8. SITE ACCESS PLAN

This report does not favor any access route to the project site. Initial analysis of a number of potential access routes was carried out by Alaska Department of Transportation and Public Facilities (ADOT&PF) – the results of which are summarized in Sections 8.2 through 8.5. Sections 8.6 and 8.7 record further detailed analysis by MWH of three of the routes selected by ADOT&PF using aerial imagery and topographic surveys.

8.1. Background

Although it is expected that most personnel, fresh food, and emergency equipment and supplies would be transported to the construction site by air as discussed in Section 8.9 below, most bulk materials (e.g., cement, fuel, reinforcing steel) and manufactured materials (e.g., transformers, power parts) for dam construction would be transported to the site by a road access from a railhead. Much of the required material is assumed to arrive at one of the ports of south-central Alaska. For the purposes of estimating the cost of the project, it has been assumed that all materials will arrive at Whittier.

Although the port of Whittier is assumed in this study, currently under development is the Port Mackenzie Rail Extension which is a 32-mile rail line north from the port facility in Matanuska Susitna Borough connecting to the existing Alaska Railroad Corporation (ARRC) rail system near Houston. Although Port MacKenzie is the closest port to the Susitna-Watana Project, it is not clear that it would be the port of choice for the project. It is expected that materials would be transported either directly by rail to the offloading site at the railhead, or by road to an interim staging post and thence on the railway to the offloading site. As discussed below, this offloading site would require about 5,000 ft. of new railroad siding along existing rail lines. Also necessary would be a marshaling/laydown yard for the stockpile and storage of materials being transferred from rail to truck.

The initial analysis of the potential road access corridors was performed by Alaska Department of Transportation and Public Facilities (ADOT&PF) with technical work contracted out to the engineering firm, HDR. The feasibility of using the ARRC, and the preliminary design of a railhead facility was performed by Hanson Alaska LLC under subcontract to MWH. This section describes the work performed and the conclusions reached at the end of the two studies, together with the assessment of a potential airstrip location at the project site.

The initial studies of road access routes were performed in the 1980s, but a fundamental difference in those studies was the requirement to service the Devils Canyon site.

For the current analysis, although using some of the 1980s analysis, the road routes were first examined using topography at 100 ft. contours, and a ranking was derived. An examination was also made, at this preliminary level, of a railroad link paralleling the 1980s studies.

Following the initial analysis, the routes were examined in greater detail; after 20 ft. topographical maps became available, to derive more accurate road alignments, panel maps, etc.

8.2. Objectives

The objectives of the studies carried out in 2012 were to:

- Confirm the primary ground transportation mode (road or rail) to be used during construction and for the operational life of the project;
- Identify, review and evaluate potential access corridors; and,
- Confirm the reasonableness of the originally proposed airstrip locations.

The requirement for separation of the public from the construction traffic and concern about extending the project boundaries led to a focus on terminating some of the road routes at a railhead, rather than planning to continue them to form an “all road” route.

8.3. Approach

As previously mentioned, initial road and rail access analyses were conducted by others. MWH subsequently developed a methodical approach to the selection of an overall site access plan by utilizing information from their reports. The preliminary design criteria were confirmed and amended where necessary. The preliminary road alignments were then refined based on more detailed topographic maps. Finally, the cost was reevaluated based on these changes. Additionally, MWH paid close attention to aspects not addressed in the ADOT&PF Report and there may need to have further studies conducted.

8.4. Corridor Selection and Evaluation

The basic alternatives considered by ADOT&PF were the three road and one rail alignment previously identified in the 1982 APA licensing studies. The three basic corridors are as follows: a corridor running west to east on the north side of the Susitna River from the Parks Highway to the dam site, which is often referred to as the North (Chulitna) corridor; a corridor running west to east on the south side of the Susitna River from the Parks Highway to the dam site, often referred to as the South (Gold Creek) corridor; and a corridor running north to south from the Denali Highway to the Watana Dam site, often referred to as the Denali (Seattle Creek) corridor.

The access corridors were digitized using geographic information system (GIS) software, adjusted to the preliminary design criteria, and mapped.

In addition, a further route was added to the study in the Butte Creek area. In late 2011 a fatal crash of a U.S. Air Force F-22 Raptor occurred and environmental examination of the route was performed and permissions given quickly to allow the wreckage to be examined and cleared. This route initially appeared attractive because the existing permitted route represented about 50 percent of the road length necessary to reach the project site. The concept was to look at the possibility of upgrading the permitted route, leaving approximately 20 miles of new road to be sited and permitted. However, because the route was never developed beyond a cleared track, and because the route accesses the Denali Highway far to the east of the project area it was determined more direct routes might be more favorably advanced.

After the presentation of the initial transportation access study, further, and more accurate topography was developed from Interferometric Synthetic Aperture Radar (IFSAR) Elevation Data and the MatSu-North Susitna Bare Earth Data (Horizontal NAD83 and Vertical NAVD88) together with 20 ft. contours. MWH transposed the previously selected three routes onto the new topography, and made alignment adjustments as necessary – most particularly on the South (Gold Creek) corridor. These adjustments are further discussed in "Section 8.6 - Evolution of Access Plans."

The three routes are presented herein and have been considered equally throughout this feasibility study. The three routes will continue to be considered equally, and also studied for environmental factors such as wetlands and wildlife habitats. Additional criteria will be part of the overall evaluation of the corridors. The following measures were important for the selection of possible routes: total estimated construction cost, land status, and constructability. Other criteria considered were: number of creek crossings, construction schedule, terrain slope, terrain classification, original ground profiles, operation efficiency during dam construction, shadow analysis and necessary permits for new construction. Some geologic and geotechnical criteria: field reconnaissance; rock borrow availability and quality; soil borrow availability and quality; subgrade support; permafrost conditions; drainage; rock slope stability; and soil slope stability were also considered. These aspects will however, need to be studied further as there is a lack of quantifiable data.

Following the evaluation of the alternatives, the initial reconnaissance selected three alternative routes.

8.4.1. Description of Basic Plans

During the first (HDR) study, the following alternatives, and their variants, were analyzed and are described briefly below. (HDR, 2012. Draft Watana Transportation Access Study.)

South Road – Based on the Plan 16 corridor identified in the 1982 studies, this corridor would begin at the ARRC Gold Creek Station (ARRC MP 263), adjacent to the Susitna River, i.e. there is no interconnection with the Parks Highway. The corridor would be approximately 54.8 miles long and ranges in elevation from 750 ft. at its origin to 3,500 ft. at its midpoint. This corridor has some very favorable qualities: it contains the least amount of its length above 3,000 ft. enabling the transmission lines to be in close proximity; it would not require any use or need for upgrades to Denali Highway; it provides a lower total travel time to Anchorage than any other; and is anticipated to have fewer adverse impacts to caribou and sheep than the other alignments. The route does however require a number of bridges over creeks entering the Susitna River from the south.

