5 Summary of Findings

The purpose of the Watana Transportation Access Study was to evaluate potential access corridors from the existing transportation network to the proposed Watana Dam site. Corridors were initially identified by reviewing historical studies developed for the project in the 1980s. The goal of this study was not just to update or validate previously studied access routes, but to also evaluate other potentially feasible corridors. Major evaluation criteria included operational, engineering, environmental, and cost factors. Corridors were evaluated to identify the advantages and disadvantages and to identify suitable transportation access corridors that balances the advantages and disadvantages.

The South Road alignment is only accessible from the ARRC tracks, making it the least convenient of the four corridors. While this corridor has many benefits including the fewest linear miles located above 3,000 feet and no acquisition of Federal land, it is also the longest route, has the most linear feet of bridges, the highest cost, and a high potential for cultural resource impacts. The need to transport the majority of goods, materials, and people by rail is likely to increase the cost to construct the Watana dam. This cost has not been quantified as part of this report but is a real operating cost that must be evaluated as the project advances. Rail access also increases the logistical challenges associated with construction. For example, rail access is less convenient than road access because travel must be scheduled in advance to avoid conflicting with other rail traffic.

The Hurricane (West) alignment is the closest to the Parks Highway/ARRC corridor but it requires the most new construction. While it has many favorable conditions, it also has the second most linear feet of bridges, the most stream crossings requiring fish passage, the most Federal land, the least State land, and a high potential for cultural resource impacts. The alignment also has the second highest cost of the four corridors.

The Seattle Creek (North) has acceptable engineering and geological/geotechnical conditions. It also traverses to the highest point (4,100 feet) of the four corridors and includes the greatest number of miles at higher elevations, with 32 miles of the alignment being above 3,000 feet. However, it has the fewest number of new culverts and crosses the fewest fish-bearing streams. The Seattle Creek (North) alignment has a similar cost to the Butte Creek (East) alignment, and both alignments include upgrades to the Denali Highway (see Appendix B for the breakdown of the associated upgrades and costs). However, the distance between the Watana dam site and the Parks Highway/ARRC corridor is approximately 30 miles shorter than the Butte Creek (East) alignment, as the new roadway would start farther west on the Denali Highway. This would reduce the amount of Denali Highway that needs to be upgraded, and results in a shorter haul than the Butte Creek (East) corridor.

The Butte Creek (East) alignment has the most suitable geological/geotechnical conditions of the four corridors. However, this alternative is farthest from the Parks Highway/ARRC corridor. The additional length (and thus travel time), will increase the cost to construct the Watana dam. This cost has not been quantified because a logistics plan has not been developed, but it could be substantial. While this alignment does not cross any salmon streams, it would require crossing 29 streams that would require fish passage. While this corridor has the fewest reported wetland impacts, wetland information was only available for a portion of the corridor. It is believed that the unmapped area contains a substantial amount of wetlands and that if the entire alignment was mapped, Butte Creek (East) would have the greatest wetland impacts of the three alternatives.

The Seattle Creek (North) and Butte Creek (East) alternatives are preferable to the South Road and Hurricane (West) alternative in many categories (such as cost, engineering, and geology/geotechnical). The South Road and Hurricane (West) alignment fare better than the other two corridors for moose and caribou impacts, but these resources were primarily evaluated based on a *relative* comparison. In terms of cultural resources, fish passages, migratory ducks, swans, and bears, the South Road and Hurricane (West) corridors are not preferable over the other two corridors. Many of the environmental impacts are associated with increased access to the resources being studied. Because it does not connect to the existing road corridor, the South Road corridor would be expected to have fewer access related impacts than the other three corridors. Regardless of the corridor selected, mitigation measures may be implemented to reduce potential impacts on environmental resources.

Table 5-1 summarizes the criteria where meaningful differences were discernible among the alternatives to help identify a preferred corridor. Criteria that did not result in a discernible, substantial difference or have enough detail to support a planning-level decision are not reported; the results for the criteria that are not reported in the summary were found to be relatively uniform across the four corridors and did not contribute to the selection of suitable corridors that meets the project's cost and schedule goals.

