate efficient dispatch, the reservoir would be drafted annually by an average of about 120 ft. to 150 ft., and subject to an occasional maximum drawdown of 200 ft. Minimum in-stream flow releases would be made through the powerhouse – or through low level outlet works during the rare occasions when the power plant is offline. Flow discharges through the powerhouse under the operating plan would range from the minimum required in-stream flow release (yet to be determined) to a maximum of about 14,000 cfs (based on the 618 MW turbine capacity at normal maximum operating level), with all generating units operating) during times of maximum power generation. Daily power generation during a winter month of peak demand (January) would average about 8,300 MWh and powerhouse discharges would average approximately 8,390 cfs during that time.

For efficient operation of the whole system, powerhouse discharges are expected to vary over a 24-hour period during the winter months of peak demand, typically ranging from a low of about 5,400 cfs to a high of 10,800 cfs. The daily flow variation may be constrained because of environmental concerns yet to be defined. It is expected that any flow variations immediately downstream of the powerhouse will be partially attenuated by the time the variation in flow reaches Gold Creek, Talkeetna, and the other downstream locations.

A final operating plan will be prepared and submitted by AEA in Exhibit B of the FERC License Application.

### 1.6.8. Construction Schedule

The current schedule allows 7.5 years for dam and power facilities construction. Additional time has been allotted for final design phase site investigations and access road construction.

The following are the approximate time periods for major components of project construction:

- Site investigation and design engineering — 3 years
- Access road construction — 2 years
- Dam and power facilities construction — 7.5 years

- Reservoir filling — 1 to 2 years (in parallel with final construction activities)
- Site restoration — throughout construction

Design work would be initiated as necessary for project completion, and could be initiated during the license application review period so that construction critical to the schedule (such as access roads and construction support facilities) will be ready to commence shortly after issuance of the FERC license and obtaining other required subsequent regulatory approvals.

## 1.7. Visualization

During the performance of the feasibility study, many 3-D models have been constructed using various software. In late 2013, all models were combined into a visualization that is enclosed on a flash drive with this report. Although there have been some changes since the visualization was completed (for example, number of spillway gates, length of airstrip), it represents a reasonable depiction of the project works as proposed.

## 1.8. Principal Project Parameters

After all the various optimizations and analysis, the principal project parameters of the feasibility design – which forms the basis of the cost estimate – are shown in Table 1.8-1.

**Table 1.8-1. Principal Project Parameters**

| **Dam** | |
|---|---|
| Dam Type | Curved Gravity |
| Construction Material | Roller Compacted Concrete |
| Axis Radius (along upstream edge of crest) | 2,600 ft.(with straight flanks) |
| Crest Road Elevation | El. 2065 ft. |
| Crest Length | 2,810 ft. |
| Lowest Foundation Elevation | El. 1360 ft. |
| Height Above Foundation (approx.) | 705 ft. |
| Crest Width | 45 ft. |
| Downstream Face Slope | |
| Curved Section (H:V) | 1,650 ft. (constant radius) |
| Straight Section | 0.85:1 |
| Upstream Face Slope | |
| Below El. 1770 ft. (H:V) | 0.1:1 |
| Above El. 1770 ft. | Vertical |

| | |
|---|---|
| Top of Parapet Wall Elevation | El. 2068 ft. |
| Volume of Dam Concrete (not including powerhouse) (gross – including spillway and intakes) | 5,671,000 cy |
| Volume of Roller Compacted Concrete | 5,215,000 cy |
| Volume of Conventional Vibrated Concrete (dam) | 20,000 cy |
| Volume of CVC Intakes and Spillway | 436,000 cy |

**Seismic Parameters – Peak Ground Acceleration (PGA)**

| | |
|---|---|
| **MCE** | |
| *Deterministic* | |
| Interface (88$^{th}$ percentile) PGA *(scaled to 5000 yr. @ 0.55 sec)* | 0.58 g |
| Intraslab (84$^{th}$ percentile) PGA | 0.81 g |
| Intraslab (69$^{th}$ percentile) PGA | 0.69 g |
| Fog Lake Graben (84$^{th}$ percentile) PGA | 0.49 g |
| **OBE** | |
| 500 yr. return period | 0.27 g |

**Reservoir**

| | |
|---|---|
| Normal Maximum Operating Level (NMOL) | El. 2050 ft. |
| Maximum Level (@ PMF) | El. 2064.5 ft. |
| Minimum Operating Level (MOL) | El. 1850 ft. |
| Area at NMOL | 23,500 acres |
| Length at NMOL | 42 miles (approx.) |
| Total Reservoir Storage | 5,170,000 acre-ft. |
| Live (Active) Storage | 3,380,000 acre-ft. |
| Average Tail Water Elevation | El. 1456 ft. |

**Diversion**

| | |
|---|---|
| Diversion Tunnel | |
| Length | 2,060 ft. |
| Number | One, modified horseshoe |
| Width/diameter | 36 ft. internal |
| Lining | Concrete |

| | |
|---|---|
| Div. Tunnel Capacity | 52,000 cfs @ El. 1530 ft. wl |
| Sluice Structure capacity | 82,000 cfs @ El. 1553 ft. wl |
| Sluice dimensions | 44 ft. high x 50 ft. and 525 length |
| Cofferdams | |
| Type | Rockfill with earth core |
| Upstream Crest Elevation | 1,560 ft. |
| Downstream Crest Elevation | 1,479 ft. |
| Maximum upstream Water Level (wl) | 1,553 ft. |