Three variants of the base alignment were also studied as part of the initial reconnaissance:

- South Road Fog Creek Variant: This option shortens the corridor by approximately 4.4 miles by crossing Fog Creek closer to the Susitna River. The variant includes 1,300 total feet of stream crossing versus the 1,000 ft. for the original South Road alignment. By crossing Fog Creek closer to the Susitna, the alignment stretches across a wider (700 foot) gap, increasing the cost of this variant by approximately $27 million.
- South Road B Variant: This option was developed in an effort to shorten the overall length of the South Road. The variant is roughly 4 miles shorter than the South Road base route by continuing along the north-facing slope of the Susitna River between mileposts (MP) 15.5 and 36. While this option provides a shortened distance between Gold Creek and the Watana Dam site, it would require three additional bridges with clear spans between 200 and 300 ft. increasing cost and potentially increasing construction schedule.
- South Road Corridor-Gold Creek Variant (South C): Topographical map review identified the potential to ascend the Gold Creek drainage and avoid deep ravines and side hilling while providing a level, gently rolling terrain for most of the corridor. While this variant provides favorable landscape, it contains several areas with deep gullies and exposed bedrock. The additional costs required by the extra bridges and major rock excavation would be substantial.

South Rail – The South Rail corridor would begin at the ARRC Gold Creek Station and include 60.9 miles of new rail line along the north-facing side of the Susitna River. The route's lowest elevation is 750 ft. at its starting point, and its maximum elevation is 3,550 ft. at MP 32.8.

Hurricane (West) – Based on North-Access Plan 13 from the 1982 study, this alternative would require construction of 51.7 miles of new road from ARRC's Hurricane Station (near MP 171 of the Parks Highway) to the dam site. Its elevations would range between 1,750 ft. at its origin to 3,550 ft. near MP 32.8. While this alternative has many favorable conditions which include its overall cost, construction schedule, travel time to Cantwell, and a small effect on the moose and caribou habitat, the alternative will have the most stream crossings posing a threat to the salmon present in this corridor's path.

Variants include:

- Chulitna Variant – Road: This variant would use the ARRC Chulitna siding instead of Hurricane. The road component would remain the same as the Hurricane (West) alignment. Additional information would be needed to definitively identify the most suitable rail siding to use. As a result, this variant was retained in the Hurricane (West) corridor for future study.
- Chulitna Variant – Rail Only: This variant would use the ARRC Chulitna siding instead of Hurricane. An approximately one mile access road would connect Chulitna to the Hurricane (West) alignment near MP 7. The first seven miles of the Hurricane (West) alignment would not be constructed resulting in this variant having no direct access to the Parks Highway.

Seattle Creek (North) – This road alternative was based on the Denali-Access Plan 18 in the 1982 study, and would start nearly 20 miles east of Cantwell at MP 113.7 of the Denali Highway. Approximately 43.3 miles of new roadway and improvements to nearly 20 miles of the Denali Highway are necessary to support the additional volume and type of construction road traffic. Upgrades to Denali Highway would include: widening the highway by 8 ft.; approximately 56 culvert replacements; a new bridge structure to replace an existing multiple pipe culvert structure; additional signage; and an improvement of the Parks Highway/Denali Highway intersection to include a traffic signal and turning lanes. The alternative would begin at 2,700 ft. at its origin and peak at nearly 4,100 ft. near MP 20.9. It is the corridor with the highest elevation and containing the most length of new road above 3,000 ft., and thus is not suitable for close proximity transmission lines. This alternative seems to disrupt the most wetland area of the routes, however because of its use of the existing Denali Highway it is the most economical option.

Variants include:

- Kettle Lake Variant: The eastern portion of Seattle Creek (North) goes through a group of kettle lakes located in the center of the Brushkana Creek drainage. While the Kettle Lake variant is 1.8 miles shorter and is better exposed to the sun, it also appears to be wetter and would likely require additional stream crossings. Additional field work and research would be required to identify a more suitable location for the alignment. For the purposes of the reconnaissance study it was decided to have the alignment use the western segment.
- Deadman East Variant: At MP 14.8, the corridor runs parallel to Brushkana Creek for a short distance before turning south to ascend up to a higher valley along the western edge of Deadman Mountain. Near MP 18.5, the corridor splits into western and eastern segments because the Deadman Mountain area has the highest elevation along the alignment. The east side of Deadman Mountain would be a viable location for the road if it made economic sense.

Butte Creek – This road alternative was identified during the map review of alternatives, and would begin at MP 79 of the Denali Highway, approximately 53 miles east of Cantwell. It would utilize part of a winter trail developed from the Denali Highway in 2011 during recovery of a crashed U.S. Air Force F-22 Raptor as basis for a 47.1 mile roadway and more than 55 miles of upgrades to the Denali Highway. These upgrades would include: widening 53 miles of the highway by eight feet; replacement of approximately 116 culverts; replacing an existing bridge over Seattle Creek; replacing a multiple pipe culvert structure with a new bridge structure; additional signage; and improvement of the Parks Highway/Denali Highway intersection to include a traffic signal and turning lanes. While this alternative required the least amount of new road, the Butte Creek route is the longest of all the corridors at 92.8 miles from the Parks Highway and thus not as desirable of an option relative to the other alternatives.

- Butte Lake Variant A: This variant intersects the Denali Highway at MP 94.5 to head southwest extending toward Butte Lake. The alignment then threads through numerous small and large ponds, continuing to run southwest until it meets Deadman Creek at MP 29. Variant A then extends along the south side of Deadman Creek until it passes between Deadman Lake and Big Lake, at which point it crosses Deadman Creek twice to skirt around the east side of Deadman Lake, extending west to connect to the Seattle Creek alignment. This option is not favorable due to expected permafrost conditions, high water table, and prevalent wetlands. Also, Butte Lake Variant A would require two bridges where it crosses Deadman Creek adding to overall cost.
- Butte Lake Variant B: This variant departs the Butte Lake A variant SW of Butte Lake and runs to Butte Creek (East) alternative at approximately the midpoint. This option is

not favorable as it contains a five mile section that is possibly too steep for construction and is expected to have extensive rock excavation.

If any of the Denali Corridors are 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 four 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; and,
- Improvements will be made to the intersections including pavement markings and traffic signals.

8.5. Evaluation

Prescreening was performed on the five ADOT&PF alternatives (and nine variants), and the remaining alternatives advanced for detailed screening during the HDR study (HDR 2012).