Based on the information provided above, the project team concluded that the South Road and Hurricane (West) corridors would be less desirable as the access road corridor than the other two corridors. The Seattle Creek (North) and Butte Creek (East) corridors are both reasonable for a future access road and have similar costs. However, the Seattle Creek (North) corridor appears to best meet the schedule and cost goals for the future Watana dam access road corridor. The Seattle Creek (North) corridor is approximately 30 miles closer to the Parks Highway/ARRC corridor than the Butte Creek (East) corridor which is likely to result in lower dam construction costs. Being closer is also anticipated to reduce operations and maintenance costs of the Watana Dam. It will also reduce impacts along the additional 30 miles of the Denali Highway. The Seattle Creek (North) corridor is also preferred over the Butte Creek (East) corridor because it has greater potential for the access road and power transmission lines to be co-located. In a meeting on October 25, 2011, AEA and their consultants indicated that the Butte Creek (East) corridor is not being considered as a location for a potential power transmission line. They also indicated that the transmission line could share a corridor with the access road within most of the Seattle Creek (North) corridor.

As this project is further developed and additional information is obtained, further study will be needed to identify if the Kettle Lake variant or the Deadman East variant of the Seattle Creek (North) alternative should be used or if the primary alignment shown in this report should be the selected route. Further engineering and environmental analysis may be required before an access corridor is selected.

Table 5-1. Summary of alternatives analysis

Category	Criteria	South Road	Hurricane (West)	Seattle Creek (North)	Butte Creek (East)
Engineering	New road (miles)	54.8	51.7	43.3	42.5
	Upgrades to Denali Highway (miles)	0.0	0.0	20.0	53.0
	Total length (including Denali Highway; miles)	54.8	51.7	63.3	95.5
	Highest elevation (feet)	3,450	3,250	4,100	3,200
	New road above 3,000 feet (miles)	5.0	12.5	32.0	6.4
	Travel time from Hurricane to Watana Dam (hours)	N/A	1.5	2.4	3.1
	Distance from Hurricane to Watana Dam (miles)	N/A	51.7	102.6	134.7
	Travel time from Cantwell to Watana Dam (hours)	N/A	2.1	1.8	2.7
	Distance from Cantwell to Watana Dam (miles)	N/A	91.0	63.4	95.5
	Travel time from railroad siding to Watana Dam (hours)	1.6	1.5	1.9	2.8

Table 5-1. Summary of alternatives analysis					
Category	**Criteria**	**South Road**	**Hurricane (West)**	**Seattle Creek (North)**	**Butte Creek (East)**
Engineering (cont.)	Distance from railroad siding to Watana Dam (miles)	54.8	52.3	65.3	97.4
	Potential transmission line in close proximity	Yes	Yes	Yes	No
Geologic and Geotechnical Conditions	Borrow soil quality[a]	4	4	3	1
	Borrow rock quality[a]	2	4	3	2
	Subgrade support[a]	2	2.5	2	1.5
	Soil slope stability[a]	3	3	2	1
	Permafrost conditions[a]	2	2	3	1
Hydrology and Hydraulics	Number of bridges on new roadway	4	6	4	4
	Linear feet of bridge on new roadway	1,000	800	200	300
	Drainage culverts on new roadway	0	2	4	0
	Small fish culverts on new roadway	15	25	3	23
	Large fish culverts on new roadway	4	2	4	2

Table 5-1. Summary of alternatives analysis

Category	Criteria	South Road	Hurricane (West)	Seattle Creek (North)	Butte Creek (East)
Hydrology and Hydraulics (cont.)	New/ replacement bridges on Denali Highway	0	0	1	2
	Replacement of small fish culverts along the Denali Highway	0	0	6	13
	Replacement of large fish culverts along the Denali Highway	0	0	0	1
Fisheries and Aquatics	Salmon stream crossings	8	4	0	0
	Stream crossings requiring fish passage	23	32	15	29
Terrestrial	Caribou habitat[a]	2	2	3	3
	Moose habitat [a]	2.5	2	3	3
	Migratory duck habitat (acres)	763.5	965.3	322.1	744.7
	Swan habitat (acres)	166.4	163.6	0.0	71.3
	Bear habitat (acres)[a]	3.5	3	2.5	2
Wetlands	Category 2, 3 and 4 wetlands (acres)	226.8 [b]	553.9	699.2	544.1[b]
Fish and Wildlife Use	Sport fishing[a]	2	3	2	2.5
	Sport and subsistence hunting[a]	2	2	3	3