**Emergency Outlet Facilities**

| | |
|---|---|
| Location | In diversion tunnel |
| Type | Gated sluices |
| Capacity | 30,000 cfs @ El. 1850 ft. wl |

**Low Level Outlet Facilities**

| | |
|---|---|
| Intake Structure (Two) | Single-level, gated |
| Control Gates | |
| Number | 2 |
| Dimensions | 23 ft. H x 23 ft. W |
| Water Passage Diameter | 2–23 ft. diameter |
| Outlet Control Structures | 8–Fixed Cone Valves |
| Diameter | 79 inches |
| Capacity | 4,000 cfs each @ El. 2057.5 ft. (Total 32,000 cfs) |

**Spillway (preliminary)**

| | |
|---|---|
| Capacity at 50-yr. flood surcharge (El. 2057.5 ft.) | 205,000 cfs |
| Capacity at PMF surcharge (El. 2064.5 ft.) Control Structure | 250,000 cfs |
| Type | Gated Ogee |
| Crest Elevation | 2010 ft. |
| Gates | |
| Type | Radial |
| Number | 4 |

| | |
|---|---|
| Dimensions | 50.5 ft. H x 42 ft. W |
| Top of Gate Level | El. 2058.5 ft. |
| Chute width | 82 ft. (Total 164 ft.) |
| Energy Dissipation | Flip bucket |

**Power Intakes**

| | |
|---|---|
| Intake structures | 4, Multi-level, gated |
| Number of Levels | 5 |
| Number of shutters per level | 8 |
| Dimensions of Shutters | 25 ft. H x 22 ft. W |
| Control Gates | |
| Number | 8 |
| Dimensions | 19 ft. H x 10 ft. W |
| Invert Elevation | El. 1800 ft. |

**Penstocks**

| | |
|---|---|
| Number | 3 |

The horizontal section of the fourth penstock will be installed and capped, so that it is available for future addition of a unit.

| | |
|---|---|
| Type | Inclined, horizontal |
| Diameter | 19.0 ft. I.D. |
| Material | Steel |

**Powerhouse**

| | |
|---|---|
| Type | Surface |
| Size | 300 ft. L x 88 ft. W x 100 ft. H |
| Turbine (No. and Type) | 3 Vertical Francis |
| Speed | 180 rpm |
| Max. Turbine Capacity at Max. Operating Level | 206.2 MW (Gen. 202.1 MW) |
| Net Head (est.) | 577 ft. |
| Flow @ Operating Head (est.) | 4,618 cfs |

| | |
|---|---|
| Rated Turbine Capacity @ Res. Level 1950 ft. | 153 MW (Gen. 148.5 MW) |
| Net Heat (est.) | 480 ft. |
| Flow @ Capacity at Operating Head (est.) | 4,083 cfs |
| Min. Turbine Capacity @ Min Operating Level | 105.9 MW (Gen. 100.9 MW) |
| Net Head (est.) | 383 ft. |
| Flow @ Min. Head (est.) | 3,592 cfs |
| Generator | Vertical Synchronous |
| Continuous Rated Capacity | 225 megavolt-Ampere |
| Power Factor | 0.9 |
| Voltage | 13.8 kV |
| Frequency | 60 Hz |
| Speed | 180 rpm |
| Transformers | |
| Location | Draft Tube Deck |
| Number | 3 + 1 spare |
| Voltage | 230 kV |

**Project Output**

| | |
|---|---|
| Nominal Turbine Capacity (maximum head) | 618 MW |
| Nominal Generator output (maximum head) | 606 MW |
| Average Annual Generation (rounded) | 2,800 GWh |

**Switchyard**

| | |
|---|---|
| Location | Left abutment |
| Plan Dimensions | 350 ft. by 300 ft. |

**Transmission (Depends on chosen route)**

| | |
|---|---|
| Length | 141 circuit miles |
| Voltage | 230 kV |

**Access Road (Depends on chosen route)**

| | |
|---|---|
| Length | Up to 50 miles |
| Number of Bridges | Up to 7 |

| **Permanent Facilities** | |
|---|---|
| Airstrip Length | 5,500 ft. |
| Housing Accommodation Capacity | 30 families |

## 1.9. Board of Consultants Review

AEA has convened a Board of Consultants for the purposes of review of the feasibility studies as they relate to dam safety. The key elements and decisions recorded in this report – relating to the type of dam, the PMP and PMF studies, the Site Specific Seismic Hazard Analysis, the Finite Element studies of the dam structure, and the projected site investigations required to verify the designs adopted – have been subject to review by the Board of Consultants.

FERC approved the board members by letter dated October 23, 2012. This Board of Consultants has been, and will continue to be, supplemented from time to time by particular specialists for specific parts of the analysis and design. Initially, for example, the Board has been expanded by the addition of a meteorologist and hydrologist to review the site-specific PMP studies being performed as part of RSP Section 16.5 as noted above, and by a seismologist for opinions on the seismic hazard assessment being performed as part of RSP Section 16.6. Meetings of the Board have been held on four separate occasions during the preparation of this Feasibility Report. An initial meeting of some (but not all) of the board members was held in November 2012 to consider the study plans for the PMP determination and for the seismic hazard assessment. Subsequent board meetings were held on the following dates:

- March 7–8, 2013 in Bellevue, Washington
- May 28–30, 2013 in Anchorage, Alaska (including a site visit)
- April 4–6, 2014 in Bellevue, Washington

The Board has reviewed the text of applicable sections of this report and where appropriate their comments have been addressed.