The detailed screening used a two-tier approach to identify the most suitable access corridors. The first stage was an initial screening to identify any alternatives that were so unsuitable that they would not warrant further consideration. The second screening was more detailed, and was intended to identify the preferred access corridor using criteria that could be qualitatively or quantitatively assessed. The first screening was based on:

- *Land Status:* This criterion evaluates the general land ownership and status along the corridors. All five corridors have a mixture of State, Federal, Native, and private properties which influence the potential impacts to right of way (ROW) acquisition.
- *Creek Crossings:* All corridors include various creek crossings along their routes. The crossings were used as an evaluation metric with attention to how they would impact the overall cost and schedule of the alignments.
- *Mode Evaluation:* This criterion screened the corridors and their relative efficiency of road vs. rail to support the construction at the project site and operation of the facilities.
- *Range of Magnitude Cost:* After a comprehensive cost estimate, it was determined that a mile of rail would on average cost $2.5 million versus a mile of road at $1.5 million. The individual corridor’s costs per mile will vary based on terrain.
- *Field Reconnaissance:* Aerial reconnaissance was performed to validate each corridor’s terrain, geologic conditions, and drainage characteristics. All of the corridors had similar terrain, excluding the South Road/Rail which contained incised drainages. The banks on these drainages were observed to have sloughing soils and consist generally of poor

foundation materials which would result in larger spans and abutments. The original evaluation noted the more robust structures on this alignment, a difficulty that has been addressed.

- *Ability to Support Dam Construction Schedule:* The original evaluation noted that the more robust structures have an influence on the construction schedule. At a minimum, it was estimated by HDR that the South Road/Rail would take at least one additional year to construct than the other three alignments.

Based on the first screening by ADOT&PF, due to cost the rail access option was removed from further consideration as the primary transportation to the project site. Four road corridors were recommended for further consideration: South (Gold Greek), North (Seattle Creek), West (Hurricane), and Butte Creek.

The secondary screening considered:

- Engineering:
  - *Terrain Types & Roadway Grades:* Studies were conducted to assess the terrain and original ground profiles along the corridors. Alignments should be minimized, when possible to maximize the performance and operating efficiency of the access route. However, design grades can be increased in certain situations to decrease grading costs. Results of the studies show that Seattle Creek (North) and Butte Creek (East) have the most amount of level terrain, while the South Road and Hurricane (West) alignments have significantly more mountainous terrain.
  - *Operational Efficiency During Dam Construction:* These criteria were evaluated to compare the movement efficiency of goods between the South-central Alaskan ports and the dam site. The South Road and Hurricane (West) alignments are the most favorable as they have the least travel time between two of the three ports. Seattle Creek (North) is somewhat favorable, as it is the closest to Cantwell of the four corridors, but relatively far from Hurricane.
  - *Shadow Analysis:* For road design and maintenance it is preferable to have a roadway that is in direct sunlight as it minimizes icing during the winter months, delays road freeze-up until later in the fall, and thaws more quickly in the spring. These factors greatly reduce snow-clearing costs.
  - *Construction Season:* It is estimated that, on average, 20 miles of roadway could be built in one construction season. This is based on the assumption that a construction season is the summer months of the year as winter construction may not be preferred due to the need to achieve compaction with moisture and density controls. The South

Road will take longer than the other three corridors as it contains more mountainous terrain.

- *Geological/Geotechnical Considerations:* Due to lack of readily quantifiable data to evaluate the geological and geotechnical conditions, a set of specific development criteria has been developed and assigned to each criterion as a value between one and five. Pages 33-42 of the ADOT&PF Watana Transportation Access Study provide for more detailed information on the following criteria:
  - Rock Borrow Availability
  - Rock Borrow Quality
  - Soil Borrow Availability
  - Soil Borrow Quality
  - Subgrade Support
  - Permafrost Conditions
  - Drainage
  - Rock Slope Stability
  - Waste Area Availability
  - Foundation Support
  - Hydrology
- *Stream Crossings:* All four corridors require a similar number of bridges, however the length of bridges on the South Road and Hurricane (West) alignments are substantially greater than the Seattle Creek (North) and Butte Creek alignments. Alternatively, the Seattle Creek (North) requires more fish and drainage culverts than the other corridors. The corridors which utilize Denali Highway will need to replace or upgrade culvert and bridge structures on their respective portions of the highway.

▪ Environmental Considerations:

- *Fish Streams/Waterbodies:* Maintenance of access by fish to water bodies and streams is important in Alaska for the health of this resource. A total of 14 fish species have been documented to occur throughout the streams and waterbodies within all the proposed access corridor study area. Hurricane (West) seems to have the greatest impact on the fish as it has the most crossings of salmon streams and other fish habitat. Seattle Creek (North) seems to have the least impact as it has no salmon crossings and the lowest amount of resident fish crossings.

- *Wildlife:* It is difficult to equate the effect of the four corridors because all four impact different habitats to some degree. The South Road appears to pose the least disruption to caribou and moose habitat, but the highest with respect to other winter animals and bear habitat. The Butte Creek (East) corridor intersects more trumpeter swan habitat than any of the other corridors while it has a similar level of intersection of the migratory duck habitat as the South Road. The Hurricane (West) corridor intersects the most migratory duck habitat of all of the alternatives. Overall, the Seattle Creek (North) appears to have the least effect on terrestrial resources as it intersects with the lowest amount of all terrestrial species habitats and migratory bird habitats.
- *Wetlands:* Currently, the National Wetlands Inventory mapping does not include half of the Butte Creek (East) alternative and a portion of the South Road alternative making it difficult to evaluate the corridors against each other. For more information on wetlands, construction suitability categories, and vegetation refer to pages 61-65 in the ADOT&PF Watana Transportation Access Study.
- *Land Status:* As stated above, the status of ownership of the land can substantially impact the ROW acquisition. After evaluation, it appears the South Road has no federal lands, but it has four times more Native lands than any other alternative. Butte Creek (East) appears to be the best alternative as it has a low percentage of federal lands and the highest percentage of state lands.
- *Socioeconomics:* The development of a road to the dam site will affect the socioeconomic characteristics of the surrounding region, and these effects may be both positive and negative. It is probable that they will be greater during construction of the dam than during its operation. Construction and operation of the South Road alignment could have impacts on cabin owners in the area. Although access would still be limited to ARRC and all-terrain vehicle access from the Parks Highway, it would be easier for people to travel between Gold Creek and the dam site. Project impacts by Hurricane (West) to Talkeetna would likely be relatively large in terms of socioeconomic effects. Traffic increases would be negligible to the Talkeetna community, but would likely be substantial to the Parks Highway. The greatest impact the Hurricane (West) corridor would have is that to the property/cabin owners of the Chulitna areas who have purchased the land to be remote from others. The corridor would not give direct access to the Chulitna land; however it would provide an alternative point of access to trails leading to those locations. Seattle Creek (North) would likely shift the socioeconomic impacts further along Parks Highway and that may affect the highway with an increase in traffic during construction. Likely there would be an impact on Cantwell with fewer impacts on Talkeetna and

Trapper Creek, similar to the Butte Creek (East) alignment. Butte Creek (East) is near Cantwell and as part of this alignment's construction, Denali Highway east of Cantwell would be upgraded and become available for year-round use. Comparable to Seattle Creek (North), Cantwell would see a socioeconomic benefit as traffic and a larger demand for housing, community service, and utilities.