Category	Criteria	South Road	Hurricane (West)	Seattle Creek (North)	Butte Creek (East)
Land Status	Corridor (acres)				
	Federal lands	0	14,817	6,613	10,238
	State lands	13,719	19,443	36,042	50,634
	Native	40,828	9,521	896	896
	Private or Borough	1,692	5,160	0	818
	ROW (acres)				
	Federal lands	0	771	357	255
	State lands	417	749	1,174	1,230
	Native	1,466	300	45	45
	Private or Borough	112	66	0	0
Socioeconomics	Distance between Parks Highway junction and Cantwell (miles)	N/A	39	0	0
Costs	New road construction ($ millions)	251.2	211.5	149.1	144.0
	Denali Highway upgrades ($ millions)	0	0	14.6	31.7
	Total roadway ($ millions)	251.2	211.5	163.7	175.7

Table 5-1. Summary of alternatives analysis

Red: Not preferable **Green: Favorable**

[a] Criteria evaluated on a qualitative basis

[b] Wetland information was only available for a portion of the corridor. However, based on existing aerial photography and other information, it is believed that the unmapped portion of the corridor also contains a substantial amount of wetland.

6 Airport

Given the remoteness of the area, an airport is proposed for the project in order to be able to start construction on the dam prior to the road being complete, and to support future dam operations. It is anticipated that the airport will be used to transport construction materials and passengers to the Watana dam site. This section examines two potential airport locations identified in previous studies to validate that they are feasible. The evaluation considered the design demands of the anticipated aircraft to use the facility (the design aircraft) and examined the site's ability to accommodate an airport meeting these dimensional standards. In addition, the team examined the location to verify that approach surfaces and wind coverage would be suitable and that an airport at the location would be constructible. Finally, a cost estimate was prepared.

6.1 Airport Location and Conditions

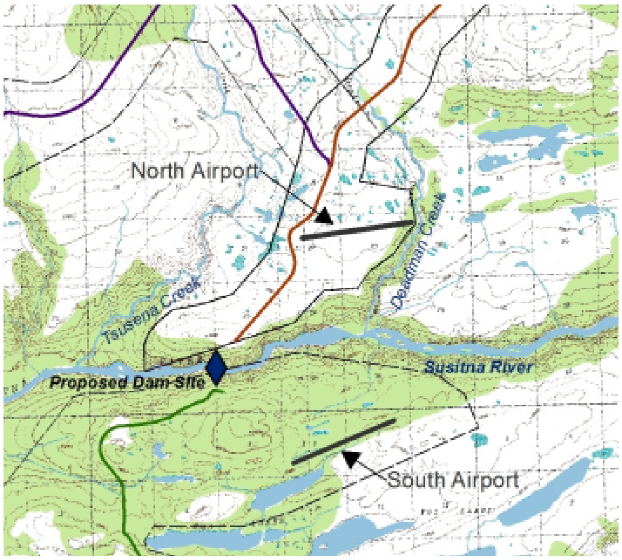

Figure 6-1. Airport alternatives

The Alaska Energy Authority (AEA) provided the project team with two potential runway alignments for validation based on work done in the 1980s: one on the north side of the Susitna River and one on the south side (see Figure 6-1). As part of the Watana Transportation Access Study, the project team identified the runway south of the Susitna River as the primary airport for the South Road alignment. This proposed location is on relatively level terrain at approximately 2,300 feet of elevation (see Figure 6-1). The site is relatively unconstrained but there are some wetlands and ponded water in the area.

The runway north of the Susitna River was identified as the primary airport for the Hurricane (West), Seattle Creek (North), and Butte Creek (East) alternatives. This site is on relatively level terrain and the proposed airport would be located on a relatively flat bench of tundra at roughly 2,300 feet of elevation (see Figure 6-3). The site is constrained by Deadman Creek on the east and wetland areas to the west.