- Cost and Permitting:
  - *Cost:* The overall examination of costs which include new road costs, upgrades to Denali Highway, rail sidings, intersection improvements, etc., have indicated – at the reconnaissance level – that the South Road is the most costly of the corridors while Seattle Creek (North) is the least costly.
  - *Permitting Requirements:* All four corridors need the same permits with one exception; the Seattle Creek (North) and Butte Creek (East) corridors are not anticipated to need a Title 16 Habitat permit.

After all the screening, the resulting favored routes were used in the initial cost estimating in 2011. Further analysis was delayed until more detailed topography was available.

8.6. Evolution of Access Plans

During the second stage of the access analysis, which was performed by MWH, three of the routes initially analyzed in the ADOT&PF report were refined to better fit the more detailed 20-foot contour topographic maps subsequently obtained. The South (Gold Creek) route, North (Denali) route, and Chulitna road alignments defined in the initial studies were plotted on the 20-foot contour maps, and then selected sections of the road were realigned to minimize cut and fill quantities, to avoid lakes and other features not previously identified, to avoid obvious wetlands, and to shorten the route.

Field reconnaissance of the Gold Creek route was performed by helicopter in September 2012. The seven bridge locations were identified from the air, and the road alignment in the vicinity of each bridge was further refined based on visual observation of the topography and ground conditions.

In addition, several aspects of the road and transmission corridors were re-examined. Specific changes resulting from the reexamination of the routes included:

- A 15-mile-long section of the Gold Creek road was rerouted to the north to avoid an 800-foot change in elevation shown along the initial alignment studied.
- Several of the bridge locations on the Gold Creek route were changed to cross the canyons at more favorable locations defined by the 20-foot contours.

- Areas along the Chulitna route previously identified as having avalanche potential were reviewed with the more detailed topography, which showed that the avalanche prone areas cannot be avoided along that route.
- Partial rerouting of the Denali route to the east, with the consequent junction with the Denali highway being moved some 10.8 miles further east.

The initial reconnaissance of all routes performed on behalf of ADOT&PF had been based on their standards – including their standards for permanent bridges. The bridges on the southern (Gold Creek) route were seen as a major challenge associated with an otherwise attractive option. In particular, because the linear construction of the access road is on the critical path of the whole Susitna-Watana Project, it is necessary to minimize bridge construction time to render the Gold Creek route viable. Therefore a specific investigation of the potential for use of prefabricated modular steel bridges was instigated for crossing the several deep canyons along the Gold Creek route, and manufacturers were canvassed to determine the viability of such prefabrication and the speed of construction. The use of such prefabricated "modular" bridges is commonplace for construction initiatives, for logging roads, and even within Alaska (and elsewhere) for extended use on public highways. In considering these types of bridge, it has been noted that the two west access routes will not be accessible by non-project traffic (and the Gold Creek route is almost entirely on private land), and it is a simple matter to institute one way (or restricted speed) traffic across such bridges without sacrificing supply chain economics or safety. In that light, a decision was taken to base the Gold Creek route on the use of prefabricated steel modular bridges that can be quickly assembled on site.

Modular bridges are commonly "launched" from one abutment, so the most complex aspect of the bridging of the various creeks will be the installation of the required intermediate piers. The fabricators of the bridges considered usually propose the creation of vertical piers by the use of the standard truss panels bolted together (and the cost estimates include this method of implementation) but a faster method may well be to assemble space frames (pre-fabricated off site from standard steel pipes) at the site and lower them onto small concrete foundation blocks – rock bolted to the valley sides – to form pin ended connections at the base of angled piers. A rigid, yet light, structure can be created thus, and the bridge can be launched across each creek (depending on total superstructure weight and span) in a period of between 10 and 40 days, depending on the total bridge weight. The bridge deck width has been chosen as 24 ft. – which allows for the passage of the widest projected vehicle using the road, a Caterpillar 777 dump (rock) truck (during mobilization and demobilization). The bridge itself would encompass a design load of HL-93 and comprise side trusses at least two deep with the deck mounted between them – so that any large load on a flatbed (and wider than the bridge deck width) could pass above the top of the upper side truss. As well as the Caterpillar 777, weighing (empty) 82 tons the bridge will be capable of handling a 190 ton transformer load on a suitable multi axle trailer.

It is envisaged that a road with such bridges would be sufficient for construction and for normal operation. In the future, if ADOT&PF were to take over the road or its maintenance, or if the private land owner wished to invest in upgrading the road for more extensive traffic – the bridges could be replaced with standard spans and the roads could be realigned at the bridge abutments to suit.

8.7. Access Plan for Estimate

The engineering studies to date have not identified a preferred access route because that selection will be made after the appropriate environmental analysis has been undertaken. Of the three corridors and routes further refined after the initial reconnaissance study, the Chulitna route was subsequently under evaluation for potential elimination, and each of the other two have advantages and disadvantages. The South (Gold Creek) route has, however, been selected for use in preparing the cost estimate for the Project, and the cost of overcoming its main disadvantage (the bridges) has been included in the overall cost estimate.

The Gold Creek route begins at the ARRC Gold Creek Station (ARRC MP 263), is 55 miles long, has seven deep canyon bridge crossings, and does not appear to cross avalanche prone terrain. The Gold Creek route contains the shortest total distance of corridor above an elevation of 3,000 ft. so that the transmission line can be located close by. As noted in the previous study, it would not require any use of or need for upgrades to Denali Highway; it provides a lower travel time to Anchorage; ensures that construction traffic is separated from residential areas, and it is anticipated to have fewer adverse impacts to caribou and sheep habitat than the Denali Corridor routes.

8.8. Bridge at Site

Whichever access route is selected, a permanent bridge – immediately downstream of the dam – will be required for construction access and in the long term for providing access to both sides of the river upstream and downstream. A location for the bridge has been selected to minimize the span, provide for sound rock abutments, and to be far enough downstream to be unaffected by the plunging jet from the operating spillway. The same key design criteria as selected for the access road bridges would apply – HL-93 loading, traverse by an unloaded Caterpillar 777 dump truck and a 190 ton transformer on a multi wheel trailer.

Although the tailrace downstream of the dam and powerhouse is expected to be relatively ice free, the river gravels are deep so it is advisable to avoid a configuration using a central pier. For the purposes of estimation therefore, a long span (330 ft.), through-truss steel bridge has been selected, and it is envisaged that it will be delivered in pre-engineered sections for assembly on site. If the project utilizes a "CAT train" across the snow for mobilizing some of the early contractors, the bridge could usefully be constructed from the surface of the river ice – thus simplifying construction.

A bridge design is included with the feasibility drawings and includes a 28 foot roadway, and 18 ft. clearance suitable for the Caterpillar 777 dump truck.

8.9. Railhead

8.9.1. Previous Studies and Site Selection

The ADOT&PF study identified three possible locations for a railhead facility for transloading construction materials from the ARRC to highway vehicles. Those sites were along the ARRC's main line at Gold Creek, Chulitna, and Cantwell. Following evaluation of the three sites, the Cantwell site was selected for the preparation a preliminary design. Subsequently designs were prepared for the other two locations for transloading facilities.

Project staff, in late 2013 travelled with ARRC staff in a Hi-rail pick-up truck from Talkeetna to Gold Creek (and back) on the track to examine the conditions and the Gold Creek site. The assessments made during that examination have been incorporated in the Susitna-Watana Project feasibility design, and cost estimate.

8.9.2. Transportation Methods

The bulk of the construction materials (besides the primary generating equipment components) required to be transported from outside of Alaska to the project site are cement and pozzolans. There are two methods for transporting these materials over long distances utilizing railway, marine, and roads:

- In covered hopper railway cars between the initial source and the transload site, with the cars carried directly on barges between Seattle and (currently) Whittier. The materials would be transloaded at the railhead to cement trailers for final roadway movement to the project site.
- In bulk material tank containers between the initial source and the project site. The containers would be transferred as needed between modes (barge/rail/road) without directly handling the material.

Capacity limitations with the Alaska Rail Marine service, the potential need to construct additional barges to carry railcars, and the cost to construct cement and pozzolan transfer facilities indicated that the most economical method for hauling would be in bulk material tank containers. Similarly, fuel and other materials would be containerized to the maximum extent feasible.

Although Port MacKenzie and the associated railroad spur are projected to be completed sufficient for project needs by 2017 – well before the initiation of substantial construction – the railroad is not projected to extend to the dockside at Port MacKenzie, so no "roll on roll off" of railcars will be possible from Alaska Rail Marine, and CN Aquatrain rail equipped barges. Any delivery of special rail cars – such as those normally used to transport large transformers – will necessarily be routed through Whittier. It has not yet be determined if a supply chain substantially based on containers would be more economic through Whittier or Port Mackenzie because container transit has to include – at Port Mackenzie – an intermediate truck haul, up the bluff from the dock.

The required track capacity at the railhead was estimated to accommodate a delivery rate based on the maximum possible containerization. Additional track capacity was determined to allow equipment on flat cars to be unloaded by end or side ramp.

8.9.3. Railway Cars

The weight limit for railcars on ARRC is 263,000 pounds, which yields a car load capacity of approximately 100 tons, depending on the tare weight of the car. ARRC currently transports containers of various lengths on flat cars with deck lengths ranging nominally from 50 to 89 ft.

Liquid petroleum products such as fuel and oil can be transported in large quantities in two ways: a petroleum tank car or an International Standards Organization tank container in an intermodal well car. For track capacity purposes, tank cars and container flat cars are estimated at 55 ft. in length.

Bulk transport of cement and pozzolans during each construction season are expected to average more than 8,200 tons per week. Covered hopper cars or dry bulk containers in intermodal well cars could be used for transport so that offloading of these high volumes can be done using pneumatic discharge. However, as noted above, for the purposes of estimating, it is being assumed that all bulk materials will be delivered in containerized tanks minimizing the potential for spills, etc.

It is planned that steel reinforcement will be shipped as straight bar. Normal "rebar" length is 40ft. Reinforcing bars are typical for formed concrete structures shipped on various lengths of flat cars, bulkhead flat cars, or gondola cars.

Large project components such as turbine parts and spillway gates will likely be transported on flat cars. Very heavy equipment such as transformers will likely be transported on specialized multi-axle flat cars configured to accommodate the weight.

8.9.4. Transloading Facility – Cantwell Site

The Cantwell site is located at ARRC MP 319 and is accessible by highway.

The layout of the transloading facility at Cantwell and the amount and arrangement of the tracks was determined from the types, quantities, and delivery rates of the railway cars expected to be used, and the means by which the various railway cars will be unloaded.

ARRC initially indicated that they are willing to use their existing mainline and siding tracks to exchange a train of incoming loaded cars for a train of outgoing empty cars. The existing siding at Cantwell has approximately 6,200 ft. of capacity, with approximately 4,500 ft. of that capacity south of the existing turnout to the Section Track that also leads to Track 1. This is sufficient capacity, south of that turnout, to store the length of the assumed twice weekly shuttle train and its locomotives, without fouling the mainline.

In addition to the track arrangements, the site layout would include the following new facilities:

- Fuel storage for tractor trailers performing the delivery to site
- Flat area for manipulating and storing up to 100 containers
- Covered storage area
- Offices for the logistics controllers
- Lodging for 40 drivers and associated canteen and recreational
- Parking for 43 tractor/chassis units
- 60,000 sq.ft. of concrete hard standing
- Helicopter pad
- Tractor maintenance workshop

8.9.5. Railway Construction

Most of the transloading facility will be constructed by a contractor. However, due to existing labor contracts, and the requirements for track standards, ARRC will procure and install any new turnouts that need to be installed in existing ARRC track and any new track leading away from new turnouts out to the "clearance" point. ARRC stores preassembled track suitable for sidings, etc., in their yards, so placement of sidings is not a problem. It is understood that each required siding, using pre-assembled track – could easily be laid by ARRC in three weeks. During detailed planning, it might be more appropriate and economic to negotiate with ARRC the construction of all the rail facilities at the railhead.

8.9.6. Gold Creek Site Alternative

The Gold Creek site is located at ARRC MP 263 and is not accessible by highway. The site would be located on the east side of the tracks to be away from the Susitna River and so that construction traffic would not have to cross the ARRC tracks to access the road to the construction site. Tracks 1 and 2 have a combined capacity of 9,000 ft. for unloading and loading containers. Since space is available, these tracks would be double ended and two turnouts installed in the existing ARRC tracks. While a second turnout increases the cost of the site, it provides considerable switching flexibility for ARRC while serving the site.

ARRC did not provide details of their right of way at Gold Creek. Adjacent private property owners are unknown.

All the facilities described for the Cantwell site would also be incorporated in the Gold Creek railhead.

8.9.7. Chulitna Site Alternative

A facility was designed for the Chulitna alternative located at ARRC MP 273.8, and like Gold Creek, not accessible by highway. The site would be located on the west side of the tracks to avoid impacting private structures and a private runway on the east side. Construction traffic would have to cross the ARRC tracks to access the road to the Susitna-Watana construction site. Tracks 1 and 2 have a combined capacity of 9,000 ft. for unloading and loading containers. The short length of the mainline tangent between Curves 273A and 274 suggest that these tracks would be stub ended similar to those in the Cantwell site concept. The existing Chulitna Siding is too short for locomotives to run around the typical 4,000-foot long train that would be delivered to the facility twice per week. To avoid long backing movements of this train length, the locomotives would run around the train at Hurricane Siding, eight miles north of Chulitna. Grades of up to 1.8 percent exist immediately north and south of Chulitna siding, which would add difficulty to switching cars into the facility.