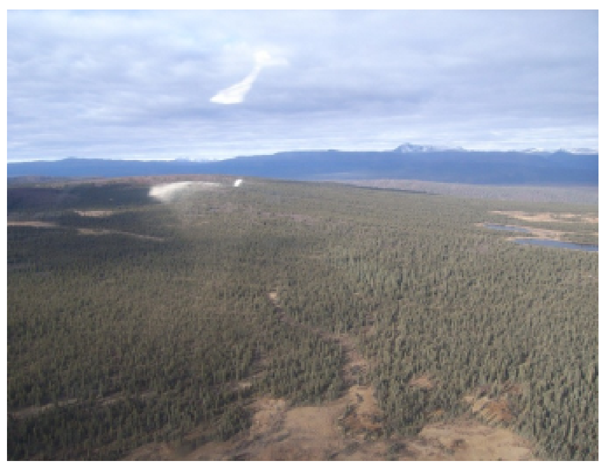

Figure 6-2 Proposed South Airport Location Wet tundra, relatively flat, with mountainous terrain in the distance

6.2 Design Aircraft and Airport Features

Design Aircraft. The team first selected a design aircraft and determined the required runway length and dimensions required to accommodate that aircraft. AEA suggested a Lockheed L-382 aircraft as the design aircraft, and DOT&PF asked the project team to evaluate a Boeing 737-200 aircraft.

Runway Dimensions. Based on Federal Aviation Administration (FAA) runway length criteria, a gravel runway that is 6,500 feet long by 100 feet wide would accommodate both of these aircraft types.[36] The runway safety area would need to be 8,500 feet long by 500 feet wide to meet FAA requirements (see Figure 6-4 and Figure 6-5).

Figure 6-3. Proposed North Airport location
Wet tundra terrain, relatively flat, with mountainous terrain far enough from the site to proved safe approaches into the airport.

Apron Dimensions. A 400-foot-long by 200-foot-wide apron (8,000 square feet) is recommended as a reasonable, workable apron size, based on the anticipated need of having two aircraft unloading/loading supplies or personnel at the same time[37]. The proposed apron could easily accommodate two lease lots in the proposed 400-foot by 200-foot configuration. The apron could be expanded for additional lease lots if needed or desired in the future. The apron would be set back 500 feet from the runway centerline in accord with FAA requirements.

Parallel Taxiway. A parallel taxiway is a desired feature of:

- Airports that use instrument approaches and generally have less than one mile visibility
- Airports where aircraft landings and takeoffs are often delayed by aircraft taxiing on the runway

The current proposal does not include the construction of a parallel taxiway and one is not recommended at this time.

A runway with these specifications meets all FAA design criteria for these aircraft.

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[36] A runway of this size would accommodate aircraft currently being used by at least three cargo carriers (Lyndon, Northern Air Cargo, and Everett).
[37] This was not based on a specific logistics study, but rather was based on experiences of constructing the Trans Alaska Pipeline. The apron size should be re-evaluated after a logistics plan is developed for the project.