ARRC did not provide details of their right of way at Chulitna. Adjacent private property owners are unknown.

8.9.8. Necessary Modifications to the Railroad

During the investigation of the ARRC track from Talkeetna to Gold Creek, most of the track was observed to be suitable for moving materials without problem. There are occasional passing locations where trains of the size required could be held while more important traffic passed. Principal among these in current use are:

- Chase 6200 ft.
- Dead Horse 6700 ft.
- Gold Creek 5200 ft.

In general each siding has 15 ft. centerline to centerline spacing from the main line.

An unknown issue however is the extent to which a contractor would wish to move wide loads up and down the railroad. The following were noted as modifications that might be required if any wide loads were contemplated:

- At ARRC MP 227.1 is the Talkeetna River Bridge, a through truss bridge which represents the most significant width limit between Talkeetna and Gold Creek – and the sole height limit. Approach to the bridge is straight, and the bridge includes two spans of 200 ft. If the transport of wide loads is essential, then rebuilding of the bridge using plate girders might be required to allow for wide loads.
- At ARRC MP 227.9 is the Billion Slough Bridge. Although this is a straight over bridge it has side structural plate girder members supported by angled webs. The width at about 4 ft. above rail is 19 ft. This bridge includes one span of 120 ft. with the side members and a 22 ft. span at grade. At a later stage of project planning, it must be determined if this bridge would need to be replaced to allow for wide loads.
- At various points north from Talkeetna, on the east side of the track there are locations at which the rock cuts are close, and the rock wall can sometimes be as close as 9 ft. 6 inches from the track centerline (although 12 ft. is more normal in these particular locations). However, the total length of line with these limited clearances is less than 500 ft. The ARRC staff member conducting the visit indicated that a routine maintenance task for the railroad is to use their onboard backhoe (on work trains) to remove these materials. It is therefore considered that it would not be a difficult job to increase clearance by two feet or more – thus facilitating 13 ft. of clearance – at these locations. This type of modification could easily be accommodated within the normal scheduled track maintenance operations.

8.9.9. Other Potential Facilities

It is conceivable that a contractor may wish to use road transport for many items for as much of the journey to site as possible, and it may be necessary to establish another facility for the assembly of equipment, or the transfer of equipment from road to rail. Just south of Talkeetna – at ARRC MP 223 mile is McKinley siding and yard. The principle siding is 2,300 ft. long, but of interest is an associated pit for which ARRC has built a spur. The spur is at significant grade – and moving a train out of the area could require extra assistance – but the pit could easily be used by a contractor as a storage area/transshipment area to load trains after bringing material by road from south. ARRC could easily include in the track a derailing link under their control so that a contractor could work within the area without ARRC interference until ready to move out. The land is all owned by ARRC but the area is used as a "bone yard" so is probably available. The area available is estimated to be 12 acres or more. There is considerable space for laying down and sorting of equipment and materials, as well as for transferring from trucks to railcars – if material has been brought from Anchorage by road. The location is sufficiently far from Talkeetna that its use would not affect the town.

If the McKinley spur is not deemed suitable, at MP 215 is Sunshine siding – which is 5,800 ft. long and very close to the Parks Highway.

8.10. Airstrip

8.10.1. Previous Siting

In the 1980s study, consideration was given to the construction of both a temporary and a permanent airstrip, and nine sites were examined in the report entitled "Construction Camp and Village Siting Study." The site deemed most favorable did however have a potential interference with an eagle's nest. A temporary airstrip site, closer to the project was located on an area which was to form a borrow area.

The Watana Transport Access Study prepared by ADOT&PF examined two airstrip sites –one north of the river at the approximate location of Option 9 of the 1980s study, and one south of the river near Fog Lakes. Both sites were found suitable.

For the current study, the previous study was reviewed, and further aerial and surface observations were made – particularly with regard to the fact that – using a layout based on an RCC dam, there is no longer a requirement for a borrow area on the right abutment.

8.10.2. Airstrip Criteria

Although much of the heavy equipment and consumables will be transported to the site using the ARRC and the access road, it is highly desirable to construct facilities for air transport of personnel and urgent items such as food, spare parts, medicine and rush goods.

At this planning stage, it has been assumed that the criteria for an airstrip will be similar to that adopted in the 1980s study. At that time it was assumed that an airstrip would be constructed suitable for use by a Boeing 737 (now known as the B737 – 100 and 200 series) and a C130 (now known in its civilian version as a Lockheed L-382). It is known that local cargo carriers such as Northern Air Cargo, Lynden, Air North Canada, Everett, and others have used jet aircraft that would be suitable for landing at the Watana strip.

A recent study by ADOT&PF (of Kotzebue airport relocation) indicated that through 2026, Northern Air Cargo would continue to operate B737-200s, while Alaska Airlines would continue to operate B737-400s. Lynden are expected to operate L-382s. The aircraft reference codes for these planes are respectively ADG C-III and ADG C-IV.

It is assumed that the strip will be an unsurfaced gravel strip, which would require jets such as the B 737 to be equipped with a "gravel kit." No parallel taxiways are envisaged, so the turning areas at either end of the single runway would need to be surfaced, as would the apron and the taxiway for access to the apron. Initially it was thought appropriate to provide a strip length suitable for a 737 with gravel kit, but further research has indicated that all 737-200s (the last model with engines mounted high enough to facilitate gravel kit modification) may well have reached their cycle limit for landings and takeoff by the time the Susitna-Watana Project proceeds. Therefore the airstrip length was reduced slightly to 5,500 ft., which is safe for economic use by the L-382 and CASA CN 235 planes on which the estimate was based.

Based on Federal Aviation Authority (FAA) requirements set out in the "*Airport Design Advisory Circular AC 150/5300-13*" and in "*Boeing 737 Airplane Characteristics for Airport Planning*", the requirements/criteria assumed are described in the following sections.

A location close to the original 1980s location 9 was reexamined based on topography, and an examination at the site. It appears that a suitable strip can be located on relatively flat topography, and on ablation till, somewhat closer to the dam site, but more detailed examination of the extent of wetlands vs. till must be carried out during the future site investigation.

8.10.3. Selected Airport

The available meteorological data from the site weather station has been examined. A wind rose is shown in Figure 8.10-1.

This wind rose indicates that the runway alignment should be at an orientation of 068/248. Using this orientation the location of the southern end of the runway has been chosen at N 3234102.6794, E 1890592.8668 as shown on Drawing 03-10C002. This is deemed to be suitable for safe landing in the prevailing wind. The strip would have a rolled gravel surface of at least six inches with no areas of deep loose gravel. Aircraft manufacturers recommend that the surface be smooth, with no bumps higher than three inches in 100 ft. The gravel surface must be checked frequently and rolled as soon as possible after damage.

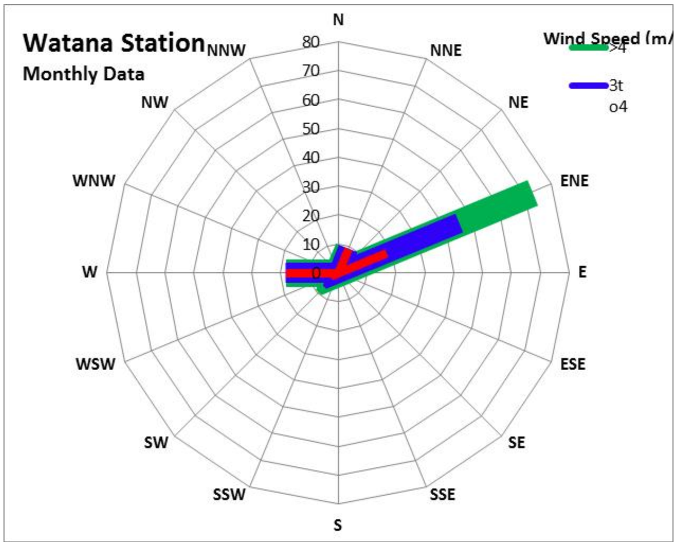


Figure 8.10-1. Wind Rose Full Year

8.10.4. Runway Length and Width

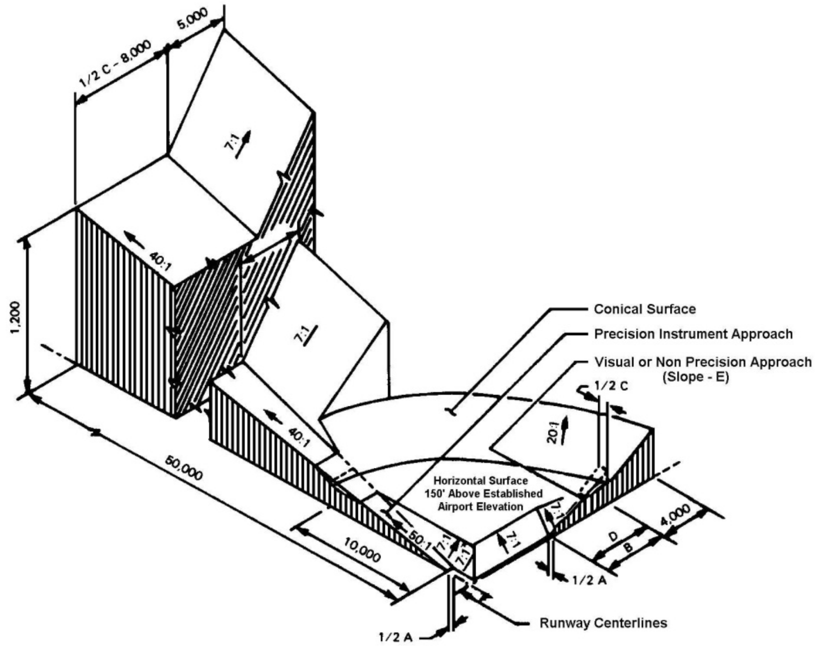
As noted runway length was originally determined from the performance curves in the Boeing handbook. The required runway length so derived with a contingency of 15 percent for a "contaminated" (i.e., snow covered runway) was 6,300 ft. so for this stage of the study a length of 6,500 ft. was originally assumed. However as noted, because of the retirement of early 737 aircraft, a strip length of some 5,500 ft. was ultimately chosen which is sufficient for the turbo prop planes expected. Potential operators may prefer slightly longer lengths, and they should be consulted before finalizing design. A location has been chosen that would allow for a runway some 2,500 ft. longer, if expansion in the future is deemed worthwhile.

FAA guidelines suggest a runway width of 150 ft., but 737s are operating throughout the world from 100-foot runways, so this width has been adopted and will be suitable for all types of aircraft that would feasibly use the strip.

8.10.5. Approaches

FAA Advisory Circular 150/5300-13 and FAR Part 77 indicate the required approaches, and the proposed airstrip has been reviewed with these criteria in mind.

Figure 8.10-2 below describes the Imaginary Surfaces established by the FAR Part 77 which have been taken into account for the orientation of the airstrip. Imaginary Surfaces define the areas where, for the approach of an airstrip, there may be no physical obstructions penetrating for safety purposes.



(image url: http://airspaceusa.com/FAR_77.25_Civil_Airport_Imaginary_Surfaces.htm)
Image in accordance with FAR Part 77.25(a) Horizontal Surfaces: Chart of Surface Dimensions

Figure 8.10-2. Safe Aircraft Approach Surfaces

The proposed airstrip is expected to have a Visual Aid Slope Indicator System which will provide descent guidance information during approach. The given imaginary surface above for this system shows a 50:1 slope directly behind the approach side of the runway for 10,000 ft. Following that a 40:1 slope for 50,000 ft. until the slope has reached an elevation of 1,200 ft. These areas have been checked for the selected site around the proposed airstrip and it has been verified there are no current physical objects or geographical features that will classify as obstructions.

8.10.6. Runway Ends and Aprons

The airstrip will not be busy enough to warrant parallel taxiways, so arriving and departing aircraft must be able to turn 180° at each end of the runway. The Boeing manual indicates that a minimum pavement width for a 180° turn is 60 ft., so it has been assumed that at each end of the runway the full width (100 ft.) will be surfaced, for a distance of 200 ft., which should provide sufficient area for aligning the aircraft.

In a similar manner, the apron must be sized so that a plane can turn 180°, and so that two planes can simultaneously be offloading. Thus the apron must be at least 100 ft. wide for each plane. As noted in the ADOT&PF Watana transportation report, it is suggested that a surfaced apron some 400 ft. by 200 ft. is appropriate.

There will also be a helicopter pad, approximately 45 ft. by 90 ft.

The apron has been set back more than 500 ft. from the runway in accordance with FAA requirements.