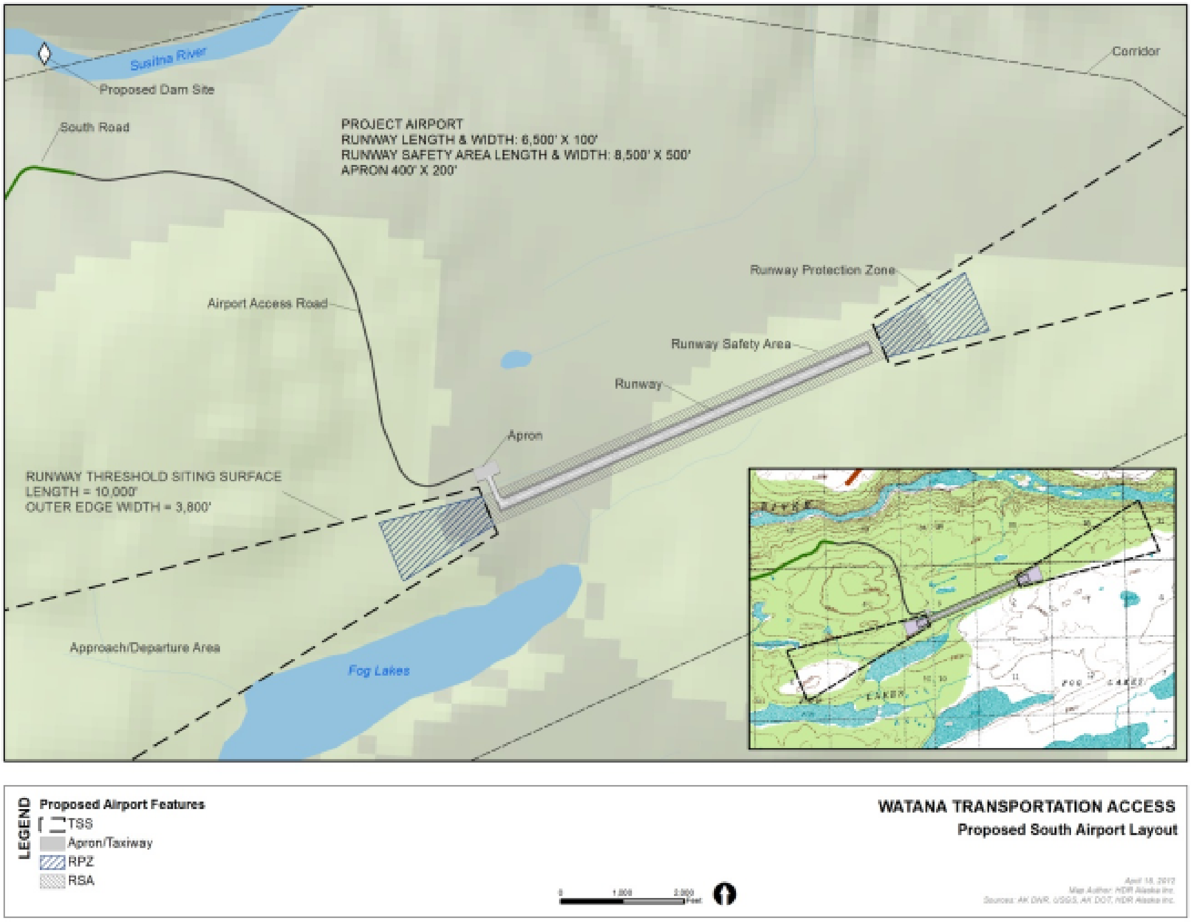

Figure 6-4. Proposed South Airport layout

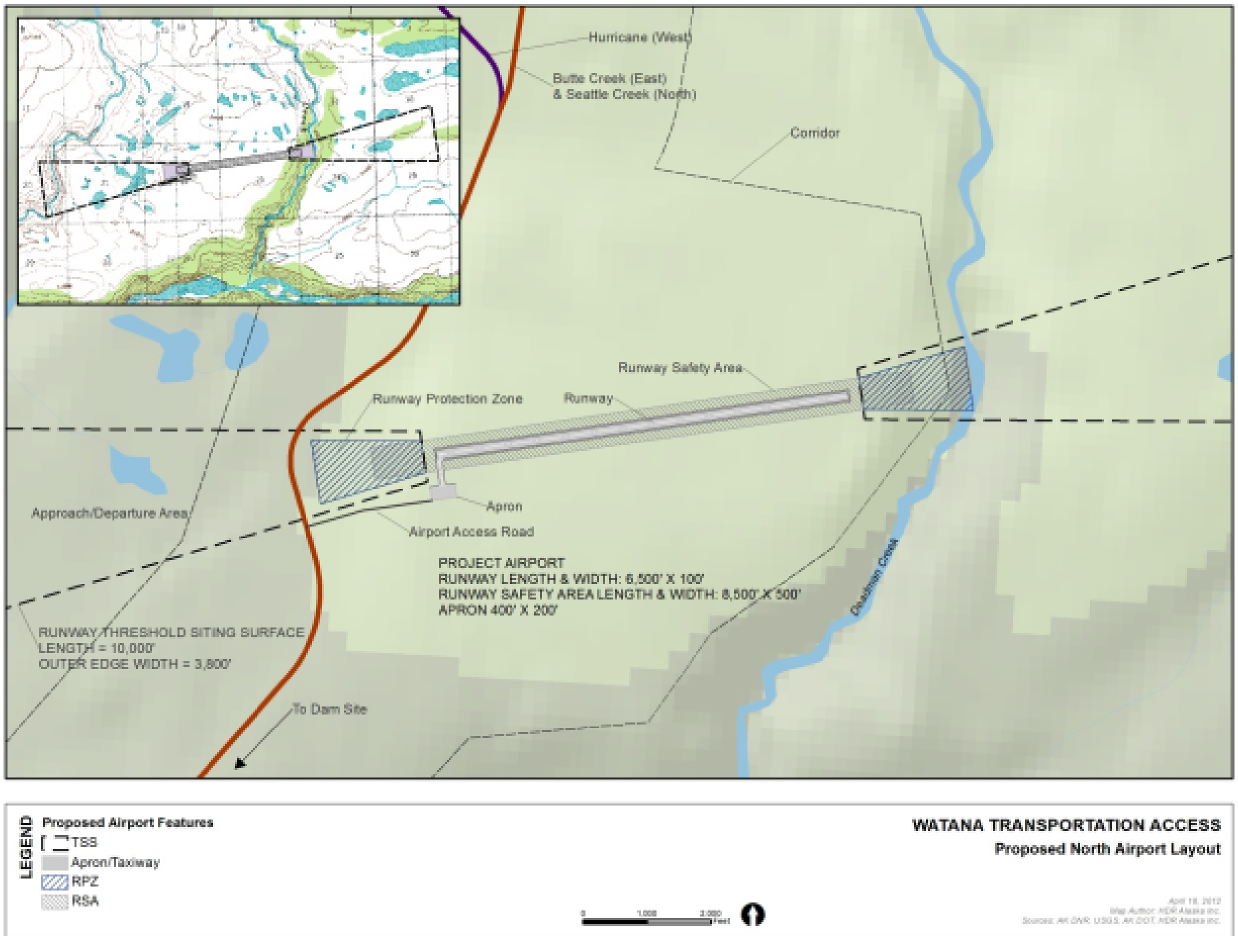

Figure 6-5. Proposed North Airport layout

Passenger Facilities. It is anticipated that typical passenger aircrafts include Beech 1900, De Havilland Twin Otter, and CASA 212. As these aircraft hold fewer than 30 seats, it is anticipated that the airport should not require an Airport Operating Certificate under 14 CFR 139.[38] As a non-certified airport, it will not require fire fighting and rescue equipment.

Airport Access Road. An airport access road will be needed to connect each alignment to the airport. The airport access road is anticipated to have the same design criteria as the alignment.

[38] Alaskan airports that serve aircraft with fewer than 30 seats are exempt from Federal airport certification requirements (FAA 2011)

6.3 Runway Approaches

In addition, the project team evaluated the runway approaches to verify the approaches have sufficient clearances for safe operations.

6.3.1 South Airport

The runway elevation will be approximately 2,350 feet. With the proposed runway orientation, there are no object penetrations to the threshold siting approach slope as defined by FAA Advisory Circular 150/5300-13 CHG 12 (Line 9 of Table A2-1 in Appendix 2).

When approaching the runway from the west (landing to the east), there is a hill with an elevation of 2,630 feet and 3.4 miles out from the airport, along the runway centerline; and a second hill 2,500 feet in elevation and 1.5 miles out from the airport. Both of these hills are below the threshold siting approach slope in Table A2-1. The precision instrument imaginary surface extends 9.5 miles (50,000 feet) from the runway. The 2,630-foot hill will be approximately 250 feet below the specified approach slope; and the 2,500-foot hill will be approximately 85 feet below the specified approach slope used to land at the runway under instrument conditions. Consequently, the hills should not be a factor for establishing an instrument approach on the west side of the runway. Should a more detailed survey or the final design of the runway change any of the parameters, the hills could be modified to eliminate the approach slope penetration.

When approaching the runway from the east (landing to the west), there is no high terrain within 9.5 miles of the runway threshold along the extended runway centerline that would affect the approach siting surface meaning a precision instrument approach would also be established on the approach from the east. All the terrain encompassed by the Part 77 precision approach imaginary surface is below the runway elevation.