8.10.7. Aircraft Operational Aids

Certain basic aids will be required for the safe landings and take off in inclement weather. These include:

- A beacon
- An instrument landing system (Transponder Landing System)
- Radio
- Automated weather observational system
- Wind indicator
- Visual glide slope indicators
- Runway and apron lighting

Also desirable and included in the project cost estimate are:

- Radar
- (Potentially) identifying lights on any peak or equipment

8.10.8. Facilities

Permanent facilities associated with the airstrip will include:

- An office/control room for controlling the airstrip
- A small waiting room and toilet facilities
- Fuel storage – probably in tank containers
- A fuel truck
- A fire truck that also services the township
- Pneumatic truck
- Mobile air stair as necessary

8.10.9. Summary

The basic dimensions and criteria for the airstrip are summarized in Table 8.10-1 below:

Table 8.10-1. Airstrip Criteria

Minimum Runway Length:	5,500 ft., with a clear area available for extension
Runway Width:	100 ft.; possible 25 ft. shoulders
Runway Safety Area:	7,500 ft. by 500 ft.
Runway Protection Zone (RPZ):	1,000 ft. at end closest to runway & 1,510 ft. at remote end by 1,700 ft. long
Clearance between Runway & RPZ:	200 ft.
Runway Object Free Zone	1,000 ft. by 7,500 ft.
Clearway (Departure end of Runway):	500 ft. by 1,000 ft. @ 1.25% slope
Threshold Siting Approach:	No penetrations (FAA AC 150/5300-13 CHG 12)
Prevailing Wind:	SW-NE
Precision Instrument Imaginary Surface:	FAR Part 77
Runway Blast Pad:	N/A
Stopway:	N/A

* Dimensions above were found in the USDOT FAA 150/5300-13 Airport Design, Tables 2-4 and 3-3.

8.11. Unconventional Access

This section has dealt with the suggested arrangement that can be made for construction and ongoing access to the project site, based on road and railroad access, implemented in a sequential manner.

At a later stage – to, and during development of, the individual project procurement packages – AEA must decide the extent to which they will dictate to the main contractor the methodology for – and contractual rules for access, given that the cost and reliability of the supply chain logistics will greatly influence the cost of the project and the schedule for construction.

There are also drivers however which may necessitate the consideration of unconventional access. Two key aspects will have to be considered:

- If required by an accelerated schedule, the extent to which material and equipment can be relocated to the site before the full construction access has been established; and
- The size of the largest items and the economics of establishing particular transport of those pieces.

These drivers are important because the ability to move material, equipment and consumable stores to site before the road is built – or later in the construction process without requiring disassembly for movement along the railroad – may beneficially affect cost and schedule.

8.11.1. Hoverbarge

The use of the ARRC will impose a constraint on the maximum size of any equipment that can be delivered to the site (whether for the permanent works or for the construction). Some items may have to be brought to site in pieces and assembled, either at the railhead or at the site.

Typical are the Caterpillar 777 trucks expected to be used in the quarry, which are, fully assembled, more than 21 ft. wide. Such trucks are able, fully assembled to drive on normal highways as an escorted load, from (say) Port MacKenzie to Talkeetna, but would not be able to be shipped on the ARRC.

However, there exist hoverbarges (both self-propelled, and towed) that could be used to move large loads, such as the 777s up the Susitna river from Port Mackenzie to Gold Creek during the winter, over the river ice. There are varying sizes of hoverbarge available, up to 300 tons cargo capacity. The speed of the barges is a maximum of five knots, but delivery to Gold Creek of particular oversize equipment unsuitable for the ARRC is practical. An offloading area would have to be developed at Gold Creek.

8.11.2. CAT Trains

If it is deemed useful to move equipment to site before the access road is completed, CAT trains can be used. For delivery to the southern abutment, the train can be assembled at Gold Creek and follow a similar route to that used by others in the upgrading of Stephan Lodge. For delivery of equipment to the northern abutment the CAT train would be assembled at the Denali Highway. It may be advisable – for passage to the northern abutment – to use the winter trail developed from the Denali Highway in 2011 during recovery of a crashed U.S. Air Force F-22 Raptor, and then extend the CAT trail on snow through to the site.

8.11.3. Air Transport of Heavy Equipment

During the feasibility study, the team was requested to examine the possibility of movement of equipment – and heavy equipment – to the site by air, even if this method was solely used for initial mobilization before the road is complete.

At the date of writing, the only potential for lifting heavy equipment is by helicopter. The largest helicopter that is relatively easily available is the Chinook which are limited to 26,000 lbs. on the hook. The Russian manufacturer Mil Moscow Helicopter Plant has built a number of Mi-26 helicopters that can lift 20 metric tons (44,000 lbs.) but these are only in service with Aeroflot and the Russian military.

There are no heavy lift airships – either rigid or hybrid designs – currently possessing FAA airworthiness certificates by air.

Although no rigid airships are currently used for heavy lifting, hybrid airships are being researched for such purpose.

The project team researched the "state of the art" of hybrid airships and the current situation is:

- Aero Vehicles, Inc., based in Argentina, produces the AeroCat, a hybrid airship. The AeroCat has a 20 ton (44,000 lbs.) capacity with a cruising speed of 70 knots. The company was non-responsive when asked about potential FAA certification. No operating costs were provided.
- ILC Dover, based in Frederica, Delaware has designed the lighter than air Cargolifter, a hybrid airship. The Cargolifter will have a 75 ton lift capacity. Cruising speed was not available. ILC Dover does not directly manufacture this product, but supplies design to other firms. No operating costs were provided.
- Hybrid Air Vehicles Ltd, based in the United Kingdom, produces the Sky CAt – a hybrid airship. The Sky CAt has a 20 ton capacity with a cruising speed of 78 knots. The company was non-responsive when asked about FAA certification. No operating costs were provided.
- Worldwide Aeros Corp., based in Montebello, California, produces the Aeroscraft, a Rigid Variable Buoyancy Air Vehicle. The Aeroscraft has a 20 ton capacity with a cruising speed of 100 knots. Aeros currently has FAA Production approval and is working with FAA towards obtaining an airworthiness certificate. This certificate is anticipated in the 2015-2016 time frame. No operating costs were provided.
- Lockheed Martin is developing the Hybrid Air Vehicle (P-791). A 20 tons cargo airship would be available for service (FAA Certified) in the 2014-2015 timeframe. A larger projected airship will be about 70 tons capacity and is projected to be available for service in the 2015-2016 timeframe. Both aircraft will accomplish the 70 mile range and return without refueling at the site and would travel between 60-80 knots airspeed. No operating costs were provided.
- Northrup Grumman Aerospace Systems produces the ISR Hybrid, a hybrid airship. Currently building a 20 ton capacity model for the U.S. Army but are also looking at 50 ton, 100 ton and 200 ton configurations. Northrup Grumman said they could meet the

operational need for construction in 2016, but cannot guarantee an airworthiness certificate by that time. No operating costs were provided.

No manufacturer can give a definite date for the FAA to provide an airworthiness certificate for a hybrid airship. Postulated dates are as early as 2015, but the developments are prototypes and that date must be regarded as tentative. Construction planning based on the use of hybrid airships therefore appears premature, but the situation can be re-examined periodically to see if potential manufacturers can provide more definite information about an airworthiness certificate and operating costs.