The runway location was also checked to determine the ability to better orient the runway for wind coverage. The proposed location provides some flexibility for changing the runway bearing or orientation before airspace penetrations would create issues. The runway can be rotated clockwise 15 degrees and counterclockwise 19 degrees from the orientation shown before encountering terrain penetration of the FAR Part 77 precision approach imaginary surfaces.

6.3.2 North Airport

The runway elevation will be approximately 2,400 feet. With the proposed runway orientation, there are no object penetrations to the threshold siting approach slope as defined by FAA Advisory Circular 150/5300-13 CHG 12 (Line 9 of Table A2-1 in Appendix 2).

When approaching the runway from the west (landing to the east), there is a hill with an elevation of 4,056 feet 11 miles out from the airport, along the runway centerline. This hill is beyond the outer edge of the precision instrument runway imaginary surface[39] used to define obstructions to navigable airspace. The precision instrument imaginary surface extends 9.5 miles (50,000 feet) from the runway. There are no other terrain penetrations to the imaginary surfaces to a precision approach from this direction. This 4,056-foot-high hill will be approximately 1,440 feet below the approach slope used to define obstructions for landing under instrument

[39]The runway imaginary surface is defined in 14 CFR 77.19of the Federal Aviation Regulations Part 77.

conditions and should not be a factor for establishing an instrument approach on the west side of the runway.

Figure 6-6. Ponded water and terrain west of the North Airport's western end

When approaching the runway from the east (landing to the west), the nearest high terrain is 13 miles from the runway threshold along the extended runway centerline (see Figure 6-6), meaning a precision instrument approach would also be established on the approach from the east. All the terrain encompassed by the Part 77 precision approach imaginary surface is below the defined obstruction elevation.

The runway location was also checked to determine the ability to better orient the runway for wind coverage. The proposed location provides some flexibility for changing the runway bearing or orientation before airspace penetrations would create issues. The runway can be rotated clockwise 17 degrees and counterclockwise 21 degrees from the orientation shown before encountering terrain penetration of the FAR Part 77 precision approach imaginary surfaces.

6.4 Runway Wind Coverage

To determine if the runway locations were feasible, the project team also looked at whether the proposed location and alignment can meet FAA wind criteria for an airport. For this analysis the project team conducted a wind analysis (based on AC 150/5300-13 Appendix 1) using wind data collected in the 1980s and FAA's wind rose program. The project team concluded that both of the proposed runways meets FAA's goal of 95 percent wind coverage and neither would require a cross-wind runway.

As noted above in section 6.3 runway approaches, mountainous terrain is far enough from the runway that mechanical turbulence caused by terrain is not anticipated to be a substantial concern. For more detailed discussion on the wind analysis, please see Appendix L.

6.5 Constructability

Both potential airport locations would be located on relatively flat, dry terrain. Standard arctic engineering principles for construction are anticipated. For the south airport, there are no limiting creeks or drainages, but there are some lakes that should be avoided. A more detailed mapping effort could allow the proposed runway to shift to miss wetland features that might be identified.

For the north airport, Deadman Creek to the east is a constraining feature. To the west, the proposed runway is wetter, with standing ponded water and wetlands. Wetland fill in the tundra area is anticipated to be required. Based on aerial reconnaissance of the proposed locations, the terrain and conditions appear to be suitable for a runway.

6.6 Cost

As both airports are the same size and have the same features, the cost is estimated to be the same for each airport. The estimated total construction cost is $36.7 million dollars and it is estimated to take between 1 and 2 years to construct.

6.7 Conclusion

Both potential airport locations near the proposed Watana Dam site appears feasible. An airport with a 6,500-foot-long by 100-foot runway would accommodate the likely design aircraft. Both sites have sufficient room and terrain conditions to accommodate this airport with standard construction techniques and would avoid and minimize involvement with streams and wetlands. Both sites have sufficient airspace for safe approach surfaces and wind coverage is good. Both sites offer flexibility to rotate the runway about its access during design, based on additional wind data and design and environmental information, and still provide for safe approaches.

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